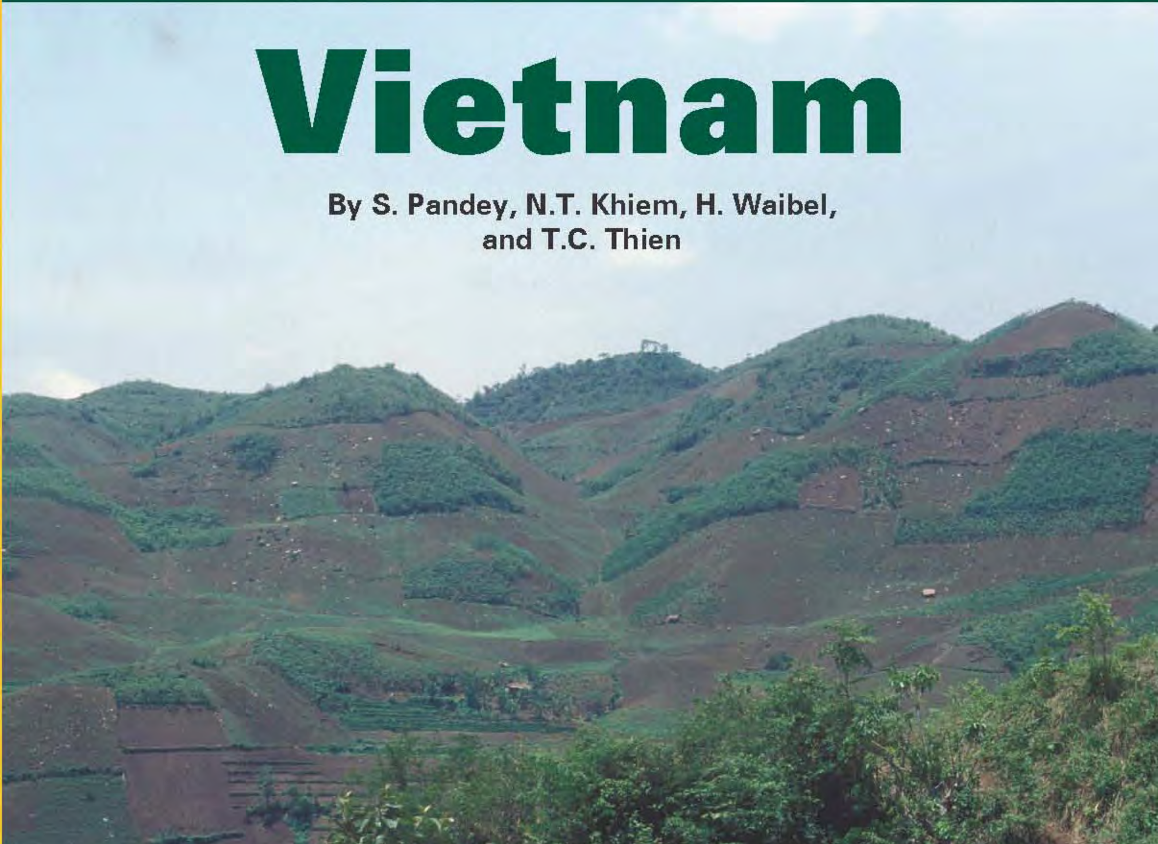
Upland Rice, Household Food Security, and Commercialization of Upland Agriculture in Vietnam



By S. Pandey, N.T. Khiem, H. Waibel, and T.C. Thien

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Mailing address: DAPO Box 7777, Metro Manila, Philippines
Phone: +63 (2) 580-5600
Fax: +63 (2) 580-5699
Email: irri@cgiar.org
Web: www.irri.org.
Rice Knowledge Bank: www.knowledgebank.irri.org
Courier address: Suite 1009, Security Bank Center
6776 Ayala Avenue, Makati City, Philippines
Tel. +63 (2) 891-1236, 891-1174, 891-1258, 891-1303

Cover: Photo on the front cover shows upland rice fields that are ready for sowing. Back cover: Upper-left photo shows method of sowing rice seeds using a stick; upper-right photo shows method of drying and storing rice panicles; lower photo shows rice landscape consisting of upland rice in the foreground and on sloping fields, forest on the mountain top, and paddy rice on terraces.

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Contents

Foreword

Addressing the problems of hunger, ill health, and environmental degradation in regions of extensive poverty is now firmly placed on the agenda of international development agencies and national governments. IRRI's new Strategic Plan 2007-2015, *Bringing Hope, Improving Lives*, has the goal of reducing poverty, food insecurity, and environmental degradation as its centerpiece. Large parts of the Asian uplands are characterized by high incidence of poverty, poor physical access to markets, ill-functioning marketing institutions, and subsistence-oriented agriculture with low productivity. Rising population pressure and the consequent intensification of marginal areas for food production have contributed to environmental degradation and a further reduction in agricultural productivity. Upland areas are caught up in a vicious circle that perpetuates poverty, food insecurity, and environmental degradation. Development strategies must therefore seek to achieve a sustainable reduction in poverty and food insecurity while protecting the environmental functions of uplands.

Given the importance of rice as a staple crop, interventions that increase rice productivity can serve as a critical entry point in initiating and reinforcing the process of agricultural growth and income generation in uplands. Improved technologies for rice-based systems will promote income-generating activities by freeing household resources that are currently tied up in meeting food needs. Achieving household food security and income growth can thus be seen as complementary and mutually reinforcing goals. Increases in productivity will also help protect the fragile upland environment by reducing pressure to intensify food production in steeply-sloping fields and forest margins. In this way, improved productivity of upland rice-based systems can contribute substantially to achieving the Millennium Development Goals.

The potential role of improvements in food crop productivity and other livelihood strategies that are based on indigenous resources in facilitating pro-poor growth in remote areas, however, is not fully appreciated in policy circles. The belief in the success of rapid agricultural commercialization is strong and therefore investment in the improvement of food crop production is often neglected. The nature and role of food production in uplands in farmers' livelihood are inadequately understood as food production is practiced mainly by socially and politically marginalized ethnic minorities. As a result, varying perceptions regarding upland agriculture tend to color policy decisions.

This research monograph, based on a detailed microeconomic study of rice farmers in the uplands of northern Vietnam, throws light on the role of upland rice in farmers' livelihood systems in this remote area that is still lagging behind in development. We hope that the findings of this study will be helpful in both guiding rice research for productivity enhancement and formulating policy interventions for encouraging an inclusive and pro-poor growth process.

Robert S. Zeigler
Director General, International Rice Research Institute

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CHAPTER 1

Introduction

Vietnam's success in achieving rapid agricultural growth since the implementation of policy reforms in the late 1980s is now well documented (World Bank 2004). Agricultural growth was fueled mainly by growth in rice productivity following the rapid adoption of modern varieties, increased fertilizer use, and increased cropping intensity. The policy reforms created the right economic incentives for farmers to adopt yield-increasing technologies. Rice production grew at more than 5% per annum during the early 1990s and Vietnam rapidly achieved the status of a major exporting country.

The economic growth of Vietnam during the 1990s was impressive, with a real annual growth in GDP per capita of over 4% throughout the nineties. Growth in Vietnam was also "pro-poor." In 1993, the incidence of poverty in Vietnam was 58.1%. By 2002, this had fallen to 28.9% (Vietnam Development Report 2004). Even though there was some slowdown in the wake of the East Asian financial crisis, Vietnam's economic growth accelerated strongly after the crisis and this has had a strong effect on poverty reduction. After the crisis, the aggregate headcount index of poverty fell to 29% in 2002 and it is expected to fall further to 19% by 2010. In part, this improvement can be linked to a series of policy measures to strengthen the private sector and gradually move the country toward a market-based economic system.

Despite these economic achievements, concerns are now being expressed about growing economic disparities in Vietnam. Market liberalization, while unleashing the process of economic growth, may have exacerbated regional economic disparities. While economic growth in the deltas has been rapid, the Central Highlands and Northern Uplands have experienced a much slower growth. The poverty rates in these regions for 2002 exceeded 40%. In some regions of the northern mountains, poverty rates are reported to be as high as 68% (Vietnam Development Report 2004). Inequity in income distribution has also increased over time (Vietnam Development Report 2004), that is, growth in these regions was not sufficiently pro-poor.

This regional imbalance in growth and poverty reduction calls for a reexamination of the development strategies. The market-based strategy pursued by the government of Vietnam earlier appears not to be able to achieve sufficient poverty reduction in the uplands, especially in the Northern Uplands. There are several reasons for this, among which the major one is inadequate investment in marketing infrastructure and in institutional capacity building (Justino and Litchfield 2002, Vietnam Development Report 2004). When a market-based strategy is adopted in the absence of such support measures, high fluctuations in the market price of cash and food crops are the ultimate consequence. This can increase the probability of households falling back into poverty by making them more vulnerable to income shocks. In addition, socially and politically marginalized ethnic minorities that mainly inhabit these areas often are not well placed to rapidly exploit emerging market-based economic opportunities to their full advantage. The incidence of food insecurity in these areas is high. The fact that Vietnam has become a major rice-exporting country bears no relationship to the economic welfare of these groups whatsoever. Poverty and food insecurity due to various types of market failure ultimately contribute to environmental degradation such as deforestation, soil erosion, and loss of biodiversity in upland areas. Thus, addressing the food insecurity and poverty problems of these upland areas has emerged as an important concern of national policymakers in Vietnam in recent years. This is attested by the implementation of a major program (Program 135) aimed at improving the economic well-being of the poor and ethnic minorities in remote areas that have not benefited directly from the market-driven growth of the national economy.

Inducing pro-poor growth in these areas that are still largely characterized by subsistence agriculture may depend critically on tackling the cause of low food productivity. Development of improved technologies for food production specifically targeted to these areas can hence be a component of a pro-poor growth strategy. Such technologies, backed up by supporting policies, can overcome the problem of food insecurity by increasing the household food entitlement and can thereby contribute to poverty reduction directly. In addition, improvements in food security can encourage households to diversify into income-generating activities that provide an important pathway for escape from poverty.

The potential role of improvements in food crop productivity and other livelihood strategies that are based on indigenous resources in facilitating pro-poor growth in remote areas is, however, not fully appreciated in policy circles. The belief in the success of rapid agricultural commercialization is strong and therefore investment in the improvement of food crop production is often neglected. Being practiced mainly by socially and politically marginalized ethnic minorities, the nature and role of food production in uplands in farmers' livelihood are inadequately understood. As a result, varying perceptions regarding upland agriculture tend to color policy decisions. One of these misperceptions is to put the blame solely on shifting cultivators for environmental degradation of uplands.

The focus of this study is on the Northern Uplands of Vietnam. Rice is a major food crop that is grown in dryland (or upland) conditions on mountain slopes as well as in wetland conditions in valley bottoms and in terraced fields. It is a subsistence crop for most farmers. In areas with better access to markets, farmers have now started to grow a range of cash crops. Rice production, however, still dominates agricultural activities in the region.

Study objectives

The specific objectives in this research are

- to investigate the role of subsistence production in the livelihood systems of upland farmers of Vietnam,
- to better understand the role of upland rice in achieving household food security,
- to assess the potential impact of improvements in rice technology on the commercialization potential of upland agriculture, and
- to derive implications for technological and policy interventions aimed at sustainable agricultural growth of uplands.

Uplands and upland rice: an overview

Uplands are considered as lands on which agriculture is practiced in nonirrigated fields that do not hold impounded surface water. This condition is mostly satisfied in mountainous areas; hence, uplands are often considered to refer to mountainous terrain, but this is not always the case. Upland conditions can occur at lower elevations also. Similarly, upland areas do not have to be sloping; they can be flat also, as is the case of much of South Asian uplands.

Upland rice is dryland rice grown in soils that do not hold rainwater for a considerable period of time. After rains, water drains out of these fields fairly rapidly, so that crops grow in soils that are "aerobic." Upland rice thus grows in hydrological conditions similar to those of other upland crops such as wheat and maize.

Upland rice is grown on about 14 million hectares worldwide. It accounts for about 11% of the world rice area and contributes 4% of the total rice output. Of the 14 million ha of upland rice area, Asia accounts for two-thirds, with Latin America and Africa having an equal proportion of the remainder. Of the 9 million ha of upland rice area in Asia, South Asia accounts for about 60%, with the remainder being in Southeast Asia. As upland rice is mostly grown in rotation with other crops, the actual area under upland rice-based systems is much larger. Assuming a 3-year rotation, the area under upland rice-based systems in Asia is estimated to be about 27 million ha. About 100 million people depend on these systems for their livelihoods.

Upland rice systems are highly heterogeneous, with the climate varying from humid to subhumid and soils varying from fertile to highly infertile. Upland rice is also grown on flat to steeply sloping areas. Cultivation practice ranges from shifting to permanent. In Sri Lanka, Bangladesh, and India, most rice is grown on permanent agricultural land. Shifting cultivation is more common in Laos, Vietnam, the Philippines, and Indonesia, although the area under this system has decreased over time.

The crops grown in uplands also vary across these environments. Upland rice farmers grow a range of nonrice crops such as maize, millets, yams, beans, and cassava. Upland rice is grown as a monocrop or as an intercrop. Despite this diversity, a general feature of the upland system is that it is inhabited by very poor farmers who grow food crops mainly for subsistence using very few inputs other than labor. Upland areas are often remote, with poor access to markets. They are also generally inhabited by ethnic minorities that tend to be socially and politically disadvantaged.

Rice is a crucial component of the diet of upland households. However, its yield is generally low. The average yield of upland rice is estimated to be about 1.5 t ha^{-1}. At the aggregate level, the average yield of upland rice in Asia is considered to be much lower than that for irrigated areas (5 t ha^{-1}) and rainfed lowlands (2.3 t ha^{-1}).

The growth rate in the yield of upland rice has been modest during the past 25 years, indicating that the Green Revolution that led to a rapid growth in yield in irrigated areas has had almost no direct impact on rice productivity in the Asian uplands. The observed growth in yield is probably due to the gradual concentration of upland rice in the relatively more favorable areas. Upland rice production practices have changed little, except in some locations such as in southern Yunnan (China), with farmers mostly growing traditional varieties. The low observed yields, however, do not imply that high yields cannot be achieved when farmers apply fertilizer and other inputs (George et al 2001).

Methodological approach

The study uses a farm household modeling framework for analyzing upland farmers' choices regarding food and cash crop production. Econometric analyses based on household survey data are also conducted to identify factors that explain interhousehold differences in the level of food security, land productivity, and poverty. These analyses illustrate the effect of major drivers of change such as rising population pressure and increasing access to markets on cropping choices and household food security. Detailed cross-sectional farm-level data are analyzed to test a set of hypotheses that elaborate the role of upland rice in households' livelihoods.

Study outline

This study consists of nine chapters. An overview of the nature of production systems and patterns of changes occurring in the Northern Uplands of Vietnam is provided in Chapter 2. Major policy initiatives taken by the government of Vietnam for the uplands and their impact are also discussed in Chapter 2. Chapters 3 and 4 discuss the conceptual and analytical framework for the study. In addition, major hypotheses investigated in the study are covered in Chapter 4. Chapters 5 through 8 provide results of empirical analysis based on econometric models, a linear programming model of a representative farm household, and a simulation analysis of future patterns of change in the uplands of Vietnam. A synthesis of findings, conclusions, and recommendations based on the study appear in the final Chapter.

CHAPTER 2

Characteristics of upland systems and recent development trends

An overview of the characteristics of upland systems of Vietnam and the patterns of changes in land use occurring in these areas in the context of overall agricultural growth of Vietnam is provided in this chapter. Several policy initiatives have been undertaken by the government of Vietnam to address the issue of upland development and an overview of these policies and programs is also provided. This serves as a background to the issues analyzed in the empirical section of this study.

Features of upland systems of Vietnam

With a total land area of 33 million ha, Vietnam has a wide range of latitudes and altitudes and a wide variety of landforms stretching for more than 1,600 km from north to south. Two-thirds of the natural area is classified as uplands, covering highland area with elevation over 500 m and midlands with elevation from 50 to 500 m. More than 50% of the upland areas have slopes higher than 20 degrees. The Northern Uplands[1] represent the largest upland environment (11.6 million ha or 35% of the national territory) of Vietnam and are the most diversified topographically and ecologically. Although referred to simply as the Northern Uplands, a number of flat intermountain basins and narrow river valleys provide the basis for a settled population growing wetland rice.

The climate in the Northern Uplands is monsoonal, with an average yearly rainfall of 1,600 to 2,500 mm largely occurring from late April to October. During the winter months of December to February, northern cool winds bring a period of prolonged cloudiness, high humidity, and light rains. The soils are acidic and have low fertility. Intense rainfall combined with steep topography make the region highly susceptible to soil degradation and erosion (World Bank 1995).

[1]Prior to 1999, the region was referred to as the Northern Mountains and Midlands. In 1999, the region was divided into northeast and northwest. The northeast currently has 11 provinces (Ha Giang, Cao Bang, Lao Cai, Bac Kan, Lang Son, Tuyen Quang, Yen Bai, Thai Nguyen, Phu Tho, Bac Giang, and Quang Ninh). The northwest has three provinces (Lai Chau, Son La, and Hoa Binh).

Table 1. Forest cover, deforestation, and barren land in Vietnam, 1943-2002.

Region	Land area (000 ha) 1991	Forest cover (% of land area)[a]				Barren land (% of land area) 1993
		1943	1991	1997	2002	
Northern Mountains[b]	7,645	95	17	18	–	60–65
Northern Midlands[b]	3,982	55	29	27	37	27–33
Red River Delta	1,030	3	3	4	7	5–14
North-Central Coast	4,002	66	35	36	35	40–44
South-Central Coast	4,582	62	32	36	55	42–49
Central Highlands	5,557	93	60	56	44	25–32
Southeast Region	2,348	54	24	21	30	23–34
Mekong River Delta	3,957	23	9	7	8	12–21
Totals	33,104	67	29	30	36	35–42

[a]In a recent report, total forest cover of 1999 was estimated at 33% (Nhan Dan Daily, April 2000). National statistics reported in the 2002 Year Book show that the proportion of land classified as forest land that has tree cover stands at 35%. The large increase in percentage of forest cover in 1997-2002 might be partly due to a redefinition of forest land and land covered with trees.
[b]Mountains and midlands were later combined into uplands.
Sources: World Bank (1995), Vietnam Environmental Program and Priorities for a Socialist Economy in Transition and GSO (1998-2002), Hanoi.

The Central Highlands are the second largest upland region bordered by mountain chains on the west side and a large flat plateau on the east. They constitute 1.8 million ha of soils of basaltic origin that have good potential for crop production. Another upland environment is the Southeast Region, sometimes referred to as the “Northeast of Mekong.” It includes a large flat expanse of land or slightly sloped hills with yellow-red and degraded gray soils that are acidic and of low fertility. Compared with the Northern Uplands, the Central Highlands and Southeast Region are less susceptible to erosion.

One of the distinctive features of the upland systems in Vietnam is the existence of rainfed or irrigated lowland fields and upland fields within a single village or among a cluster of villages. This is particularly the case in the Northern Uplands, where mountains and sloping hills are intersected by small basins and river valleys forming narrow, flat lowland fields.

Deforestation

In 1943, Vietnam had 67% of its area covered in natural forest, but the forest cover decreased to only 30% in 1997 (Table 1 and Fig. 1). At least 13 million ha of forest was lost during the last 50 years (World Bank 1995, GSO 1998). The Northern Uplands experienced the greatest loss, with forest cover dropping from 95% to 17% in 48 years. The decrease in forest cover in this region was driven by the rapidly growing population’s demand for forest products and agricultural land. The net deforestation rate was highest from 1975 to 1983. The high demand for timber resulted from a high demand for postwar construction and increased exports. The problem of overcultiva-

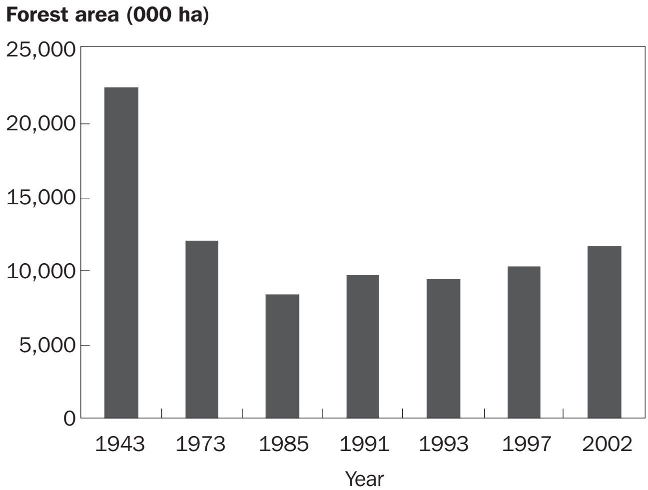

Fig. 1. Total forest area in Vietnam, 1943-2002. Source: GSO (1998-2002) and World Bank (1995).

tion and shortened fallow period is particularly acute in the region because of the high percentage of unstable land (World Bank 1995, GSO 2002). Deforestation and soil degradation have rendered a large proportion of the upland environment barren or unused land (Jamieson 1998).

Policy reforms initiated in the early 1980s provided an improved land-tenure system. The allocation of forest land to households and the promotion of reforestation programs have resulted in a reduced rate of deforestation (Son 2001). However, the problem of deforestation still persists.

Ethnicity and land use

There are 54 officially recognized ethnic groups in Vietnam. The Kinh or the Vietnamese lowlanders account for 87% of the population. The Northern Uplands are the home to most of the minority ethnic groups. About 12 million people of 31 ethnic groups belonging to 7 language groups live in this region. The Tay, Thai, Nung, Hmong, Muong, and Dzao account for most of these ethnic minority groups. Of the 109 districts and towns in the Northern Uplands, 59 districts have ten or more ethnic groups (Khong Dien 1995, Vien 1997).

Based on ecological and ethnic variables, upland agriculture can be classified into three categories (Cuc 1996, Vien 1997, Yanagisawa 1997). Agriculture based on shifting cultivation is practiced by the Dzao and Hmong on sloping lands usually above 800 m in altitude. The Thai, Tay, Nung, and Muong groups who settled on lower slopes (elevation 200–300 m) specialize in wet-rice cultivation. A mixture of the Kho Mu, Xin Mun, and Ha Nhi is found on the medium slopes (300–800 m). Upland cultivators on the medium slopes simultaneously maintain a number of wetland paddy plots and

Table 2. Agricultural land, forest land, and unused land per capita (ha) in agroecological regions of Vietnam, 2001.

Region	Agricultural land	Forest land	Unused land	Total area
Northern Uplands[a]	0.11	0.34	0.40	0.88
Red River Delta	0.05	0.01	0.01	0.08
North-Central Coast	0.17	0.51	0.42	1.17
South-Central Coast	0.05	0.11	0.13	0.32
Central Highlands	0.19	0.44	0.15	0.80
Southeast Region	0.14	0.08	0.03	0.28
Mekong River Delta	0.18	0.02	0.02	0.24
Vietnam	0.12	0.15	0.12	0.41

[a]Combination of midlands and mountains.
Source: Agricultural Census (2002), GSO, Hanoi.

swidden upland plots (Vien 1997). The historical association among altitude, ethnicity, and cultivation practices has weakened somewhat, however, in recent years (Castella et al 2002).

Demographic change and population density

A combination of higher birth rate and lower mortality rate due to improved health services resulted in a population growth rate of over 2% per annum during the 1970s and 1980s in many highland communities. In addition, the internal population growth was augmented by the migration of lowlanders from the Red River Delta. The Northern Uplands alone experienced an increase in population of more than 300% from 1960 to 1984. The population of the Kinh in the region increased more than fourfold from 1960 to 1989 (Institute of Ethnology 1995). Population growth has declined, however, in recent years to around 1.4% per annum (GSO 2003).

There is a high spatial variation in the population growth rate, which is higher in the northwest than in the northeast. In most of the remote provinces, population growth still exceeds 2% per annum.

Agricultural land per capita in the Northern Uplands at 0.11 ha is close to the national average (Table 2). However, the population density (defined as the number of people divided by the total land area) is low at 68 people per km^2. Relative to other regions of Vietnam, the Northern Uplands are less densely populated.

The region had a population of 11.6 million in 2003, giving it a population density of 115 people per square kilometer. However, the density varies considerably across provinces. The provinces in the midland region with more lowland area bordering the Red River Delta are more populated, with densities ranging from 307 people per km^2 in Thai Nguyen to 405 people per km^2 in Bac Giang. Lai Chau, located in the far northwest, has the lowest population density of 38 people per km^2. In much of the Red River Delta, the density is over 1,000 people per km^2.

Table 3. Incidence of poverty by region, 1993-2002.

Region	Headcount index (%)		
	1993	1998	2002
Northern Uplands	81	64	44
Red River Delta	63	29	22
North-Central Coast	75	48	44
South-Central Coast	47	35	25
Central Highlands	70	52	52
Southeast Region	37	12	11
Mekong Delta	47	37	23
Vietnam	58	37	29

Source: GSO (2004).

Over 1995-2003, the population growth rate for the region as a whole was estimated at 1.4% per year, though it differs widely across provinces. In general, the least densely populated provinces experienced the highest growth rates and vice versa. Lai Chau, the most sparsely populated province, has the highest rate of population growth: 2.3% per year. Son La, Lao Cai, and Ha Giang, also with low densities, have growth rates of 2.0%, 1.9%, and 2.1%, respectively. In contrast, the more densely populated provinces bordering the Red River Delta have growth rates of 1–1.5%.

Poverty

More than 80% of the poor in Vietnam live in rural areas. Within the rural sector, 54% of the poor are found in the uplands. Based on recent poverty estimates, the average incidence of poverty in the Northern Uplands is 44% compared with the national average of 29% (Table 3). According to the living standard survey conducted in 2002, per capita GDP in the Northern Uplands was US$215 and $150 in the northeastern and northwestern regions, respectively, vis-à-vis the national average of $285. The northwestern provinces are, hence, relatively poorer. District-level poverty estimates based on the 1997-98 household living standard survey indicate that many districts have a poverty ratio in excess of 80%. Among the 50 poorest districts of the country, 36 are found in the uplands, with 32 belonging to the Northern Uplands. Among the 150 poorest and second poorest districts, 99 are in the uplands (Minot 1998). Poverty in the uplands is more prevalent in remote and isolated areas and is correlated with deficiencies in infrastructure (Wiens 1998, Minot et al 2003). In addition, poverty in rural areas is closely related to agricultural productivity, with locations that have low agricultural productivity having a higher incidence of poverty (Minot et al 2003).

Vietnam has made impressive progress in overall poverty reduction during the past decade. The incidence of poverty measured as a headcount index from three rounds of the Vietnam Living Standard Survey (GSO) shows that the poverty rate

Table 4. Estimates of area under swidden agriculture and upland rice in Vietnam.

Source	Area under swidden agriculture (million ha)	Upland rice area (million ha)
NIAPP (1993)	1.4	–
Sam (1994)	3.5 (includes area under fallow)	–
Arraudeau and Xuan (1994)	8.0 (includes area under fallow)	0.45
Agricultural Census (1994)	1.0	0.20
World Bank (1995)	1.2	–

declined from 58% in 1993 to 37% in 1998 and to 29% in 2002 (Table 3). However, the percentage of population below the poverty line in the uplands is still much higher than the national average. Not only is the incidence of poverty in the Northern Uplands high, poverty is much deeper in this region relative to the national average. In their poverty mapping study, Minot et al (2003) established that poverty depth shows a strong positive correlation with the incidence of poverty. In other words, some of the poorest of the poor people live in this region.

Cropping systems and recent trends in area under various crops

The dominant landscape of the Northern Uplands is a combination of moderately flat valleys between hills and sloping uplands. The lowland part of the valleys is usually composed of flat-terraced and bunded paddy fields. Lowland fields are intensively cultivated with rice grown mainly in the summer season. A second winter-spring rice crop is also grown if irrigation water is available. Other crops planted in rotation with rice are peanuts, mungbeans, and soybeans. Lowland fields are generally covered by vegetation year-round. In addition to rice production, paddy fields are used for a range of activities: grazing of livestock on bunds and in fallow fields; fishing or foraging for aquatic animals such as fish, crabs, or snails; collection of edible weeds; and raising of vegetables on bunds.

Sloping uplands are mostly planted to upland rice, maize, and cassava under a system of shifting cultivation. Because of the rotational pattern and difficulty in collecting information on land use, estimates of cultivated upland area and production vary widely among sources. The National Institute for Agriculture Planning and Projection (NIAPP 1993) estimated that, out of 2.7 million ha of agricultural land in upland provinces, about 1.4 million ha are composed of currently cultivated swidden fields. If including the fallow area, Sam (1995) gave an estimate of 3.5 million ha under shifting cultivation in which upland rice is usually the first crop to be grown in the cropping cycle following slash and burn. The World Bank (1995) estimated the total area under the shifting cultivation system to be about 1.2 million ha (Table 4).

Food crops, mainly rice and maize, account for the dominant share of cultivated area in the Northern Uplands. Area planted to food crops accounts for 78% of the total

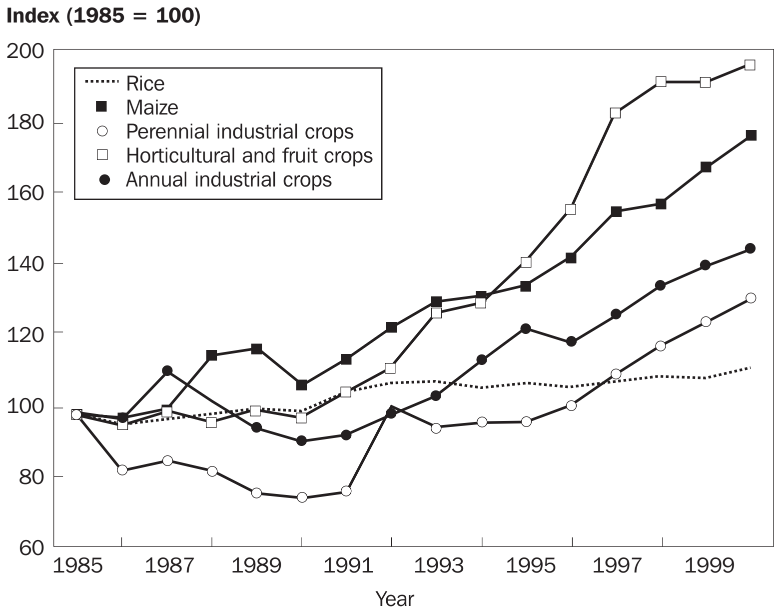

Fig. 2. Index of area planted to crops in the Northern Uplands (1985 = 100).

cropped area, in which the shares of rice and maize are 66% and 22%, respectively. In 2002, rice area in the Northern Uplands was about 0.68 million ha out of the total cultivated area of 1.4 million ha. The share of rice in total cropped area has dropped over time as the area under other crops has increased faster than the area under rice. In 2002, the share of rice in gross cropped area in the Northern Uplands was around 44% compared with 50% in 1995.

Figure 2 shows the trend of planted area of the main crops of the region. One recent development trend of the uplands is the emerging transition toward commercial agriculture. As a result, the area under horticultural and fruit crops (vegetables and beans) and maize grew most rapidly. The area of fruit trees increased from an insignificant level of 20,000 ha in 1985 to 115,000 ha in 2002.[2] Similarly, the area under annual and perennial industrial crops increased rapidly after 1994. Despite these emerging patterns of diversification, rice is still the crop that accounts for the lion's share of the total cropped area in many parts of the Northern Uplands. Although commercial crops may be more profitable in general, marketing constraints, price risks, and food security considerations may limit the allocation of household resources for their production.

[2]Diversification out of food crops toward cash crops occurred at a faster pace in the southern parts of the Central Highlands, where favorable natural conditions and the incentive of export markets induced farmers to shift from cultivating upland rice and other staples to coffee, tea, and other cash crops.

Rice area and production

With approximately 700,000 ha of rice area, the Northern Uplands account for about 10% of the total rice area and 12% of the total rice output of the country. The northeastern provinces account for 75% of the rice area of the Northern Uplands. The northwestern provinces account for a smaller share of rice area. However, upland rice is more important in the northwest than in the northeast.

In 1995, rice yield in the Northern Uplands was about 2.6 t ha^{-1} compared with 3.7 t ha^{-1} at the national level. Although productivity in the major rice-growing deltas increased rapidly following the reform, growth in the Northern Uplands was relatively sluggish, leading to this productivity gap relative to the national level. However, rice yield in the Northern Uplands increased rapidly after 1995 because of the adoption of improved high-yielding rice varieties in irrigated lowlands (mostly in provinces closer to Hanoi such as Thai Nguyen, Tuyen Quang, and Phu Tho). This increase in yield was more pronounced in the northeast than in the northwest. As a result, rice yield (4.1 t ha^{-1}) in the northeastern uplands in 2002 became close to the national average of 4.5 t ha^{-1}. In the northwest, the average yield for 2002 was only 3.2 t ha^{-1}.

Examination of province-level rice yields indicates that Son La and Lai Chau are the two provinces where yields have remained low. The average rice yields in these provinces in 2002 were only 3.0 and 2.5 t ha^{-1}, respectively. These are the two major provinces with large shares of upland rice area. Thus, despite an increase in rice productivity at the national level and in several provinces in the Northern Uplands, yields in provinces where upland rice is a dominant crop have remained relatively low.

Upland rice ecosystems in Vietnam are characterized by high degrees of environmental and socioeconomic diversity. Upland rice is grown alone or in diverse mixtures in shifting or permanent fields under a wide range of conditions of climate, slope, and soil type. Upland rice remains the principal food crop in the Northern Uplands. The estimates of area under upland vary widely, depending on the source, as shifting cultivation systems make it difficult to estimate the area accurately. Arraudeau and Xuan (1994) gave an estimate of upland rice in Vietnam of about 0.45 million ha grown by 54 ethnic groups, with 50 groups practicing shifting cultivation. As a part of the land is under fallow, they also estimated that the total area under the upland rice system was approximately 8 million ha. Based on the 1994 Agricultural Census, an estimate of the annual area planted to upland rice can be derived at about 0.2 million ha. Given the shifting cultivation practice for growing rice and the average fallow period of 5 years, the total area under rice-based systems is approximately 1 million ha. This estimate is somewhat close to that of the Ministry of Agriculture and Rural Development (MARD 1998) and the estimate provided by Sam (1994). Table 4 summarizes the different estimates of the area under swidden cultivation and upland rice. Based on data from GSO, the current area of upland rice in the Northern Uplands is estimated to be 85,000 ha (Table 5). This area is distributed nonuniformly across provinces, with Son La and Lai Chau having as much as 60% of the total rice area in uplands.

Table 5. Rice area in selected provinces of the northern mountains.

Province	Total rice area (000 ha)	Upland rice area (000 ha)
Ha Giang	29.5	4.7
Tuyen Quang	41.7	1.7
Lao Cai	32.4	10.4
Yen Bai	39.2	6.3
Son La	43.0	25.8
Lai Chau	46.1	26.7
Cao Bang	28.6	2.9
Thai Nguyen	83.6	3.3
Total	344.1	81.8

Source: GSO (1998), Hanoi.

In general, there has been a declining trend in upland rice area in Vietnam. The decline has been most rapid in the Central Highlands, where favorable physical and market conditions exist for growing high-income cash crops. Upland rice in these regions is being replaced by coffee, feed maize, and sugarcane. The trend in upland rice area in the Northern Uplands is less apparent and more varied across provinces. Upland rice, however, continues to play a vital role as the main source of food for millions of people, most of whom are poor and belong to ethnic minorities. Sam (1994) estimated that, among the 9 million ethnic minority people living in the upland area, 2.9 million people made their living from swidden agriculture. Their main subsistence food derives from upland rice.

Major policy initiatives for the development of uplands in Vietnam

Major policy initiatives implemented by the government of Vietnam for upland development include the resettlement of lowlanders to the uplands, the sedentarization and resettlement of shifting cultivators, promotion of tree planting, and introduction of technologies to improve the productivity of paddy fields and upland crops. Table 6 summarizes the major policies and programs targeted to the uplands since the 1960s.

Since the early 1960s, the government has encouraged the official settlement of 4.8 million people under the population redistribution program designed to develop the mountainous rural sector, increase rural employment opportunities, and strengthen national defense. Most of this migration and resettlement was within the region. About one million people were encouraged to migrate from the Red River Delta to the Northern Uplands.

After reunification of the country in 1975, another resettlement campaign was implemented during 1975-89. Among the 2.4 million people officially resettled from 1981 to 1990, about 1.8 million moved within their own provinces and about 0.6 million moved from the Red River Delta and North Central Coast to southern provinces

Table 6. Government programs and policy toward uplands.

Program	Objective and contents	Time span
Resettlement	Population redistribution, reduction of lowland population pressure	1968-89
Sedentarization of Shifting Cultivators	Reduction of swidden cultivation practices	1968 onward
Hunger Eradication and Poverty Alleviation	Subsidies and donation of agricultural inputs	1992
Law on Forest Protection and Land Law	Forest protection, encourage forest planting	1993
Forest Land Allocation Program	Allocation of forests to individuals for protection of forests	1992
Program 327	Greening of barren land	1992-98
5 Million Hectare Reforestation Program (5MHRP)	Five million ha, framework for Forest Sector Development, transfer of forest protection to smallholders	1998-2010
Program 135	Infrastructure of remote communes	1998-2010

and the Central Highlands. After 1989, most of the migration was spontaneous or "illegal." Spontaneous migration to the Central Highlands accounts for nearly 1.5 million people since 1989.

The "Sedentarization of Shifting Cultivators Program" has been the main source of intraprovincial migration in the uplands. It is also one of the most important programs targeted toward approximately three million shifting cultivators in the mountainous area. The main objective of the program, which began in 1968, is to stabilize the cultivation practices of ethnic minorities. After more than 20 years of the program, 66% (1.9 million people) of the originally targeted population has adopted permanent settlement (World Bank 1995).

The Law on Forest Protection and Development of 1991 and the Land Law of 1993 reaffirm the legality of the long-term allocation of land, including forest land, to households for agricultural purposes and for forest production. As a general guideline, each household can be allocated 1–2 ha of agricultural land and 5–10 ha of forest land. The terms of land-use rights on agricultural land are 20 years and 50 years on forest land or land planted to perennial crops. Land-use rights can be renewable, inherited, transferred, mortgaged, and exchanged, with suitable compensation provided in the case of appropriation by the government. Tachibana et al (1998) found that land allocation and stablility of land tenure in the Northern Uplands induced increased crop yields and reforestation of formerly barren hills.

Decree 327 promulgated in September 1992 set out "the guidelines and policies to utilize unoccupied land, barren hilly areas, forests, denuded beaches, and waterfronts." Program 327 was initially set as a ten-year program. The primary goals of the highland portion of the program were to stabilize settlement villages and sedentarize the itinerant shifting-agriculture population by developing the barren uplands, with emphasis on linking agriculture, livestock, and forestry and to increase the protection of reserved forest and head watersheds. The program provided a package of initial investment in infrastructure, financial incentives in the form of interest-free credits, tax cuts and tax exemptions, and legal provisions applied to barren-land development. The three major activities were the settlement of lowland farmers, the settlement of itinerant highland cultivators, and agricultural intensification in sedentary highland communities.

After six years, Program 327 was cut short in 1998 and was replaced by two other national programs addressing poverty reduction and the development of forestry in a separate manner: the Five Million Hectare Reforestation Program (5MHRP) provides government funds for forest protection and Program 135 undertakes infrastructure development in the poor and remote communes that are primarily mountainous and inhabited by ethnic minorities. The major objectives of Program 135 launched in 1998 were to build the economic base and provide welfare support in targeted poor areas. The program includes the implementation of policies to improve land use, direct public investments and investment incentives (through subsidies and reduced taxes) for raising farm incomes, investment in education, and better coordination of government line agencies for effective program implementation. During 1998-2004, the Program covered over 2,000 villages. The total amount of funds allocated to this program up until 2004 was US$3.5 billion (personal communication, Hoang Cong Dung, deputy director, National Commission on Ethics).

One of the major policy reforms has been to grant land-use rights to upland households. Increased public investment in uplands has also led to improvements in infrastructure and market access. As a result, parts of the upland systems have become more integrated with markets. Results of these reforms have been impressive in many parts of upland areas in terms of increased crop yields and reforestation of formerly barren hills (Donovan et al 1997, Tachibana et al 1998). Whether the strengthening of land-use rights and commercialization of upland production systems will improve food security and reduce pressure on upland resources remains to be seen.

Summary

Upland rice is an important crop in the Northern Uplands of Vietnam. It is grown in a larger area in the northwestern region than in the northeastern region. These areas are inhabited by ethnic minorities that mainly practice subsistence agriculture under a shifting cultivation system. The incidence of poverty is very high relative to the national average.

Although the current population density is relatively low, the area is experiencing rapid population growth over time. Land-use patterns are changing in response to improved access to markets, especially at lower altitudes, and increasing population pressure. The area under cash crops such as maize and industrial crops (such as tea, coffee, peanuts) has increased in recent years in the southern parts of the highlands. Overall, the area under upland rice has decreased over time in response to economic pressure and the government policy of discouraging upland rice production. However, upland rice is still a decisive component of food security for many upland farmers, especially in the northern part. The area under the upland rice system, including the land kept fallow as a part of the rotation, is almost 250,000 ha.

The government of Vietnam is actively pursuing various policies to promote economic growth of these areas and improve the welfare of farmers. These policies are oriented toward protection of forests, sedentarization of shifting cultivators, assignment of land-use rights to farmers, and the provision of economic assistance to poor farmers. These policies, however, often exclude the goal of improving the productivity of upland rice. Furthermore, government policies even actively discourage the planting of upland rice. Considering the role of upland rice in food security, this policy deserves close scrutiny through empirical analysis and modeling, which will be done in this book.

CHAPTER 3
Conceptual approach

A conceptual approach for analyzing farm household responses to various economic and demographic drivers is developed in this chapter. The chapter begins with an overview of the literature on the major drivers of farming systems in the tropics. A conceptual framework is outlined that identifies the major determinants of the nature of agricultural production systems in the Northern Uplands of Vietnam. A household model for analyzing the impact of exogenous factors is subsequently discussed and the modifications needed to apply the model to the uplands of Vietnam are presented.

Impacts of population growth and commercialization: an overview

The literature on population growth and the commercialization of agriculture is rather extensive. Recently, a comprehensive review of hypotheses on the direction of the impacts of population growth on land and labor productivity, human welfare, and natural resource conditions was provided by Pender (1998). Extensive reviews of evidence on how population growth and agricultural commercialization interact have been compiled by Templeton and Scherr (1997).

Historical evidence in developing countries suggests that population growth is one of the major drivers of changes in agricultural production systems. An increase in population raises the demand for food and farmers tend to respond basically in two ways. Unless outmigration is possible to a significant extent, either the area under cultivation is increased or land use is intensified. The choice of strategy depends on the relative costs of land, labor, and external inputs. An area increase occurs where open-access land of acceptable quality is available and accessible. However, intensification is the only option when the land frontier is closed (Smith et al 1994, Tachibana et al 1998). The latter process usually requires a higher labor input per unit of land, for example, for weeding, and can result in a decrease in labor productivity. The nature and pattern of these changes in uplands are conditional on marketing infrastructure, government policies, security of land tenure, and local institutional setup. The impacts of such responses on natural resource conditions and on land and labor productivity, and poverty, are highly varied across agroecological regions. Such responses are determined by factors that affect household decisions about land use, labor or capital intensity, product choice, technology adoption, migration, and community decisions relating to collective management of common property resources (Pender 1998).

Evidence from farming systems research worldwide indicates that the length of the fallow period and population density are negatively correlated (Ruthenberg 1980). The reduction in the opportunity cost of labor relative to land that usually accompanies population growth provides incentives to intensify land use by increasing cropping frequency. A positive correlation was found between population density and cropping frequency based on 52 cases in sub-Saharan Africa (Pingali et al 1987). In research on hillsides of Rwanda, von Braun et al (1991) observed that the rapidly rising person-land ratio led to an increase in intensification of food crop production and the use of higher labor inputs per unit of land.

Land-use intensification may lead to land degradation or investment in land improvement. Increases in population density were found to be associated with greater soil erosion and declining soil fertility in several African countries (Templeton and Scherr 1997). Increases in population density and resulting increases in cropping frequency can, however, have a positive impact on resource conservation. Intensive use of fragile land may lead to land degradation through soil erosion and loss of fertility (Templeton and Scherr 1997). This is a major concern regarding the impact of intensification in uplands. However, when the incentives are right, farmers may respond by using soil enhancement practices or by adopting and adapting agricultural methods that protect the hilly landscapes (Boserup 1965, 1981). Several cases from around the world support this more optimistic view of the environmental impacts of population growth (Pingali et al 1987, Blaikie and Brookfield 1987, Binswanger and Pingali 1987, English et al 1994). Pingali and Binswanger (1987) showed that as agricultural wage decreases due to increases in labor supply, labor-intensive improvements to agricultural land also become more profitable. On the densely populated island of Java, the area devoted to home gardens increased with population density, occupying from 15% to 75% of the cultivated land, producing more than 20% of household income and 40% of caloric requirements (Templeton and Scherr 1997). Similarly, case studies also indicate that, as population density increases, people in some instances transform native forest and swidden land into agro-forests that are more economically beneficial and ecologically viable (Templeton and Scherr 1997). Farmers in areas in Mindanao, Cebu, Batangas, and Bicol of the Philippines representing a wide variety of soils and rainfall patterns construct and maintain more grass strips and contour hedgerows as real agricultural wages decline (Templeton 1994, Lapar and Pandey 1999). Econometric evidence from Rwanda, selected areas of Thailand, and the Philippines indicates that decreases in farm size induce agricultural land investments, such as bunds, grass strips, hedgerows, and rock walls (de los Angeles 1997, Feder et al 1988, Templeton 1994). Thus, population growth in hilly-mountainous areas of developing countries can either lead to land degradation or land enhancement. In general, most of the environmental impacts of production increases in these areas depend on whether sufficient microeconomic incentives and flexibility exist for crop and land-use choices (Templeton and Scherr 1997).

Land-use intensification can also be induced by an improvement in access to markets. Public investments in infrastructure such as roads and markets are important factors driving commercialization of agriculture in Asia. However, commercial agriculture may have a positive or a negative effect on land conservation. Commercial logging, plantation, and ranching in some cases are more proximate causes of reductions in forest cover than is local population growth (Cruz and Repetto 1992). Improving the infrastructure, such as the road network, reduces marketing costs and therefore increases farm-gate prices. Farmers on the middle volcanic slopes of Central-East Java created widespread change from annual food crops to perennial cash crops because the markets for these crops were strong (Fujisaka 1993). Similarly, farmers on the Philippine island of Palawan converted swidden plots into fruit orchards in part because of their proximity to markets (Templeton and Scherr 1997). Improved access to markets also increases returns to inputs and therefore provides an incentive to apply higher levels of inputs. Market-driven intensification can facilitate the adoption of land-saving, input-using technologies more strongly than can population-driven intensification (Smith et al 1994). Hence, commercialization may have mixed effects on land improvements.

The process of intensification can be speeded up if appropriate technologies are available (Smith et al 1994). As land value increases relative to labor, farmers shift from a grass-fallow system of production to an annual cultivation production system that is more land-saving and labor-using. The transition from fallow systems to permanent cultivation occurs faster if technologies that raise land productivity are available. Therefore, if technological advances are accompanied by improved access to markets, the result can be a dramatic increase in intensification.

Intensification in uplands also depends on the interaction with other sectors of the economy. By modeling the economic linkages among upland agriculture, lowland agriculture, and other sectors in developing economies, Coxhead and Jayasuriya (1994) showed the potential for welfare-enhancing shifts from more to less erosive upland-use patterns. They indicate that the Green Revolution in lowland agriculture helped alleviate upland degradation, and that policies aimed at slowing land degradation through technological progress in upland crops may have the opposite of their intended effects.

In the mountains of northern Vietnam, paddy rice plays a major role in most households' food security. Households' production strategies were found to depend on two key factors: access to paddy fields and each household's rice self-sufficiency level. Households that have met their rice needs were found to diversify their production systems toward cash cropping and buffalo raising (Castella and Erout 2002).

Government policies and regulations also influence the use of upland resources. Governments regulate or maintain *de jure* ownership of large portions of hills and mountains in developing countries for watershed or forest protection. Secure, long-term rights of access to land, particularly in the form of locally recognized use rights, create an incentive for people to make landscape-improving investments. Terracing and other investments in soil erosion control are generally associated with secure, long-term rights to land in West Java, Nigeria, Tanzania, and colonial Kenya (Pingali

1989, Place and Hazell 1993, Place and Otsuka 1998). Prerequisites for attaining intensification with sustainability include secure tenure, a conducive economic environment, responsive government policies, and strong community involvement in resource management decisions.

Thus, upland intensification and changes in land use can be induced by a combination of population growth, commercialization, food availability in the lowland, and a conducive policy and institutional environment. Their impacts on resource conservation, however, are conditioned by factors that affect farmers' incentives to invest in enhancement of land quality.

A conceptual framework for analyzing the nature of upland production systems

Classic location theory developed during 19th-century Europe suggests that distance to markets, which at that time was a major factor of market access, determines the spatial arrangements of agricultural systems. Hence, the farther away a producer is from product and factor markets, the more an agricultural system tends to be subsistence-oriented. Although transportation costs are no longer a factor in developed-country agriculture, in developing countries with poor transportation infrastructure, this theory is still valid. As pointed out in the previous section, population density is also a major factor that influences land use (Boserup 1981).

A simplified typology of upland systems can be developed on the basis of these two major driving forces (Fig. 1). When population density is low and market access is poor, the production system tends to be subsistence-oriented (Type 1). Limited access to markets reduces the possibilities of gains through exchange in the market place. Extensive food production systems based on shifting cultivation with a long fallow predominate under such conditions. However, when the land frontier is closed, increases in population pressure provide incentives for intensification of agricultural production by reducing the fallow period or by using external inputs. Intensification results in a transition toward a continuous land-use system for food production (Type 2). Improvements in market access lead to the evolution of a market-oriented system, with the choice of crops governed mainly by market opportunities (Types 3 and 4). In the market-oriented system, subsistence production of rice is unlikely to be important unless otherwise dictated by field hydrological conditions such as submergence that constrain the production of nonrice crops.

This conceptual framework can be modified to account for the composition of land endowment. A major indicator of the land endowment composition is the relative area of lowland and upland fields. Yield of rice in lowlands tends to be higher than in uplands because of more favorable hydrological conditions and better fertility. In addition, good yields can be obtained in lowland fields on a continuous basis. Thus, in most areas of Asia, lowlands are invariably planted to rice. In the mountainous region where farmers may have limited areas of lowlands in addition to the usual upland fields, how does the endowment of lowlands affect rice production in uplands?

Households with no or very limited endowment of lowland paddy fields and that at the same time suffer from poor market access have little choice other than to rely

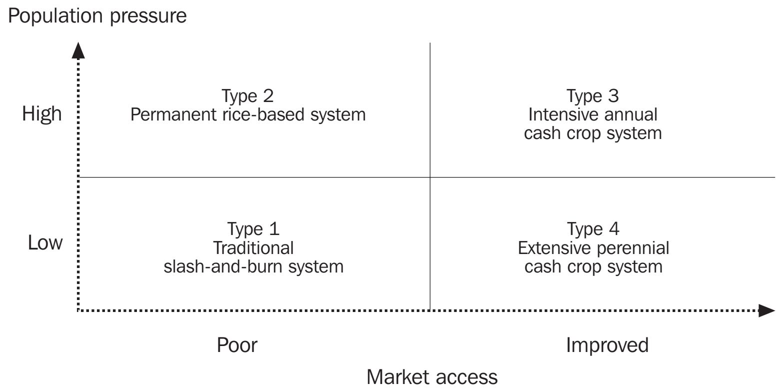

Fig. 1. Typology of uplands.

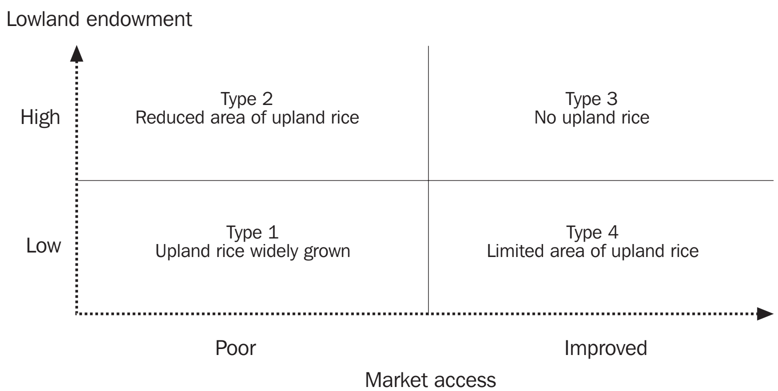

Fig. 2. The prevalence of upland rice based on market access and lowland endowment.

on the production of upland rice (Type 1, Fig. 2). On the other hand, when sufficient paddy rice area could be developed at a relatively low cost, most of the rice is likely to be grown in fertile lowlands or in valley bottoms. Under such situations, upland rice becomes a minor component in the household's food security strategy (Type 2). In areas with good access to markets, upland farmers are likely to engage in cash crop production, with the subsistence crop becoming less important (Type 3). This situation would be similar even though the endowment with lowland paddies is low (Type 4).

Characteristics of a household model

The above conceptual model identifies the broader driving forces that determine household choice regarding food (rice) and cash crops. The implementation of this conceptual model requires the use of a household decision-making model for the allocation of land and labor resources of the household to various activities. Microeconomic models of a farm household in developing economies that combine producer, consumer, and labor supply decisions have been developed and used extensively (Singh et al 1986, Sadoulet and de Janvry 1995).

This study draws upon theories of the rural household that combine production, investment, labor supply, and consumption decisions in which family labor is allocated to the production of home consumption goods and agricultural goods for markets, and off-farm work. Household land-use decisions are determined by both household-specific and exogenous variables. Household-specific variables include land, labor, and capital endowment, whereas exogenous variables are access to markets, institutional environment, and government policy.

Figure 3 summarizes a microeconomic conceptual framework for the formulation of a household model typical of the Northern Uplands of Vietnam. Household objectives include earning profit from production and reducing consumption variability. The choices are influenced by several factors, such as (1) ecological conditions of the natural resource base, such as soil quality, rainfall, and topography; (2) household endowment of land, labor, and capital; (3) other household characteristics such as ethnic consumption preferences; (4) land-labor endowments as affected by demographic change; (5) institutional and organizational factors such as property rights; (6) rural market conditions, such as access to markets, transport costs, crop prices, and nonfarm income opportunities; and (7) availability of information and technology on crop and livestock management. Overall, household characteristics, exogenous factors, and the farm production function determine the returns to land, labor, and capital in different uses. Also, these factors influence decision-making regarding household factor allocation, including land use and investments intended to enhance productivity (e.g., through land terracing, bunding, and mulching) and sustainability (through periodic fallowing and conservation practices).

In applying the model for this study, we initially assume that all prices are exogenous to the household and all products and factors are tradable with no transaction costs, with the household objective being to maximize household income. In the second stage of the analysis, we relax these conditions and explicitly take account of the food security objective that constrains income maximization.

To incorporate the food security objective, it is useful to refer to the general definition of food security, that is, "access to enough food at all times for a healthy and productive life" (World Bank 2000). To apply this definition to the context of upland farming in Vietnam requires entering a time dimension into the household model. In other words, it is not enough to account for the households' supply of and demand for food on the aggregate over the year but we also need to examine the food supply at critical periods during the year. For example, Pemsl et al (2001) found that farmers

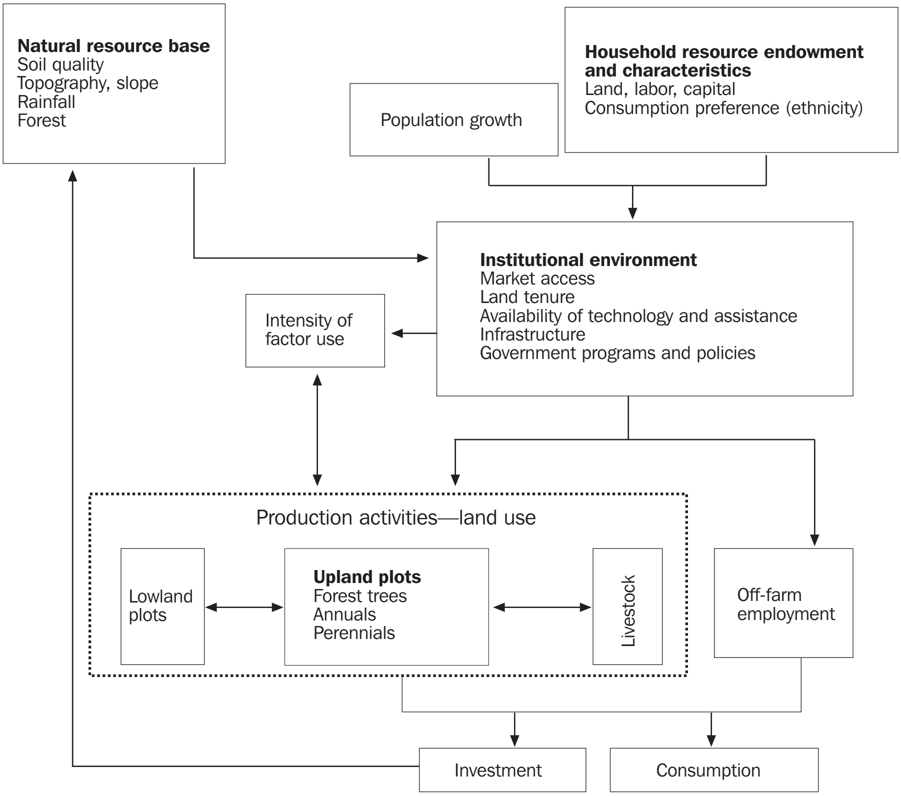

Fig. 3. Microeconomic conceptual framework of an upland household model.

in Ha Giang Province frequently experienced a food shortage during September—a time period before the harvest of lowland rice. This was one reason why farmers planted upland rice, which could be harvested earlier in September to provide food during the "hungry month." Hence, a multiperiod dimension was built into the model in order to assess the implications of policy change and technology adoption for the household food security situation. The model thus allows capturing the income and resource allocation effects of technological improvements in subsistence crops like upland rice.

The next step in making the model more in line with the conditions of upland farming is to explicitly account for the risky environment under which these households operate. The behavioral response of the households to these uncertainties is likely to be determined by risk-averse behavior. While traditionally risk aspects have been incorporated in the economic analysis of small-scale farming in developing countries by applying the expected utility theory (EUT) framework, treating the analysis in the context of poverty and poverty reduction brings into play the concept of vulnerability. The vulnerability idea has emerged from the discussion of pro-poor growth strategies, which many see as one of the ways to achieve the Millennium Development Goals

(MDG). For example, the World Development Report (WDR) of 2000-01 (World Bank 2000) focused on the interface among empowerment, security, opportunity, and poverty. In this context, proactive social protection measures are thus incorporated into growth strategies in order to reduce the risk of poor people falling back into poverty when they are subjected to external shocks arising from ecological, economic, and political factors. As the experience from the Asian financial crisis has shown, financial market shocks generally reduce off-farm income opportunities. A sudden drop in nonagricultural income generates an additional burden for upland farmers, especially when coupled with lower prices of agricultural products and higher factor prices as caused by currency devaluations. For example, it was shown in a study in Thailand and Indonesia (Bresciani et al 2003) that the financial crisis hit small-scale farmers significantly more than larger commercial farmers. Large farmers benefited from the devaluation of the Thai currency through the revival of export opportunities, whereas small farmers suffered from the slump in off-farm income.

Recent literature on pro-poor growth (e.g., Holzmann and Joergensen 1999) has emphasized the importance of the vulnerability concept. It describes the relationship among poverty, risk, and the management of risk (Allwang et al 2001, Duclos 2002, Hoddinot and Quisumbing 2003). Vulnerability is concerned with the risk of a possible decline in well-being in the future stemming from exposure to external shocks. It can thus be expressed as the probability of falling below a benchmark or poverty threshold if external shocks occur or the inability of households to sustain their minimum consumption expenditures in the case of external shocks. In the Vietnam poverty report of 2003 (World Bank 2004), vulnerability was quantified in terms of a 10% shortfall in per capita consumption expenditures relative to the poverty line. Farm families in rural areas in the Northern Uplands are particularly vulnerable to external shocks inflicted by market forces, which did not play much of a role in traditional subsistence-oriented farm household systems. The risk of falling even deeper into poverty (poverty gap) may increase during transition toward commercial crops. Therefore, the performance of market-oriented development must be assessed not only with regard to its overall poverty reduction impact as measured by the average increase in income and a related decrease in the headcount ratio. It is also necessary to assess its impact on the vulnerability of households of the various ethnical and regional groupings in the mountainous region of Vietnam. As theoretical work on the vulnerability concept is still in its infancy, no formal inclusion in the household model was possible. Therefore, this aspect has been dealt with through a scenario analysis.

Summary

In this chapter, a conceptual framework for a study of the development of upland farming in Vietnam was developed. It was also shown, based on the literature review, that the key drivers of changes in labor and land allocation decisions are population growth, endowment with lowland paddy area, and market access. The review of literature has also made it clear that the effects of population growth on the sustainability of upland resources can be varied depending on a number of factors.

CHAPTER 4

Analytical approach

Based on the conceptual model of cropping choices discussed in the previous chapter, specific hypotheses to be tested in the empirical section of this study are developed here. In addition, analytical methods for testing the hypotheses are also presented. The definitions of major variables such as population density, land-use intensity, and market access used in the study are provided. The final section of the chapter provides a brief description of the sampling approach for the household survey needed to generate the basic data.

Hypotheses of the study

The basic microeconomic model described in the previous section will be used to test a number of hypotheses that are derived from the problem analysis and the conceptual framework. Two types of hypotheses are tested in this study. The first set of hypotheses is related to a scientific explanation for the observed land allocation decisions of poor households in the mountain areas in Vietnam, especially in relation to the area devoted to upland rice cultivation. These hypotheses will be tested using standard econometric techniques. The second set of hypotheses relates to the impact of actual and potential development interventions aimed toward improving food security in these poverty-stricken areas of Vietnam. Here, a normative form of household model, which is further specified in Chapter 7, is used. This model allows investigating some of the questions related to household food security and the vulnerability of these households of falling back into poverty.

Five subhypotheses make up the first set of hypotheses. These subhypotheses expressed in the form of research questions are

1. What is the effect of population pressure on fallow periods in uplands?
2. How does market access affect the allocation of land for upland rice production?
3. What is the effect of population pressure on labor productivity in agriculture?

4. How does market access affect the degree of subsistence orientation in farming?
5. How does an improvement in upland rice productivity affect upland rice area?

The above hypotheses are derived from the conceptual model discussed earlier. For example, hypothesis 1 is specified to test the effect of rising population pressure on land-use intensity. Based on the discussion above, rising population pressure is expected to reduce the fallow period as land-use intensity rises as predicted by the Boserupian model.

The effect of market access on the allocation of upland area for food crop versus cash crop production is investigated in the second hypothesis. Improved market access is expected to have a negative effect on the allocation of land for producing subsistence crops (i.e., upland rice). As explained in the conceptual model above, households with more lowland area are likely to reduce upland rice area since more of their food needs can be met from lowland rice.

The third hypothesis is specified to test the Boserupian prediction that labor productivity in agriculture decreases with population pressure. Farm size is a good proxy for population pressure at the household level, as explained above. The Boserupian hypothesis is supported if the farm size affects labor productivity positively. Household capital endowment and market access are other variables that are also expected to have positive effects on labor productivity.

The effect of market access on subsistence production is tested by the fourth hypothesis. Improved market access is expected to have a negative effect on subsistence production. Similarly, land endowment and household size are likely to be the other determinants of the degree of subsistence orientation.

Finally, the fifth hypothesis is designed to examine the likely effect of an improvement in upland rice productivity on upland rice area. When rice productivity goes up, farmers would need a smaller area to meet their consumption requirements. If this is the case, farmers with higher upland rice productivity are likely to have a smaller upland rice area than farmers with lower upland rice productivity, with other things remaining the same. With their food needs satisfied from a smaller area, such farmers are likely to be more interested in growing cash crops for income generation.

The second set of hypotheses refers to the impact of the development interventions that aim at reducing income-poverty, food insecurity, and vulnerability of rural households in mountainous areas. Here, the general hypothesis is that a strategy of agricultural commercialization in areas with limited access to markets and poor marketing institutions will tend to increase food insecurity and vulnerability unless measures are taken that increase the productivity of the subsistence crops that form the food security base of these households. Testing of this hypothesis is conducted using a mathematical programming model of a typical rural household in the uplands and by conducting scenario analyses. The specific hypotheses tested are

1. Will commercialization increase the pressure for intensification of uplands?

2. Will better access to food from lowlands reduce the pressure to grow food crops in uplands?

Definitions and measurement of some major variables used in the study

When studying the prospects of agricultural commercialization in upland areas, it is helpful to clarify some concepts generally used to describe changes in agricultural systems. The most important among those concepts are land-use intensity, population density, and market access as well as subsistence and commercialization. The respective definitions and various measures of these variables used in the study are discussed here.

Land-use intensity

The evolution of agriculture has shown a shift from traditional forms of shifting cultivation to highly intensive forms of permanent agriculture. Hence, land-use intensity is one indicator of this process. It can be expressed in terms of the length of the cropping cycle and length of the fallow period. Following Ruthenberg (1980), an intensification index can be defined as

R = (years of cropping period) / (years of fallow + years of cropping period)

The cropping period refers to the length of continuous planting of annual crops. Fallow is the time period, measured in number of years, between two cropping cycles. Ruthenberg classified the cultivation systems in uplands as shifting cultivation ($R < 33$), short fallow cultivation ($33 < R > 66$), annual cropping ($R > 66$), and multiple cropping ($R > 100$). The intensification index R thus represents land-use intensity under annual cropping systems.

For a given cropping period, the intensification index can be approximated by the length of the fallow period, which can be measured at three levels of aggregation:

1. The commune average of the fallow period refers to the weighted average of the fallow periods collected from all individual parcels of land being cultivated by the sample households within the commune. The area of each parcel can be used as the weight.
2. At the household level, the fallow period can similarly be defined as the weighted average of fallow of all the parcels cultivated by the household.
3. At the parcel level, the fallow period refers to the number of years a specific parcel is kept fallow.

The use of the measure applicable to a lower level of aggregation permits the inclusion of more factors to explain cross-sectional variations in the fallow period.

Population density

Population density is measured as the number of people per unit land area in a designated territory. It is a measure of the population pressure on the land. Population pressure can be measured at different geographical scales (village, commune, or province). It can also be measured at the household level.

In this study, we use the commune total population density as a proxy for population pressure. Population density at the commune level is defined as the number of persons per square kilometer calculated as the ratio of total population and total natural area of the commune. Natural area covers agricultural land, forest land, and unused or barren land. To obtain the commune-level population density, relevant data were taken from GSO (1995).

At the household level, population pressure can also be measured in terms of the person-land ratio, that is, farm size. Farm size tends to decrease with an increase in population. Hence, farm size can be used as a proxy for population at the household level.

Market access

Limited market access restricts the interaction between upland and lowland economies in two ways. First, upland farmers cannot access food from lowlands because of the high costs of transportation. This forces upland farmers to grow subsistence crops even though they may have a comparative advantage in producing cash crops in terms of natural location factors. Second, high transportation costs also limit opportunities for enhancing income by growing cash crops, which are in demand in lowlands. With improved market access, upland farmers are likely to be able to generate income from the production and sale of cash crops and purchase rice in the market.

Market access can be measured by various indicators such as the physical distance from the farm locality to the market center, travel time, the cost of transportation, and the marketing margin. The upland environment in the Northern Uplands is characterized by highly broken terrain; the motorable road network often reaches up to the district centers. The lowest organizational level of agricultural, education, health, and other social services is located in the district center. Besides the district markets usually located in the district center, there are town centers of markets located at the crossroad of the main transportation routes where most of the goods are traded. In the Northern Uplands, small traders who usually travel on bicycles can come up to the households to purchase marketable farm products. These local traders in turn will sell assembled products to assemblers at district centers. Many farmers may bring their products to district markets and purchase most of their needs from the district or town markets.

The price difference of marketable products at the farm gate and consumption center can be used to measure the degree of market access or integration. Similarly, marketing margins for factor prices such as chemical fertilizers purchased in the farming locality and at the market center reflect transportation and handling costs under competitive market conditions. However, the current marketing system of agricultural inputs in the Northern Uplands is still channeled through the extension service and cooperatives. On the other hand, fertilizers in the region are heavily subsidized by the government. In 1998-99, a total budget of US$18 million was spent on a price and transportation subsidy of basic goods in the mountainous regions in which about 0.5

million tons of chemical fertilizers were distributed at a subsidized price (Nhan Dan Daily, July 2000). As a result of this subsidized distributive system, the retail price of chemical fertilizer (e.g., urea) in the remote districts (Phong Tho and Tuan Giao) of the northernmost province of Lai Chau was almost equal to its retail price in the more accessible district of Bao Yen in Lao Cai Province.

While most production inputs are being channeled through state enterprises, most farm produce is being traded at local markets or through private traders who assemble and transport goods to market centers. Their costs of handling and transportation of marketed products depend on accessibility, distance, quality of roads, and seasonality of farm products. These attributes are expected to contribute to the size of the marketing margin. However, given the current distortion of marketing costs and prices of agricultural inputs in the Northern Uplands and the fact that our one-time household survey did not include the tracing of marketing channels of farm products to estimate the marketing margin, we depend on a subjective combination of physical distance and the nature of transportation (year-round or dry season only) as an indicator of market access. For the purpose of econometric analysis, this is expressed as a binary variable (i.e., good access and poor access).

Subsistence and commercialization

The term subsistence refers to the production of goods for consumption by the household. The term analogous to subsistence is commercialization. The latter refers to the volume of produce and household resources that enters the exchange economy. This may include sales or barter of farm products not used for subsistence and off-farm employment of labor and capital. The extent of subsistence orientation versus commercialization of farm households and of an entire rural economy may be considered from several angles (von Braun et al 1991):

- The extent to which farm households consume out of their aggregate agricultural produce as compared to the total value of agricultural produce, that is, the ratio of the value of nonmarketed agricultural produce to the total value of agricultural production (Concept 1).
- A more comprehensive concept of subsistence takes into account the overall degree of market integration of rural households into the exchange economy and does not just look at agriculture. This can be approached from the income and consumption side:
    - On the income generation side, subsistence is measured by the ratio of the value of nonmarketed agricultural produce to total income (the total value of agricultural production – cost of agricultural production + any other income from transfer or renting out of assets + off-farm wage income + income equivalent of leisure) (Concept 2).
    - On the consumption side, subsistence is measured by the ratio of the total value of goods consumed out of home production to the total consumption value of the household, including purchased and own-produced items for consumption (Concept 3).

Constrained by the lack of information collected from the sampled households, we use mainly the first concept of subsistence, that is, the extent to which farm households consume out of their aggregate agricultural produce as compared with the value of total agricultural produce.

Survey design

The study of transitions in production systems requires temporal data over a long period. As such data are not available, a cross-sectional comparative analysis based on household surveys is used here to study the patterns of changes.

Using prior information on the Northern Uplands, a stratified sampling design was used to generate a household data set that covers a wide range of variations in population density, market access, ethnicity, the relative proportion of upland and lowland area, and the extent of crop diversification.

In the first step, 12 districts in six provinces (Cao Bang, Ha Giang, Yen Bai, Lao Cai, Son La, and Lai Chau) were selected (Fig. 1). The second step consisted of selecting in each district two to three communes that differ in ethnicity and degree of market access. Within a district, one commune nearer to the district center and with relatively more wetland paddies and one or two communes farther away from the district center and with limited areas of wetland paddies were selected. The selection of the districts and communes was made by staff of Thai Nguyen University in consultation with provincial and district agricultural officers.

In the final step, 30 to 50 households in each commune were randomly selected for structured interviews. In total, 980 households in 33 communes were included in the survey. Tables 1 and 2 show the distribution of selected sites and their major characteristics.

Summary

Five major hypotheses to be tested econometrically and two hypotheses tested through a mathematical programming approach were discussed in this chapter. These hypotheses relate to the major drivers of farming systems and the household decisions on cropping choices that are operating in the Northern Uplands of Vietnam. Definitions and measurements used for some of the major variables were also provided. These hypotheses are tested statistically and scenario analyses are carried out in the empirical sections (Chapters 5 through 8) of this study.

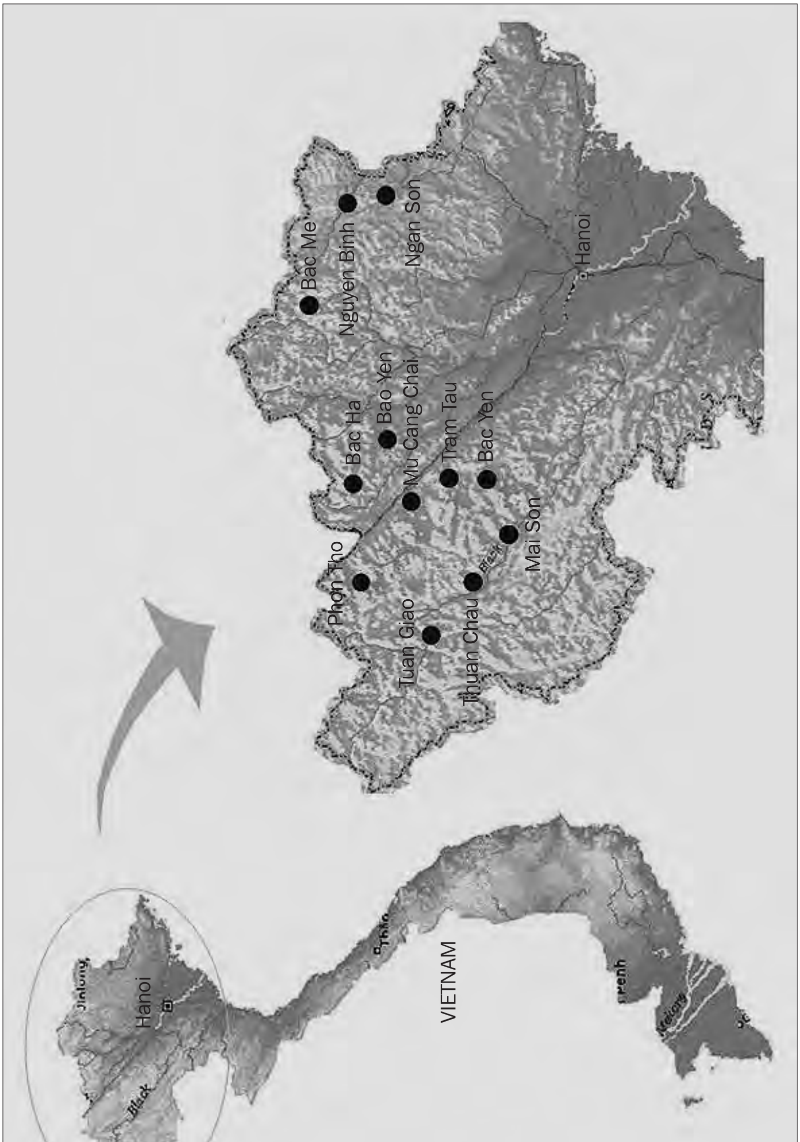

Fig. 1. Location of sampled districts.

Table 1. Sample characteristics.

Province	District	Commune	No. of sampled households	Population density (no. km^{-2})	Distance to district market (km)	Distance to provincial road (km)	Travel time to provincial market (h)	Market access
Cao Bang	Nguyen Binh	Tam Kim	50	49	10	30	3	Low
	Ngan Son	Thuan Mang	27	90	5	10	2	High
Son La	Thuan Chau	Chieng Pha	13	290	12	1	2	High
		Muong Giang	12	47	45	5	4	Low
		Co Ma	12	34	50	50	5	Low
		Chieng Khoang	13	143	30	20	6	High
	Mai Son	Chieng Mung	13	164	15	2	2	High
		Chieng Chung	13	48	40	12	4	Low
		Ta Hoc	12	39	30	20	4	Low
		Chieng Pan	12	27	70	15	5	Low
	Bac Yen	Ta Xua	33	19	8	10	5	Low
		Hong Ngai	33	38	8	10	5	Low
		Phieng Ban	34	77	2	4	3	High
Ha Giang	Bac Me	Yen Cuong	20	50	5	60	7	Low
		Yen Phong	40	31	5	60	7	Low
		Yen Phu	40	73	2	60	5	High

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Table 1 continued.

Province	District	Commune	No. of sampled households	Population density (no. km^{-2})	Distance to district market (km)	Distance to provincial road (km)	Travel time to provincial market (h)	Market access
Yen Bai	Mu Cang Chai	Mo De	32	50	12	7	12	Low
		Kim Noi	37	43	10	5	11	Low
		Che Cu Nha	34	46	6	2	9	Low
	Tram Tau	Tram Tau	30	44	2	20	10	Low
		Ban Cong	29	15	5	20	10	Low
		Hat Luu	41	202	15	2	7	High
Lao Cai	Bac Ha	Bao Nhai	72	76	15	20	6	Low
		Na Hoi	28	215	5	5	3	High
	Bao Yen	Yen Son	33	101	18	3	3	High
		Vinh Yen	40	62	3	2	4	High
		Nghia Do	27	116	15	1	4	High
Lai Chau	Phong Tho	La Nhi Thang	27	20	9	12	5	Low
		Sung Phai	39	53	5	8	3	High
		Nam Loong	34	48	6	10	5	Low
	Tuan Giao	Quai Nua	25	72	10	1	3	High
		Pu Nhung	43	47	15	6	5	Low
		Phing Sang	32	44	25	20	6	Low

Table 2. Selected districts and communes and sampled households.

Sampled communes	Accessible by vehicle	Dominant ethnic group	Mode of travel	Other indicators
Tam Kim	No	Dzao	Walk, horse, vehicle	No road to commune
Thuan Mang	Yes	Dzao	Vehicle	Poor road to commune
Chieng Pha	Yes	Thai	Vehicle	Poor roads from communes to district, seasonally traveled
Muong Giang	Yes/no[a]	Thai	Walk, horse, vehicle	
Co Ma	No	Hmong	Walk, horse, vehicle	
Chieng Khoang	Yes	Thai	Vehicle	
Chieng Mung	Yes	Thai	Vehicle	Village road cannot be traveled in rainy season
Chieng Chung	Yes/no[a]	Thai	Horse, vehicle	
Ta Hoc	No	Hmong	Walk, vehicle	No village road
Phieng Pan	No	Thai	Walk, vehicle	No village road
Ta Xua	No	Hmong	Walk, horse, vehicle	No village road
Hong Ngai	No	Hmong	Walk, horse, vehicle	No village road
Phieng Ban	Yes	Hmong	Vehicle	Dirt road from district to province
Yen Cuong	No	Hmong/Dzao	Walk, horse, vehicle	No road from district to commune, poor road to provincial center
Yen Phong	No	Tay	Walk, horse, vehicle	
Yen Phu	Yes	Tay	Horse, vehicle	

Continued on next page

Table 2 continued.

Sampled communes	Accessible by vehicle	Dominant ethnic group	Mode of travel	Other indicators
Mo De	No	Hmong	Walk, horse, vehicle	Poor road from district to provincial center
Kim Noi	No	Hmong	Walk, horse, vehicle	
Che Cu Nha	Yes	Hmong	Horse, vehicle	
Tram Tau	No	Hmong	Walk, horse, vehicle	Poor road from district to provincial center
Ban Cong	No	Hmong	Walk, horse, vehicle	
Hat Luu	Yes	Thai	Horse, vehicle	
Bao Nhai	No	Hmong	Walk, vehicle	Village road cannot be traveled in rainy season
Na Hoi	Yes	Tay	Vehicle	
Yen Son	Yes	Dzao	Vehicle	All communes are easily accessible to Pho Rang town
Vinh Yen	Yes	Tay	Vehicle	
Nghia Do	Yes	Tay	Vehicle	
La Nhi Than	No	Dzao	Walk, horse, vehicle	Phong Tho is a remote district of Lai Chau Province
Sung Phai	Yes/no[a]	Hmong	Vehicle	
Nam loong	No	Hmong	Walk, horse, vehicle	
Quai Nua	Yes	Thai	Vehicle	Tuan Giao is a remote district of Lai Chau Province
Pu Nhung	No	Hmong	Walk, vehicle	
Phing Sang	No	Hmong	Walk, vehicle	

[a]Accessible only by two-wheel vehicles up to village center.

CHAPTER 5

Descriptive analysis of farm survey data

This chapter provides a descriptive analysis of the upland rice production systems in the study villages. In addition, an analysis of income structure and nature of food insecurity and poverty is provided. The data set used consists of 980 upland households sampled from 12 districts of 6 provinces in the Northern Uplands.

Ethnic distribution

Sample households in the selected communes belong to four main ethnic groups: Hmong, Dzao, Thai, and Tay. The Hmong account for most of the households in the sample (47%), with the Dzao, Tay, and Thai accounting for 18%, 17%, and 15%, respectively (Table 1). The Hmong and Dzao generally live in higher altitudes and depend mainly on upland rice cultivation to meet their food needs. In the sample, they predominate in the less accessible and mountainous districts of Bac Yen (Son La), Mu Cang Chai (Yen Bai), Tram Tau (Yen Bai), Tuan Giao (Lai Chau), and Phong Tho (Lai Chau). These districts are located in the northwest region of the Northern Uplands.

The Thai and Tay ethnic groups included in the sample are mostly located in the relatively lower portion of Thuan Chau and Mai Son districts. They practice more diversified farming that includes a combination of lowland and upland rice cultivation. This is reflected in the distribution of landholding. The share of upland in the total household land endowment is more than 80% for the Hmong and Dzao. The Thai and Tay, on the other hand, have relatively less upland area (Table 2).[1]

[1]The sample data show a strong association between land endowment and ethnicity despite some recent claims that such historical association has weakened somewhat in recent years (Castella et al 2002).

Table 1. Ethnic composition and demographic characteristics of the sampled households.[a]

Item	District											Total	% of total
	Thuan Chau	Mai Son	Bac Yen	Mu Cang Chai	Tram Tau	Phong Tho	Tuan Giao	Bac Ha	Bao Yen	Bac Me	Cao Bang		
Percentage of ethnic group													
Dzao				2		26		30	21	23	92	173	18
Hmong	26	12	76	98	58	72	76	42	2	15		461	47
Tay								27	76	62		165	17
Thai	64	78	11		41		23					146	15
Others[b]	10	10	13		1	2	1	1	1		8	35	3
No. of households	50	50	100	103	100	100	100	100	100	100	77	980	
Household size	8.1	7.2	9.2	9.2	8.3	6.7	6.9	6.2	6.7	6.9	7.0	7.4	

[a]Total sample size = 980.
[b]Other ethnic groups are Kinh, Muong, Khomu, Khang Giay, and Nung.

Table 2. Average landholding and upland rice area per household for four major ethnic groups.

Group	Landholding per household (ha)	Share of upland (%)
Dzao	0.78	84
Hmong	1.43	81
Tay	0.66	52
Thai	1.03	70

Table 3. Average landholding per household (ha hh^{-1}).

Area	Average area (ha)	Average no. of parcels
Lowland	0.26	1.68
Upland	0.86	3.42
Home garden	0.04	–
Forest garden (not included in upland)	0.53	–

Landholding and land characteristics

The average landholding of 1.12 ha per household is composed of 0.26 ha of lowland and 0.86 ha of upland (Table 3). This land endowment is distributed, on average, over 3.4 upland parcels and 1.7 lowland parcels. Fragmentation of landholding is high, with households having up to 18 upland parcels and up to 9 lowland parcels. The high level of fragmentation is due to broken terrain, variable altitude, and slopes that characterize the mountainous areas. Furthermore, the process of land allocation in which the government attempted to provide every household with at least a small area of productive land contributed to this high level of fragmentation.

In addition to lowlands and uplands, each household has an average of 0.04 ha of home garden and 0.53 ha of forest garden. Home gardens are usually the plots adjoining the house where a range of timber trees, fruit trees, tea, and vegetables are planted and livestock are kept. Home gardens are an important source of supply of vegetables for home consumption and fruit tree products for the market. Apricots, plums, banana, jackfruit, longan, and citrus are common fruit trees planted in home gardens.

Forest gardens are defined as the area of common forest land that is contracted on a long-term basis to households for planting of forest trees or a mixture of various tree crops. The area of forest gardens maintained by the household varies largely among the sample communes. Forest trees such as montana (*Vernicia montana*), cinnamon (*Cinnamomum zeylanicum*), acacia, manglitia (*Manglitia glauca*), melia

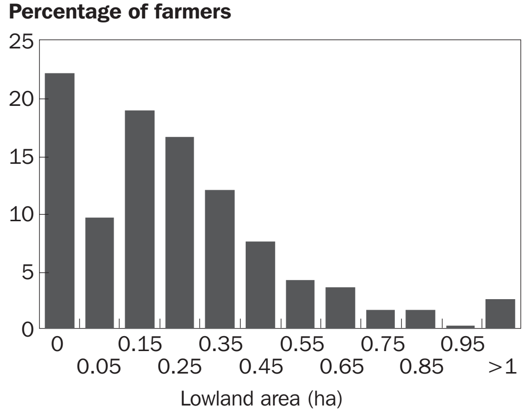

Fig. 1. Frequency distribution of lowland area in the survey area.

(*Mangletia melia*), and teak (*Tectona grandis*) are the most commonly grown plants in forest gardens. Many of these forest tree species are introduced to farmers through agroforestry programs.

Lowlands make up almost a quarter of the average landholding per household. The proportion of lowland in total landholding of the sample households varies from 0 to 60%. Roughly 20% of the households do not have any lowland, with about 35% having 0.1–0.3 ha of lowland (Fig. 1). The large variation in topography and landscape across the communes and the districts accounts for the wide differences in the proportions of lowland. In some districts, almost 70% of the farmers have no lowland (Fig. 2).

Depending on the availability of land within a commune, lowland and land for homestead and home gardens were allocated to households on a fairly equitable basis during the process of decollectivization that took place after 1987. The area of paddy land each household received was in proportion to the number of persons in the household. This is the reason for the very small variation in the average lowland area per person among the four farm-size groups (Table 4). However, landholding of the upland area was not completely subject to collectivization and the area cultivated depended on the household labor supply. Thus, there is a greater variation in the endowment of uplands across households. For example, households belonging to the bottom-quartile farm-size group have an average of only 0.23 ha of upland, whereas farmers in the top farm-size quartile have 1.91 ha of upland.

Landholding, land use, and market access

The major characteristics of sample households based on their access to markets are indicated in Table 5. The grouping of households on the basis of market access is not to imply that all the observed differences are due to differential access to markets,

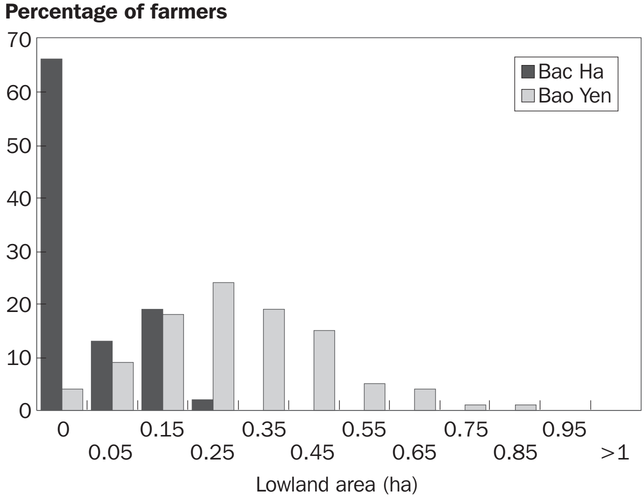

Fig. 2. Frequency distribution of lowland rice area in two districts of Lao Cai, northern Vietnam.

Table 4. Total landholding in upland and lowland area and household size.

Farm-size group	Upland area per household (ha)	Lowland area per household (ha)	Upland/lowland ratio	Household size (persons)
Bottom quartile	0.23	0.15	1.6	5.6
Second quartile	0.48	0.23	2.1	6.9
Third quartile	0.85	0.24	3.5	7.6
Top quartile	1.91	0.40	4.8	9.6
Average	0.87	0.27	3.4	7.4

but merely to highlight some of the major differences in the characteristics of the households.

The major differences indicated in Table 5 relate to the nature of land endowment and land use. Farmers have a substantially larger area of uplands in locations with poor access to markets than in locations with good access to markets. Agriculture in remote areas is based mainly on the use of upland fields that are in greater abundance. Upland rice and maize are the major crops grown in these fields. Lowlands are less intensively cultivated in remote locations than in accessible locations as indicated by the ratio of lowland rice area to lowland area. Given this land-use pattern, the bulk of food in remote areas is produced in uplands, with upland rice accounting for almost half of the total rice output per household. In locations with good access to markets, only one-fifth of the rice output is produced in uplands.

Although the lowland endowment per household in locations with good market access is only about 25% more than in locations with poor market access, agricultural

Table 5. Household characteristics of commune areas with poor and good market access.

Item	Poor market access	Good market access
No. of sampled households	615	365
Average household size	7.72	6.98
Average area per household (ha)		
Lowland	0.23	0.29
Upland	1.03	0.59
Upland rice	0.44	0.24
Upland maize	0.33	0.23
Home garden	0.03	0.06
Lowland rice area/lowland area	1.16	1.33
Annual production per household (kg)		
Lowland rice	769	1,135
Upland rice	607	321
Maize	545	536
Upland rice output/total rice output	0.44	0.22

production in the former is oriented toward an intensive use of lowlands. Through higher rice yields and higher intensity of land use, farmers in locations with good access to markets obtain 50% higher rice output from lowlands. They also grow upland rice in a limited upland area to supplement rice from lowlands. In contrast, agriculture is mainly upland-based in the remote areas, with most of the land being used for rice production.

In market-accessible areas, the major cash crops are improved maize and horticultural crops. Generally, the proportionate area devoted to cash crops is higher in communes with better access to markets than otherwise. For example, 10% of the upland area is planted to cash crops (fruit trees, sugarcane, beans, peanuts, medicinal crops) in areas with good market access while they occupy only 3% of the upland area in locations with poor market access.

Land-use patterns

Almost all the lowland area is planted to rice. Irrigated lowlands are normally double-cropped with rice while rice is grown only once per year in rainfed areas. Uplands are used mainly for producing staple food crops. Upland rice, maize, and cassava occupy over 90% of the upland area. Rice is generally the first crop grown after slash and burn in a system of shifting cultivation. Farmers prefer to grow maize or cassava after growing upland rice for 1 or 2 years. Farmers consider parcels having good soil and located nearer to the house as being more suitable for upland rice. About half of the upland area in most of the surveyed communes is planted to upland rice.

Maize is a crop that has experienced a recent expansion in area. Traditional maize is used as a staple food by the Hmong ethnic group. Through government programs, improved maize varieties are being introduced to favorable upland areas

Table 6. Labor use, yield, and returns to land and labor for rice and maize.

Item	Upland rice	Lowland rice	Local maize	Improved or hybrid maize
No. of households	775	976	337	255
Labor (days ha^{-1})	273	296	198	194
Labor time allocation (%)				
Land preparation	30	29	28	34
Crop establishment	12	17	11	9
Weeding	39	17	34	32
Fertilizer application	0	10	2	0
Harvesting	19	23	25	25
Yield (t ha^{-1})	1.54	3.15	2.46	3.07
Average returns to				
Land ($ ha^{-1})	257	525	205	256
Labor ($ day^{-1})	0.94	1.78	1.03	1.32

in the northwest region, particularly in Son La and Lai Chau. More than half of the upland maize area in the surveyed communes in Son La and Lai Chau is planted to hybrid varieties. In other locations, farmers grow mainly local varieties.

Livestock are an integrated component of the production systems in the Northern Uplands and are an important source of cash income. Livestock provide draft animals for the farm, manure for fertilizer, and nutrition for upland households. Cattle, pigs, and poultry are the most common types of livestock in every commune. Households located in areas with more access to markets tend to raise more pigs.

Upland rice production practices

Upland rice is usually the first crop to be planted in the cropping cycle of the swidden system or in rotation with other crops on fixed plots. The average cropping cycle of the swidden plots is 9.7 years, with 5.3 years in the cropping period and 4.4 years in the fallow period. On swidden plots, one to two crops of upland rice are usually followed by two to three crops of maize. Cassava is usually the last crop before fallow.

Land preparation is commonly done by clearing and burning. Upland farmers usually select the land preparation practices that they consider as being best suited to the topography of upland plots. Land preparation on flat fields is often done by plowing and harrowing. Rocky fields are prepared by using hoes. Sloping fields that are larger in size are prepared by using hoes or plows depending on the slope of the fields. Labor use per hectare for land preparation is about 82 person-days (Table 6).

Weeding is usually done two to three times. Farmers consider weeding to be one of the most labor-intensive tasks in upland rice production. Weeding labor accounts for nearly 40% of the total labor use per hectare.

The practice of using exchange labor is common for land preparation, sowing, and harvesting. Depending on the size of the parcel, as many as 40 farmers may work in one field before moving to another field.

Table 7. The most cited problems in growing upland rice.

Problem	% of farmers reporting
Weeds	55
Damage caused by rats, birds, wild boars, and cattle	20
Low rainfall	18
Poor soil quality	16
Steep slopes	15
Insects and diseases	10
Field far from house	6
Low yield	2
No capital for fertilizer	2
Late planting	1
Theft after harvest	1

Labor is the major input in upland rice cultivation. On average, farmers devote about 275 person-days per ha to the cultivation of upland rice. Labor inputs for land preparation and weeding account for two-thirds of the total labor use for upland rice production.

Upland rice is harvested at the end of the rainy season in October. Harvesting is done by hand, using sickles or small knives, or by stripping the panicles. Cut panicles are bundled. Rice bundles that average 2 kg are dried in the field before being carried to the house for storage and are threshed only when rice is needed for food preparation or for sowing. Defining a variety as the crop population that farmers recognize and name as distinct units, 70 upland rice varieties and 50 lowland rice varieties were recorded in the sample. All upland rice varieties are traditional and most of these cultivars are sticky varieties. Farmers usually grow several varieties on the same parcel or on different parcels of their holding. On average, households grow three to four varieties that they consider suited to their upland fields.

Weeds were cited as the most important problem in upland rice cultivation. Drought was ranked as the third, with damage due to wild animals and grazing cattle being the second most important constraint (Table 7).

Lowland rice production practices

Almost all lowland fields are planted to paddy rice in the wet season (summer crop). In locations where a source of irrigation water is available, another dry season or spring crop of rice can be planted. The proportion of lowland area planted to double crops of rice varies greatly among districts. While all lowland fields in Bac Ha and Phong Tho are planted to only one summer rice crop, about one-third to one-half of the lowland parcels in other districts are planted to double rice crops.

Although most of the upland rice varieties are traditional, lowland rice varieties may be improved, traditional, and hybrids. Hybrid rice seeds are imported from

Table 8. Input use in lowland rice production in spring and summer seasons.

Item	Spring		Summer	
	Poor market access	Good market access	Poor market access	Good market access
No. of households	105	163	382	326
Seed (kg ha^{-1})	94	96	100	106
Organic fertilizer (kg ha^{-1})	2,955	3,583	1,385	2,126
Green manure (kg ha^{-1})	931	787	409	642
Chemical fertilizer				
Urea (kg ha^{-1})	97	95	42	85
NPK (kg ha^{-1})	31	31	66	119
Fertilizer cost ($ ha^{-1})	27	26	16	31
Pesticide quantity (kg ha^{-1})	1.43	2.01	1.12	1.35
Pesticide cost ($ ha^{-1})	5	5	3	4
Labor (days ha^{-1})	298	312	310	306
Land preparation	75	78	100	89
Crop establishment[a]	49	46	55	56
Chemical application[b]	40	49	19	31
Weeding	46	58	51	53
Irrigating	16	12	11	9
Harvesting	72	69	74	68
Yield (t ha^{-1})	3.29	3.18	3.18	3.05

[a]Labor used in seedbed preparation, seeding, transportation of seedlings, and transplanting.
[b]Labor used in organic fertilizer preparation, transportation, and application of fertilizers and pesticides.

China and distributed through district extension services or agricultural input supply companies. Farmers invest about 220 to 450 person-days per ha in lowland rice cultivation. The total labor input for lowland rice is 310 person-days per ha. Labor use in land preparation and crop establishment accounts for nearly 50% of the total labor input (Table 6). Organic fertilizers such as animal manure and green manure are used extensively in lowland rice. Lowland rice yield generally varies from 2.5 to 3.5 t ha^{-1}.

The major purchased inputs are chemical fertilizers and pesticides. In the spring crop, on average, 96 kg ha^{-1} of urea and 31 kg ha^{-1} of composite fertilizers are used (Tables 8). This level of input use is much lower than that of lowland farmers in the Red River Delta, where rice-growing conditions are more favorable.

Higher lowland-rice cropping intensity is generally found in areas with better access to markets where the population density also tends to be higher. However, there are no major differences in input use and productivity of lowland rice in locations with poor market access and those with good market access. The only observed difference is in the level of chemical and pesticide application. Farmers in areas with better market access tend to use a higher level of chemical fertilizers and pesticides than their counterparts in areas with poor market access.

Returns to food crop production

Average returns to land and labor in the production of major food crops such as upland rice, lowland rice, local maize, and improved or hybrid maize are presented in Table 6. Returns to both land and labor are highest for lowland rice. Because of high returns to land, lowland fields are almost invariably planted to rice. Returns to land for upland rice are comparable to those of improved or hybrid maize but higher that those of local maize. The high labor requirement for upland rice, especially for weeding, lowers the returns to labor. Average returns to land and labor in lowland cultivation were US$525 per ha and $1.70 per person-day, respectively. Returns to labor are higher for hybrid maize than for upland rice. Average returns to land and labor for hybrid maize are $256 per ha and $1.32 per day, respectively. The higher productivity of hybrid maize has induced a rapid expansion of its area, often substituting for upland rice.

Structure of income

The household income level is estimated as the sum of the total value of crops and animal production, income from sales of forest products and garden products, and income derived from off-farm activities. Total income can be divided into cash and noncash components. The former refers to cash earned by selling farm or forest products, engaging in employment, or working as wage labor. Noncash income includes the value of all crops, livestock, and forest products that are produced and consumed by the household. Information on all these components of income was collected during the survey. The average total income estimated here represents major sources of income although nonmarketed components such as the value of fuel wood used and wild roots and tubers consumed may have been somewhat inaccurately reported because of valuation problems.

Household annual income averaged at the district level is presented in Table 9. Estimates of annual total income per household in the surveyed communes range from as low as $347 in Ngan Son District of Cao Bang Province to over $800 in Mai Son District of Son La Province. Per capita annual income varied from $49 to $120. The highest level in the range is approximately 60% of the national average of $200 from the VLSS in 1998.

The principal sources of cash income are sales of crop products, livestock, garden products, and forest products, and nonfarm activities. The relative contributions to cash income by source and by level of market access are presented in Table 10. Livestock account for 42% of the total cash income, which is the largest share. Livestock income is generated mainly from the sale of cattle and pigs (Table 11). Households in communes nearer to the district market have a higher source of income from the sale of pigs.

Cash income is almost 50% higher among the households with good market access ($308) than among their counterparts with poor market access ($204) (Table 10). Cash income from crop sales is not only higher but is also derived from a more diversified set of activities in locations with good access to markets. While maize sale

Table 9. Average annual income by source.

Source of income	Son La			Yen Bai		Lai Chau		Lao Cai		Ha Giang	Cao Bang	
	Thuan Chau	Mai Son	Bac Yen	Mu Cang Chai	Tram Tau	Phong Tho	Tuan Giao	Bac Ha	Bao Yen	Bac Me	Nguyen Binh	Ngan Son
Total income ($ hh^{-1})	590	859	741	481	656	496	650	606	625	365	349	347
Per capita income ($)	74	120	90	53	85	79	107	111	102	56	49	58
Cash income ($)	238	258	341	202	253	181	345	311	238	148	133	169
Share of cash income (%)	41	31	48	42	39	38	55	53	41	43	37	47
Share of income source (%)												
Cash income												
Rice	3	0	2	1	4	4	2	0	13	3	0	0
Maize	4	3	7	0	0	9	3	13	2	3	0	0
Cassava	1	2	1	0	0	0	1	12	0	0	0	0
Other crops	4	13	4	3	1	9	20	1	2	1	1	0
Livestock	43	36	53	39	48	54	38	23	45	41	35	59
Garden products	20	11	3	15	4	4	0	37	6	4	0	0
Forest products	2	1	1	0	1	5	9	5	3	0	15	11
Nonfarm income	23	33	29	42	42	15	27	9	29	48	49	29
Noncash income												
Rice	58	28	85	87	77	60	67	37	84	80	90	78
Maize	10	2	15	8	3	37	16	9	2	15	5	12
Cassava	29	14	1	20	20	1	3	0	1	2	3	8
Other crops	3	56	0	1	0	2	0	0	0	3	2	2
Garden products	0	0	0	0	0	0	0	48	0	0	0	0
Forest products	0	0	0	0	0	5	14	9	13	0	0	0

Table 10. Annual total income per household and income source by market access.

Item	Poor market access	Good market access
Annual total income (US$ hh^{-1})	505	691
Noncash income ($ hh^{-1})	300	383
Cash income ($ hh^{-1})	204	308
Sale of crop products (%)	17	14
Sale of livestock (%)	43	42
Sale of forest products (%)	5	1
Sale of home garden products (%)	3	17
Nonfarm income (%)	32	26
Share of cash income (%)	40	45

Table 11. Source of cash income (%) per household by market access.

Source of income	Poor market access	Good market access
Animals		
Cattle	38	31
Pigs	40	42
Poultry	10	10
Fish	3	10
Others	9	7
Total	100	100
Crops		
Rice	13	29
Maize	29	32
Cassava	20	2
Potato	0	0
Soybean	1	2
Others	37	35
Total	100	100

is almost the only source of cash in less accessible communes, income from crop and home garden products in more accessible communes is more diversified and is derived from maize, coffee, fruit trees, cassava, and medicinal plants.

Both lowland rice and upland rice are planted mainly as subsistence crops. The amount of rice sold is only 30–60 kg of rough rice per household, or about only 3–4% of household consumption. Although local maize is grown mainly for home consumption, hybrid maize is mostly sold as animal feed. Maize sales contribute up to 30% of cash income from crop sales. The sale of maize is an important source of income for households in several communes in Son La, Lai Chau, and Lao Cai provinces, where the area under maize has increased in recent years.

Table 12. Farm characteristics by income quartile (%).

Item	Income group (quartile)				
	Bottom	Second	Third	Top	All
Distribution of households by ethnicity (%)					
Dzao	33	23	9	5	18
Hmong	39	49	55	45	47
Tay	12	13	17	25	17
Thai	11	12	15	22	15
Others	5	3	4	3	3
% Upland area per household	81	82	78	72	77
Average farm size (ha)	0.72	0.99	1.16	1.62	1.12
Average household size (persons)	6	7	8	9	7
Subsistence ratio (%)[a]	90	87	84	83	86
Upland rice production/total rice production (%)	43	46	39	27	36

[a]The share of nonmarketed agricultural produce in the total value of agricultural produce.

Income from forest products is derived from selling various timber and nontimber forest products. The relative importance of these individual forest products depends on proximity to the road. Selling of fuel wood is more common among farmers located closer to the road. Farmers reported that the importance of these forest products as a source of wild food as well as cash income has declined over time because of deforestation.

Government transfer payments such as pension, compensation for participation in forestry projects, and salary are the major sources of nonfarm income in all surveyed districts. This source of cash income accounts for 26% to 32% of total cash income.

Income distribution

To examine the nature of income distribution, households were divided into income quartiles. The major characteristics of households falling in different income quartiles are shown in Table 12. There is no clear trend in the composition by ethnic group across income quartiles except for some slight skewness in the Dzao group, which has more households in lower income quartiles than in higher income quartiles.

The share of upland area in total landholding is slightly higher for households in lower income quartiles. As the poorer households grow proportionally more upland rice, the share of upland rice in total rice production is much larger for lower income quartiles.

Among the households in areas with poor market access, the average income per capita of the poorest 20% of households is about one-fourth of that of the richest 20% of households. In the areas with good market access, this corresponding proportion drops to one-fifth. Thus, income inequality appears to be slightly higher in areas with good market access than in areas with poor market access. This observation is

Table 13. Average incidence of rice shortage.[a]

Province	Years of reported rice shortage during 10-year period	Months of reported rice shortage in a year
Cao Bang	4.6	2.0
Ha Giang	7.4	2.5
Lai Chau	4.6	2.2
Lao Cai	3.6	1.9
Son La	5.2	2.1
Yen Bai	7.0	2.6
All	5.3	2.2

[a]Averages calculated using the number of households in the respective category as weights.

supported by the Gini coefficient, which is 0.39 and 0.33 for areas with good and poor access to markets, respectively.

Rice shortage and food security

Rice is the main food crop in the uplands. Although maize, especially improved maize, is mainly used for domestic animals, some ethnic minorities still depend on maize as their main diet. Other staples such as cassava, sweet potato, and canna (*Canna edulis*, a root crop) are consumed when rice and maize are in short supply. Most of the households in the study areas reported that they were unable to meet their family food requirements from their own production of rice and maize.

Farmers were asked about two indicators of rice shortage: the number of years of rice shortage during the past 10 years and the number of months of rice shortage during the year just prior to the survey year. The first indicator provides a long-term picture of rice shortage, whereas the latter focuses on the specific year. The number of months of shortage in any particular year may partly reflect the effect of climatic conditions during the year.

The overall average number of years of rice shortage out of the past 10 years for the sample is 5.3 years (Table 13). This means that there is an almost 50% probability that farmers will experience a rice shortage in any particular year. This figure varies from 36% for Lao Cai to 74% for Ha Giang. About 11% of the farmers experienced no rice shortage during any of the past 10 years, whereas almost 31% had a rice deficit during all 10 years. The average duration of rice shortage in 1998, as reported by farmers, was 2.2 months. Households with good and poor access to markets reported a very similar average duration of shortage (Table 14). Due to the dominant subsistence mode of production for rice, differences in market access do not seem to have made much impact on the duration of rice shortage.

Figure 3 presents the relationship between the number of reported months of food shortage in the crop year 1997-98 and the average landholding per capita of the

Table 14. Percentage of households by months of reported food shortage and source of cash income.

Months of food shortage	% of households with food shortage	Cash income (US$ per head per year)		
		Crops	Garden products	Livestock
Poor market access				
0–1	32	7	2	15
2–4	57	6	1	14
> 4	11	2	1	4
Average = 2.4 months				
Good market access				
0–1	46	10	4	23
2–4	40	4	6	17
> 4	14	6	49	15
Average = 2.1 months				

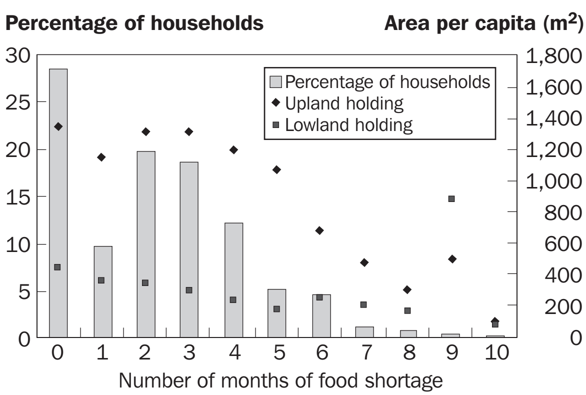

Fig. 3. Relationship between the number of reported months of food shortage and the average of landholding per capita.

households reporting a food shortage. The incidence of food shortage seems to depend on the per capita availability of both uplands and lowlands. Households that reported a food shortage in more than 6 months have half the size of both lowland fields and upland fields in comparison with those that suffered a food shortage in only one month or none.

A tobit model was used to identify the factors that determine the magnitude of food shortage. Two different specifications were used. The first specification used the number of years of food shortage during the last 10 years as the dependent variable and the second specification used the number of months of food shortage during the year preceding the survey. In both cases, land endowment (i.e., the area of lowland and area of upland) and household size were found to have statistically significant effects on the extent of food shortage (Table 15). Using a decomposition process sug-

Table 15. Tobit analysis of determinants of rice shortage.

Item	No. of years of rice shortage during 10-year period		No. of months of rice shortage in a year	
	Parameter[a]	T-value	Parameter[a]	T-value
Intercept	4.601***	11.398	1.786***	7.513
Lowland area	–0.893*	–1.783	–1.596***	–5.354
Upland area	–0.542***	–3.181	–0.322***	–3.066
Dummy for high market access	0.604*	1.858	–0.213	–1.099
Household size	0.150***	2.940	0.102***	3.429
Dummy for Thai and Tay	–0.448	–1.331	–0.001	–0.006
Log-likelihood ratio test statistic	18.97 ***		41.68***	
No. of households	980		874	

[a]*** and * imply statistical significance at 1% and 10%, respectively.

gested by McDonald and Moffitt (1980), the response to marginal changes in these determinant variables on the extent of food shortage was estimated. For households that are experiencing rice shortages, marginal increases in lowland and upland area are expected to reduce the number of years of food shortage during a 10-year period by 0.26 and 0.16 year, respectively (Table 16). Thus, the effect of lowland in reducing the food shortage period is higher than that of upland because of its higher productivity. A similar relative magnitude of effects of lowland and upland areas applies for the reduction in number of months of food shortage during a single-year period. The effect of a marginal increase in lowland and upland area on the probability of not having any shortfall in food is similarly about 3–5 times higher for lowland than for upland.

Household size has a positive effect, indicating that households with more family members are likely to face food shortage. This reflects the higher consumption demand of a household with more family members. The results also indicate that the endowment of lowlands and uplands is the major determinant of food shortage, with market access having a statistically insignificant effect. Although market access tends to favor allocation of land from rice to cash crops, household behavior regarding allocation of land to marketable crops seems to be driven mainly by food security considerations. Households, even in locations with good access to markets, continue to allocate the bulk of their land and other resources to food production rather than to generate income.

Incidence of poverty

As explained in Chapter 4, the food poverty line and the income poverty line for the Northern Uplands are estimated to be VND1.3 million and VND1.8 million per capita per year, respectively. The head-count poverty ratio, poverty depth index, and poverty

Table 16. Marginal effects of farm and household characteristics on rice shortage.[a]

Item	No. of years of rice shortage during 10-year period		No. of months of rice shortage in a year	
	Change in rice shortage of those above the limit	Change in probability of being above the limit	Change in rice shortage of those above the limit	Change in probability of being above the limit
Lowland area	–0.265	–0.316	–0.706	–0.543
Upland area	–0.161	–0.192	–0.142	–0.109
Dummy for high market access	0.179	0.213	–0.094	–0.073
Household size	0.045	0.053	0.045	0.035
Dummy for Thai and Tay	–0.133	–0.159	–0.001	0.000

[a]Marginal effects estimated using the McDonald and Moffitt (1980) approach.

severity index are estimated using these poverty lines. Using the food poverty line, 79% of the surveyed households are below the poverty line (Table 17). This ratio increases to 90% if the income poverty line is used. The estimate of poverty for the Northern Uplands for 1998 is 64% (GSO 1998). The survey data used in our study were generated from remote areas of northern mountainous provinces where upland rice production is an important economic activity. Although part of the difference from the GSO figure may be attributed to the difference in the method of estimation (income vs expenditure based), this large gap from the official estimate is indicative of a much higher poverty incidence in these remote provinces than what is captured in the official statistics. The official estimate of poverty for the northern mountainous region for 2002 is 43.9% (or a decline of 20 percentage points, GSO 2002). Assuming that the same percentage point decrease has occurred in the surveyed area also, the poverty estimates for 2002 would range from 60% to 70%. This is indeed a very high incidence of poverty.

The other two indicators of poverty (depth and severity) also point toward a very high incidence of poverty in the surveyed area. Depending upon which poverty line is used, the poverty depth index varies from 0.36 to 0.5. The corresponding national average for 1998 was 0.1 (Glewwe et al 2002). Similarly, the poverty severity index varies from 0.2 to 0.32, with the corresponding national average for 1998 being only 0.03. Thus, compared with the national average, all indicators point toward a very high incidence of poverty in the Northern Uplands.

What factors explain the variations in the head-count poverty index across the sample households? A probit model was estimated with a set of household and farm characteristics as potential explanatory variables. The estimated probit model and the marginal effects are presented in Table 18. As indicated, the incidence of poverty is lower among households with a higher land endowment and better access to markets.

Table 17. Incidence of poverty and poverty gap index computed from sample households by province.

Province	% Poor	Poverty gap index	Squared poverty gap index
Poverty line = VND1,286,833			
Cao Bang	97	0.51	0.31
Ha Giang	89	0.51	0.33
Lai Chai	75	0.30	0.15
Lao Cai	68	0.25	0.11
Son La	78	0.36	0.20
Yen Bai	86	0.41	0.23
All	79	0.36	0.20
Poverty line = VND1,789,871			
Cao Bang	100	0.65	0.44
Ha Giang	97	0.63	0.45
Lai Chai	85	0.44	0.26
Lao Cai	83	0.39	0.22
Son La	90	0.50	0.32
Yen Bai	96	0.55	0.36
All	90	0.50	0.32

Table 18. Probit analysis of poverty incidence using the general poverty line (VND1,789,871).

Item	Coefficient[a]	T-value	Marginal probability
Intercept	0.876		
Lowland area	–0.562**	–2.67	–0.026
Upland area	–0.347***	–4.68	–0.053
Dummy for high market access	–0.459**	–3.29	–0.459
Household size	0.207***	6.45	0.276
Dummy for ethnic Thai/Tay	–0.656***	–4.62	–0.656
Log-likelihood ratio test statistic	107***		
No. of households	862		

[a]*** and ** imply statistical significance at 1% and 5%, respectively.

Households with more members in the family, on the other hand, tend to have a higher incidence of poverty. The marginal effects indicate that a unit increase in upland area holding will increase the probability of the household being above the poverty line by 5.3%. This indicates that augmentation of upland endowment can help reduce poverty since it is the poorer farmers who are more dependent on uplands. As the size of the land area cannot be increased when the land frontier is closed, one important strategy for reducing poverty is by raising the productivity of these uplands so that more output (and income) can be generated from a given physical land area.

Summary

The nature of rice-based production systems in the Northern Uplands was investigated in this chapter. A distinctive feature of upland agriculture in the Northern Uplands is that households often have access to both sloping uplands and wetland paddies in terraces and valley bottoms for rice production. Although the area of wetland paddies is relatively small, households that have access to these fertile resources are able to meet a large proportion of their rice requirements without having to rely too much on rice production in the sloping uplands. These households have tended to use sloping uplands to generate cash income, especially in locations with good access to markets. On the other hand, households whose land endowment consists entirely of uplands are dependent on upland rice production to meet their food needs. These households are also often the most food-insecure and the poorest, with the incidence of poverty among them being much higher than the average reported for the Northern Uplands.

These differences in the impact of land endowment and market access on the characteristics of farming and poverty point to the need for a targeted approach to research and policy interventions. These implications are discussed in detail in the final chapter.

CHAPTER 6
Econometric analysis

Various hypotheses described in Chapter 4 are tested econometrically in this chapter. These hypotheses, posed as research questions, relate to the determinants of fallow period, effects of market access on upland rice area, determinants of labor productivity in upland agriculture, factors determining subsistence orientation of production, and the relationship between upland rice productivity and area planted. Farm-level data generated from the survey were used to test these hypotheses.

Length of fallow period

Intensification of uplands by shortening the fallow period and by increasing the cropping cycle is expected with an increase in population density when the land frontier is closed. The relationship between fallow period and population density is investigated at two different levels of aggregation. At the commune level, the relationship between population density and average fallow period (average across all fields and households) for the whole commune is analyzed. At the plot level, plot-specific information is also included in the analysis in addition to population density.

The length of the fallow period generally drops with an increase in population density (Table 1). The results of the plot-level regression are presented in Table 2. Despite a low overall fit of the model that includes data from 2,780 individual field plots, the effect of population density was found to be highly significant, with the expected negative sign. The estimate implies that the fallow period will decrease by 1 year for every increase in population density by 100 persons per km^2.

Market access and area of upland rice

The effect of market access and resource endowment of households on the allocation of upland area for rice production is investigated here. The proportion of upland rice area to the total upland cropped area is regressed on a set of variables using a tobit model. The size of lowland area operated by the household, distance (measured by travel time) of upland plots from the house, and market access have statistically significant effects on the dependent variable (Table 3).

Table 1. Average population density and fallow period.

Population density (persons per km^2)	Fallow period (years)
< 50	7.0
50–100	4.2
>100	2.5

Table 2. Determinants of the length of fallow periods.

Item	Parameter[a]	Mean
Constant	5.72	
Population density (persons per km^2)	–0.01***	64
Slope of the upland field (degrees)	–0.02***	29
Travel time to upland field (min)	0.003	38
Adjusted R-square	0.27	
F-value	85.12	
Mean length of fallow periods (years)	4.4	
Number of upland plots	2,780	

[a]*** implies significance at the 1% level.

Households with more lowland are less dependent on upland rice for meeting their food needs as they tend to produce rice intensively in lowland fields. Thus, they are more likely to allocate a smaller proportion of upland fields to rice production. The coefficient associated with the distance variable is positive, indicating that upland rice is more likely to be planted in fields that are farther away from the house. This variable probably captures the effect of land characteristics on the choice of field for planting upland rice. Fields that are closer to the house tend to be more intensively cultivated and, if farmers wish to open new land, they normally have to travel farther out from the villages. Such less-intensively cultivated lands are generally fertile and are considered by farmers to be more suitable for upland rice production.

The effect of market access on area allocated to upland rice is negative, indicating that improved access to markets encourages farmers to shift land from upland rice to cash crops. As discussed in Chapter 5, the major cash crop that has replaced upland rice in the Northern Uplands is improved maize. Markets for other cash crops are not sufficiently developed to have much effect on land allocation to upland rice. In addition, other cash crops such as fruits and vegetables are normally grown in home gardens, which are separate from upland rice fields. Thus, as indicated in Chapter 5, despite the shift toward cash crops in areas with better access to markets, farmers still are mainly subsistence-oriented and broad-based commercial agriculture is yet to evolve in the region.

Table 3. Tobit estimation of determinants of the proportion of upland area planted to upland rice.

Item	Parameter[a]	Mean
Constant	51.80	–
Lowland area (ha)	–11.21**	0.26
Household size (persons)	0.72	7.50
Slope of upland field (degrees)	–0.11	31
Travel time to upland field (min)	0.13***	39
Market access dummy	–10.27***	–
Thai ethnic dummy	–12.07**	–
Hmong ethnic dummy	–11.31***	–
Tay ethnic dummy	–34.45***	–
Log-likelihood ratio test statistic	102	
No. of households	973	

[a]*** and ** imply statistical significance at the 1% and 5% levels, respectively.

Labor productivity

An attempt is made to explain differences in labor productivity in a multivariate analysis to explore the population density–productivity link and to identify determinants of labor productivity in agriculture. In this model, it is hypothesized that labor productivity is determined by the size and quality of land, agricultural capital per person (approximated by the value of livestock[1]), human capital (approximated by the highest education level of family[2] members within the working age), and market access. Labor productivity in agriculture is measured as net returns (defined as the value of gross output minus cash cost) per day of family labor used for agricultural production. The total value of agricultural production is the sum of the total value of crop production from lowland and upland fields and the value of livestock production.

Following the Boserupian argument, an increase in population pressure is expected to reduce labor productivity, ceteris paribus. Population pressure and farm size per household tend to be negatively related. Smaller farm size is indicative of higher population pressure and vice versa. Thus, at the household level, farm size can be used as a proxy for population pressure. The expected sign of the coefficient of farm size on labor productivity is hence positive. The estimated parameters indicate that farm size, value of farm capital, education of the household head, and market access all have a positive effect on labor productivity (Table 4). Field slope—a proxy for land quality—has the expected negative sign.

[1]Cattle and buffaloes are the main livestock capital included.

[2]Exchange labor is counted as family labor due to the reciprocal nature of labor sharing arrangements.

Table 4. Determinants of total labor productivity in agriculture.

Item	Parameter[a]
Constant	5.02
Log of farm size (ha)	0.29**
Log of capital (000VND)	0.40***
Education (years)	0.32**
Market access dummy	0.69***
Slope of upland field (degrees)	–0.02**
No. of households	973
Adjusted R-square	0.27

[a]*** and ** imply statistical significance at the 1% and 5% levels, respectively.

Since the model is estimated in a double-log form, the estimated coefficient of farm size can be interpreted as the elasticity of labor productivity. The estimates indicate that a 10% reduction in farm size as a result of rising population pressure is likely to reduce labor productivity by 2.9%. A model for projecting population used in Chapter 8 indicates that the rural population is likely to increase by up to 30% by 2019. Thus, an exogenous improvement in agricultural productivity by at least 8.7% would be needed to maintain labor productivity at the current level. This highlights the need for developing improved technologies for uplands.

Subsistence orientation

The various indicators of subsistence orientation discussed in Chapter 3 are used here to summarize the degree of subsistence orientation of the production system. The relevant indicators for different farm-size quartiles are presented in Table 5. If subsistence orientation is measured by the value of subsistence production as a percentage of total agricultural production (Concept 1), the overall subsistence ratio is high at 86%. The subsistence ratio increases with a decrease in farm size as indicated by the estimate of 82% for the top-quartile farm-size group and 91% for the bottom-quartile farm-size group. When subsistence orientation is measured by the ratio of the value of nonmarketed agricultural produce to total household income (Concept 2) or the share of cash income in total household income, the relationship with farm-size quartiles becomes weak.

For both measures of subsistence (Concepts 1 and 2), income sales of crops, livestock, and home garden products are substantially higher for the least subsistence-oriented farmers (that is, the bottom quartiles) relative to the most subsistence-oriented farmers (the top quartiles) as indicated in Tables 6 and 7. The least subsistence-oriented farmers purchase a larger quantity of rice for consumption, using income generated from these sales.

Table 5. Farm size, income, and subsistence orientation by farm-size quartiles.

Item	Farm-size quartiles			
	Bottom	Second	Third	Top
Average farm size (ha)	0.383	0.708	1.090	2.318
Farm income per capita (US$)	28	22	22	31
Farm income per household ($)	142	139	155	250
Subsistence ratio, Concept 1 (%)[a]	91	88	82	82
Subsistence ratio, Concept 2 (%)[b]	46	54	53	55
Commercialization orientation (%)[c]	39	35	35	36

[a]The share of nonmarketed agricultural produce in the total value of agricultural produce. [b]The share of nonmarketed agricultural produce in total household income. [c]The share of cash income in total household income.

Table 6. Subsistence orientation quartiles (Concept 1) and source of cash income.

Item	Subsistence orientation quartiles			
	Bottom (least subsistent)	Second	Third	Top (most subsistent)
Sale of crops (US$)	102	29	14	6
Sale of animals ($)	122	105	100	81
Sale of home garden products ($)	44	28	14	10
Off-farm income ($)				
Off-farm work	24	36	40	56
Salary and pension	35	37	27	28
Rice purchases per year (kg)	307	210	309	241

Table 8 presents the results of a tobit analysis conducted to identify the factors that determine the degree of subsistence orientation. The dependent variable is the subsistence orientation level (Concept 1). Market access, lowland and upland area, and household size are the major determinants. Farmers in areas with better access to markets are relatively less subsistence-oriented than farmers in areas with a poor access to markets. Similarly, farmers with a smaller land endowment are more subsistence-oriented, as are the farmers with larger family sizes.

Upland rice productivity and area

It was hypothesized that an improvement in upland rice yield will lead to a contraction in area planted as a given output can be produced from a smaller area.

Table 7. Subsistence orientation quartiles (Concept 2) and source of cash income.

Item	Subsistence orientation quartiles			
	Bottom (least subsistent)	Second	Third	Top (most subsistent)
Sale of crops (US$)	55	49	32	15
Sale of animals ($)	169	119	88	30
Sale of home garden products ($)	70	13	10	3
Off-farm income ($)				
Off-farm work	68	41	30	19
Salary and pension	67	35	20	5
Rice purchases per year (kg)	487	275	201	95

Table 8. Tobit estimation of determinants of degrees of subsistence.

Item	Coefficient[a]	Mean
Intercept	7.131***	
Dummy for high market access	–0.185**	
Household size (persons)	0.033***	7.441
Lowland area (ha)	–0.217*	0.255
Upland area (ha)	–0.161***	0.866
Dummy for Thai and Tay	0.261**	
District dummies		
Thuan Chau	–0.473*	
Mai Son	–0.208	
Mu Cang Chai	–0.004	
Tram Tau	–0.207	
Phong Tho	–0.521**	
Tuan Giao	–2.034***	
Bac Ha	–2.422***	
Bao Yen	–1.193***	
Bac Me	–0.673***	
Bac Yen	–0.556**	
Nguyen Binh	–0.313	
Degree of subsistence ratio (Concept 1)[b]		0.860
Log-likelihood ratio test statistic	481***	
No. of households	980	

[a]***, **, and * imply statistical significance at 1%, 5%, and 10% levels, respectively. [b]The share of nonmarketed agricultural produce in the total value of agricultural produce.

Table 9. Characteristics of farm households growing upland rice.

Item	Upland rice yield category		All
	≤ 1 t ha^{-1}	> 1 t ha^{-1}	
No. of households	36	178	214
Household size	6.4	6.8	6.8
Upland rice yield (kg ha^{-1})	652	1,678	1,505
Upland rice area (ha hh^{-1})	0.96	0.58	0.64
Rice production (kg hh^{-1})	602	944	886
Maize production (kg hh^{-1})	401	663	619
Income from nonrice crop sales (US$ hh^{-1})	30	59	54
Income from rice sales ($ hh^{-1})	0	1.3	1.1
Quantity of rice sold (kg hh^{-1})	0	9	8
Income from livestock sales ($ hh^{-1})	31	82	71
Off-farm and nonfarm income ($ hh^{-1})	71	36	42
Rice purchases (kg hh^{-1})	348	288	298
Cash income/total income	0.38	0.43	0.42
Upland area (ha hh^{-1})	1.75	1.14	1.24

The cross-sectional data collected permit the testing of this hypothesis by comparing the area of upland rice planted by various households that obtain different yields, assuming that the effect of other factors can be neglected. A subsample of 210 farmers growing only upland rice, that is, households without access to lowland rice land, was considered. These households were grouped into two groups, one with upland rice yield of less than or equal to 1 t ha^{-1} (low-yield category) and the other with yield of >1 t ha^{-1} (high-yield category), to examine how the production systems of these households differ (Table 9). It was found that the households with higher yields grow less upland rice (i.e., 40% less area) but produce 57% more output. Their income from crop and animal sales is twice as high but their rice purchase is 17% lower than that of the first group of farmers. Overall, this comparison indicates that farmers with a higher yield of upland rice, on average, grow more rice from a much smaller area and purchase a smaller quantity of rice. At the same time, they generate more income from the production of cash crops (mainly maize) and livestock. This difference in resource allocation across different activities is an indication that higher upland rice yield can encourage a reduction in upland rice area and help diversification toward livestock and cash crops.

The hypothesis is tested empirically using an econometric model. Following the model developed by Dutilly-Diane et al (2004), a two-step regression method was used. The first step consists of regressing the observed upland rice yield on a set of exogenous factors. The predicted rice yield from this equation is used as an instrument in the second regression equation in which upland rice area is specified as the dependent variable. This two-step process involving the use of an instrument for yield avoids the problem of the potential bias resulting from the endogenous nature of the yield variable in estimating the area equation.

Table 10. Factors explaining upland rice yield and determinants of upland rice area estimated by two-stage regression.[a]

Item	Yield equation (Stage 1)	Area equation (Stage 2)
	Parameter[b]	Parameter[b]
Dependent variable	Upland rice yield (t ha^{-1})	Upland rice area (ha)
Constant	0.927	0.516
Length of fallow period (years)	0.088***	
Slope of upland field (degrees)	–0.008	
Predicted upland rice yield (t ha^{-1})		–0.236***
Upland crop area (ha)		0.073***
Household size (persons)		0.021***
No. of households	200	200
Adjusted R-square	0.49	0.69

[a]Regression on a subset of data for households having only upland holdings. Ten district dummies are not shown. [b]*** implies significance at the 1% level.

The coefficient associated with upland rice yield in the second-stage equation is negative and statistically significant (Table 10). Thus, the null hypothesis that the level of upland rice yield does not affect the area of upland rice can be rejected at the 5% level of significance. The elasticity of upland rice area with respect to rice yield is –0.55. This indicates that a 10% increase in upland rice yield is likely to result in a reduction in upland rice area of 5.5%. Improved upland rice technologies that increase upland rice yield by an average of 30% could result in a reduction in upland rice area of 16%. Research that leads to the development of more productive upland rice technology could be a more effective way of discouraging the expansion of upland rice area than the administrative regulations that were often used in Vietnam earlier. By relaxing the food security constraint, improved rice technologies are also likely to encourage farmers to use the land and labor resources released from rice production to generate income.

Summary

Various hypotheses tested in this chapter highlight the effect of various drivers such as market access, population pressure, and labor productivity in agriculture of the Northern Uplands. Increased frequency of land use for food production was found to be associated with the rising population density. Although market access generally encourages commercialization, the agricultural production system is still mainly subsistence-oriented, with farmers attempting to meet their food requirement from production within the farm. The finding that lower labor productivity in agriculture is associated with higher population pressure supports the Boserupian hypothesis. Finally, households with higher upland rice productivity were found to be more food-secure, despite a smaller area planted, and to have a higher cash income than those with lower rice productivity. This indicates that improvements in rice productivity can help release land and labor for engaging in other activities that generate income without an adverse effect on household food security. The research and policy implications of these findings are discussed in detail in the final chapter.

CHAPTER 7
Normative analysis of cropping choices

In the previous chapter, various hypotheses on the allocation of land for rice production were evaluated using econometric analyses. The purpose of this chapter is to complement the result by applying a normative linear programming model of a typical upland farm household. Such a modeling approach permits analyses of production responses to alternative assumptions regarding technological improvements, access to markets, and resource endowments. A simple multiperiod linear programming model is developed and used here for analyzing various alternative scenarios.

Model development

The development of a linear programming model requires the specification of an objective function and a constraint set. Many objectives, often conflicting, govern the behavior of rural households. Objectives such as achieving food security, increasing household income, and educating children are usually of prime concern. In addition, there may be many other objectives. Considering these multidimensional concerns, a farmer's objective function is best represented as the maximization of "subjective" utility (Nakajima 1970). The subjective utility can be considered as a function of various attributes suitably weighted by the relative importance households attach to attaining each of them. For quantitative modeling, simplifications are needed for model tractability. Accordingly, the objective function specified here is the maximization of total household income subject to the satisfaction of the rice consumption requirement. This is reasonable as farmers in the upland system view food production as a primary objective. Specification of food needs as a constraint in the choice set ensures that this requirement is first met before any income objectives are addressed.

The seasonality of rice production leads to a variation in food supply during the year. Rice supplies are highest at the harvest of the main wet-season crop and dwindle as the stock is depleted. If rice is grown more than once within the year, additional supplies become available as these crops are harvested. Thus, the availability of rice to meet household consumption requirements changes over time. This seasonal effect on the food supply is an important feature of rural agriculture and has been built into the model using a multiperiod framework. Thus, the model developed here is a multiperiod linear programming model for maximizing household income subject to the satisfaction of seasonal consumption needs.

The data used in the linear programming model pertain to the commune Na Ot of Mai Son District in Son La Province. This commune represents a typical upland village with limited access to markets. Altogether, 87 households were surveyed and data pertaining to different land-use patterns, input-output coefficients, and resource endowments of farmers were collected.

To construct a farm model, it is important to determine the characteristics of a farm to represent the overall production system of the locality. A "typical" farm situation that occurs most frequently is a suitable basis for this. Such a typical farm situation was identified on the basis of discussions with farmers and village leaders during the survey.

The typical household in Na Ot consists of six members, with three working adults. The household operates 370 m^2 of irrigated lowland, 162 m^2 of rainfed lowland, and 4.4 ha of upland. The typical household grows both lowland and upland rice. Rice is grown in the lowlands in the spring and/or autumn seasons. Spring rice is grown in irrigated fields during March-June. Autumn rice, which may be irrigated or rainfed, is grown during July-November.

Upland rice is grown during April-August, mostly as part of a rotation with maize and cassava. The first crop in the rotation after the land is opened up is typically upland rice, which is grown for 2–3 years. Maize and cassava are the main upland crops grown after upland rice. After 2–3 years of maize or cassava, the land is fallowed for 4–5 years. Farmers classify upland fields into two categories, fertile and infertile. Upland rice is a component of the rotation on the fertile land. On infertile land, farmers practice a maize-cassava rotation or the land is used for a forest plantation that consists mainly of bamboo. Typical crop rotations in the area are shown in Table 1.

Rice is the main staple, with farmers supplementing it with cassava whenever rice shortages occur. Maize, fruits, and bamboo are the major cash crops. A very limited exchange of food crops in the market place occurs in the study village.

The rice requirement per person is estimated to be 26 kg of rough rice per month. This is based on the assumption that 87% of the total daily calorie intake comes from rice. During periods of rice shortages, farmers mix rice with cassava. However, the taste deteriorates rapidly when cassava and rice are mixed beyond a certain ratio. To capture this, a cassava substitution constraint was specified with the cassava to rice ratio not exceeding 2:1. A kg of cassava was assumed to be equivalent to 0.33 kg of rice, based on the energy equivalence. These assumptions are based on the standard procedures used by the local governments in Vietnam. Sources of these parameters and detailed justifications of the assumptions are contained in Thien (2002).

Whenever the rice supply is inadequate, the model allows for cassava supplementation up to the limit, and a limited quantity of rice purchase. Transfer constraints were specified to permit surplus rice to be carried forward to the next consumption period or sold at a fixed price. Rice sale in the area is very small as most farmers are deficit in rice.

Table 1. Major crop rotations in uplands of Na Ot, Mai Son District, Son La Province.

Crop rotation
On fertile upland
3 years of upland rice–2 years of cassava–5 years of fallow
2 years of upland rice–3 years of maize–5 years of fallow
2 years of upland rice–3 years of fallow
3 years of upland rice–2 years of fallow
Fruit crops
On infertile upland
Forest tree plantation
1 year of maize–2 years of cassava

Other activities included were fruit and forest tree plantations, and seasonal labor buying and selling. Upper limits on these activities consistent with the current practice of farmers were also included. For perennial crops such as fruit and forest trees, the gross margins used were the annuity calculated based on a planning horizon of 9 years. Input-output coefficients for these perennial crops were the average values over the growth period. Similarly, input-output coefficients for various crop rotations were the average values for the duration of the crop rotations. These simplifications were made because of the lack of year-wise input-output data.

Rice consumption during the year is divided into three periods on the basis of the chronological order of harvesting of rice grown under different rice ecosystems. The first period includes the time interval September-November. During this period, upland rice, normally harvested in early September, is the main source of food. Autumn and spring rice are consumed mainly during the period December-June (i.e., the second period here) and July-August (the third period), respectively. The analysis of land allocation based on temporal variations in rice demand and supply during these three time periods is an important feature of the model developed here.

Gross margins for farm activities were estimated as the gross value of production minus any cash costs involved. In most cases, cash costs are minimal. Hence, gross margin closely follows the gross value of production. Existing market prices, even though some markets are very thin, were used to convert the physical output into value terms. The total gross margin from the farm was calculated as the sum of all individual gross margins. The total household income was obtained as the sum of the total gross margin and any other income such as from the nonfarm employment included in the model.

A limitation of the model is that livestock production and nonfarm employment are not explicitly included in the optimization model. Information on livestock production was not collected in detail enough to incorporate this in the model. Nonfarm employment in the study village is of very minor importance and hence unlikely to have had any major impact on labor allocation among various farm activities. Income resulting from nonfarm employment was included as a fixed income to calculate total household income. The model thus abstracts from the household labor allocation decisions to these activities, and, in this sense, is partial. However, it is hoped that model results and the sensitivity analyses conducted do provide valuable information regarding the trade-offs involved in the allocation of resources to cash and subsistence crops. The basic structure of the matrix is indicated in Table 2.

Model results—base run

The linear programming model with three rice production and consumption periods was used to generate the optimal solution. The model output from the base run was compared with the actual value for the production of rice and the total value of gross margin. As indicated in Table 3, the model results are sufficiently close to the current typical farm situation with respect to the major variables such as rice production.

The base-run output indicates that upland rice accounts for as much as 83% of total rice production. Out of 1.8 tons of rough rice produced, 20% is consumed during the first period and the rest is transferred to the second period. During the second period, 167 kg of autumn rice is harvested. Together with the balance of the upland rice transferred from the first period, this amount is in excess of the requirement of 1,075 kg for the second period. Accordingly, about 15% of the total amount of rice available during the second period is transferred to the third period, during which the spring rice harvest alone is inadequate to meet food needs (358 kg). Overall, upland rice meets the total rice requirement for 9.5 months, with the balance of rice supply coming from lowland rice. Model results illustrate that upland rice is critically important for food security of these farmers as the lowland base is too small to generate an adequate rice supply. As alternative opportunities for generating income are not available, following a market-based strategy to meet household food needs is simply untenable. In this regard, the model confirms the findings of the econometric analysis of Chapter 6.

Scenario construction and assumptions

The above base model is used to evaluate the effects of markets and improvements in rice technology on food security and income status of upland farmers who have different endowments of upland and lowland fields. Two market conditions were assumed. The first scenario has fully competitive markets for food (i.e., rice) and cash crops so that farmers can buy and sell rice at a fixed market price. In the second scenario, the market for food crops was assumed to be nonexistent and farmers meet rice requirements from their own production. Market conditions for cash crops were still assumed to be the same as in the first scenario. The difference in outcomes between these two scenarios (i.e., a perfectly competitive market for rice at the current price and no market for rice) reflects the effect of rice markets.

The assumption of the nonexistent market for rice is obviously an extreme one. In the real world, rice will be available in the market if the price is sufficiently

Table 2. Linear programming matrix.

ROW	OBJECTIVE FUNCTION AND CONSTRAINTS	X1 SRI	X2 ARI	X3 ARR	X4 3R2C5F	X5 2R3M5F	X6 2R3F	X7 3R2F	X8 3M3F	X9 Fru	X10 Fpla	X11 M2C	X12 PLBuy	X13 OLBuy	X14 FRBuy	X15 SRBuy	X16 TRBuy	X17 FRCons	X18 SRCons	X19 TRCons	X20 FCCons
1	NET CASH INCOME	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	IRRIG_Mar-July1.0	0.1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
3	IRRIG_August–November	–	1.0	0.1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
4	RAINFED_August-November	–	–	1.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
5	UPLAND_GOOD	–	–	–	1.0	1.0	1.0	1.0	1.0	1.0	–	–	–	–	–	–	–	–	–	–	–
6	UPLAND_POOR	–	–	–	–	–	–	–	–	–	1.0	1.0	–	–	–	–	–	–	–	–	–
7	Fruit tree areas	–	–	–	–	–	–	–	–	1.0	–	–	–	–	–	–	–	–	–	–	–
8	PEAK_LABOR (1/2 Mar-1/2 Oct)	243	141	141	88	80	71	106	75	85	1	135	(1)	–	–	–	–	–	–	–	–
9	OFF_LABOR (1/2 Oct-1/2 Mar)	33	69	69	40	34	40	60	25	21	16	36	–	(1)	–	–	–	–	–	–	–
10	HIRED LABOR LIMIT	–	–	–	–	–	–	–	–	–	–	–	1	1	–	–	–	–	–	–	–
11	SOLD LABOR LIMIT	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
12	CASSAVA_PERMIT_PERIOD1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	(1.0)	–	–	2.0
13	CASSAVA_PERMIT_PERIOD2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	(1.0)	–	–
14	CASSAVA_PERMIT_PERIOD3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	(1.0)	–
15	RICE_SALE_ LIMIT_PERIOD1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	(1.0)	–	–	–
16	RICE_SALE_ LIMIT_PERIOD2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	(1.0)	–	–
17	RICE_SALE_ LIMIT_PERIOD3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	(1.0)	–
18	RICE_EQUIV_CONSUMPTION_PERIOD1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	0.33
19	RICE_EQUIV_CONSUMPTION_PERIOD2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–
20	RICE_EQUIV_CONSUMPTION_PERIOD3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–
21	RICE_BALANCE_PERIOD1	–	–	–	(367)	(303)	(596)	(729)	–	–	–	–	–	–	(1)	–	–	1	–	–	–
22	RICE_BALANCE_PERIOD2	–	(3,230)	(3,230)	–	–	–	–	–	–	–	–	–	–	–	(1)	–	–	1	–	–
23	RICE_BALANCE_PERIOD3	(4,200)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	(1)	–	–	1	–
24	MAIZE BALANCE	–	–	–	–	(720)	–	–	1,250	–	–	(930)	–	–	–	–	–	–	–	–	–
25	CASSAVA_BALANCE	–	–	–	(4,000)	–	–	–	–	–	–	(12,000)	–	–	–	–	–	–	–	–	1
26	LIVING EXPENDITURE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
27	SOIL EROSION	–	–	–	(197)	(180)	(201)	(297.0)	148.0	(48)	(15)	(230)	–	–	–	–	–	–	–	–	–
28	CASH INCOME888	802	802	–	98	–	0.2	162.0	(4,599)	(624)	150	10	10	2.5	2.5	2.5	–	–	–	–	–
29	CASH BALANCE888	802	802	–	98	–	0.2	162.0	(4,599)	(624)	150	10	10	2.5	2.5	2.5	–	–	–	–	–

Table 2 continued.

ROW	OBJECTIVE FUNCTION AND CONSTRAINTS	X21 SCCons	X22 TCCons	X23 PLSold	X24 OLSold	X25 FRSale	X26 SRSale	X27 TRSale	X28 Msale	X29 Cfeed	X31 Expd	X32 FRTrans	X33 SRTrans	X34 SL	X35 NCI	X36 CT		
1	NET CASH INCOME	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.0		
2	IRRIG_Mar–July	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	<=	0.03723
3	IRRIG_August-November	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	<=	0.03723
4	RAINFED_August-November	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	<=	0.01616
5	UPLAND_GOOD	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	<=	3.4381
6	UPLAND_POOR	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	<=	1.4735
7	Fruit tree areas	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	<=	0.1
8	PEAK_LABOR (1/2 Mar-1/2 Oct)	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	<=	544
9	OFF_LABOR (1/2 Oct-1/2 Mar)	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	<=	181
10	HIRED LABOR LIMIT	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	<=	72.5
11	SOLD LABOR LIMIT	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	<=	72.5
12	CASSAVA_PERMIT_PERIOD1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	<=	0
13	CASSAVA_PERMIT_PERIOD2	2.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	<=	0
14	CASSAVA_PERMIT_PERIOD3	–	2.0	–	–	–	–	–	–	–	–	–	–	–	–	–	<=	0
15	RICE_SALE_ LIMIT_PERIOD1	–	–	–	–	10	–	–	–	–	–	–	–	–	–	–	<=	0
16	RICE_SALE_ LIMIT_PERIOD2	–	–	–	–	–	10	–	–	–	–	–	–	–	–	–	<=	0
17	RICE_SALE_ LIMIT_PERIOD3	–	–	–	–	–	–	10	–	–	–	–	–	–	–	–	<=	0
18	RICE_EQUIV_CONSUMPTION_PERIOD1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	>=	333
19	RICE_EQUIV_CONSUMPTION_PERIOD2	0.33	–	–	–	–	–	–	–	–	–	–	–	–	–	–	>=	1253
20	RICE_EQUIV_CONSUMPTION_PERIOD3	–	0.33	–	–	–	–	–	–	–	–	–	–	–	–	–	>=	418
21	RICE_BALANCE_PERIOD1	–	–	–	–	1	–	–	–	–	–	1.00	–	–	–	–	=	0
22	RICE_BALANCE_PERIOD2	–	–	–	–	–	1	–	–	–	–	(0.95)	1.00	–	–	–	=	0
23	RICE_BALANCE_PERIOD3	–	–	–	–	–	–	1	–	–	–	–	(0.95)	–	–	–	=	0
24	MAIZE BALANCE	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	=	0
25	CASSAVA_BALANCE	1	1	–	–	–	–	–	–	1	–	–	–	–	–	–	=	0
26	LIVING EXPENDITURE	–	–	–	–	–	–	–	–	–	1.0	–	–	–	–	–	=	2135
27	SOIL EROSION	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	=	0
28	CASH INCOME	–	–	(10)	(10)	(2)	(2)	(2)	(1.0)	–	–	–	–	–	1.0	–	=	0
29	CASH BALANCE	–	–	(10)	(10)	(2)	(2)	(2)	(1.0)	–	1.0	–	–	–	–	1.0	=	785

Table 3. Actual and optimal (base run) rice area and production.[a]

Indicator	Actual	Optimal
Rice area (m^2 hh^{-1})	10,977	12,226
Spring rice	373	337
Autumn rice	535	518
Upland rice	10,069	11,371
Rice production (kg hh^{-1})	1,538	1,820
Spring rice	157	142
Autumn rice	173	167
Upland rice	1,208	1,511

[a]Actual data are from a household survey. Lowland optimal rice area (spring and autumn rice) excludes the area for seedbed.

high. Surplus rice from the Red River Delta and other localities can be expected to be transported to these remote uplands if the local market price is high enough to cover the cost of transportation and other associated marketing costs. Price data from Vietnam show that these costs, however, are more than 50% of the market price of rice in the Red River Delta (Ngo 2003). Currently, very little rice is transported from the Red River Delta to the Northern Uplands because of high marketing costs. This is an indication that the cost of production in uplands is still lower than the price of rice brought in from the delta. High marketing costs and irregular market supplies have thus effectively de-linked the rice market in uplands from that of other regions of Vietnam.

Based on the conceptual framework developed in Chapter 3, the effects of market access on land use are likely to be dependent on the initial endowment of lowland and upland also. Hence, the above analysis was repeated under two different endowments of upland and lowland. Rice can be grown in both uplands and lowlands, but upland rice is harvested earlier (September) and provides food during the "lean" months (September-November) when the previous year's food stock is almost exhausted. The "shadow" price of rice during these lean months will tend to be high and this will encourage farmers to meet their food needs by allocating some land for the production of upland rice. An alternative strategy would be to use a stored surplus of lowland rice, if any, from the previous cropping year. However, farmers do not normally have this option as their lowland endowment in the mountainous regions is too small in most cases.

In all of the above scenarios, the effects of improvements in rice technologies were also examined by assuming a disembodied technological change. This basically implies that yield gains result from a general improvement in the productivity of all resources currently being used for rice production. Improvements in rice varieties as well as better management of soil, moisture, and nutrients can result in such technology changes.

Table 4. Scheme for scenario analysis.

		Ratio of upland/lowland endowment	
		High	Low
Market for rice	Fully competitive	Current technology (Scenario 1A) Improved technology (Scenario 1B)	Current technology (Scenario 3A) Improved technology (Scenario 3B)
	Nonexistent	Current technology (Scenario 2A) Improved technology (Scenario 2B)	Current technology (Scenario 4A) Improved technology (Scenario 4B)

A somewhat problematic issue in scenario analyses using linear programming approaches is the incorporation of endogenous changes in prices that may result from different cropping choices. For example, an increase in area of a crop generates additional supplies, which may have a dampening effect on market prices. This endogenous market response needs to be considered in determining the optimal area allocation. While it is possible, although somewhat imperfectly, to capture such endogenous price responses in the programming framework, estimates of the relevant demand and supply elasticity are not available for the upland area being investigated here. The endogenous price effects were excluded in much of this analysis on the assumption that any such responses resulting from marginal changes in cropping choices are likely to be small.[1] This limitation needs to be kept in mind while interpreting the results of the study.

The overall scheme for the scenario analysis appears in Table 4.

Results and discussions

Upland rice is not grown under fully competitive market conditions, even when farmers have a large endowment of uplands (Scenario 1A, Table 5). Rice is grown only in lowlands. Uplands are used for cash crops such as horticulture and maize. All "good"-quality upland is used for horticulture, whereas maize is grown in "poor"-quality upland. Cash income is used to meet rice requirements through purchases in Period 1 (Scenario 1A, Table 5) and to meet rice deficits in subsequent periods. The overall production system is market-oriented.

In the contrasting scenario (i.e., 2A), the market for rice is nonexistent. As a result, upland rice production enters into the optimal solution at the expense of horticulture. Farm income falls by 22% because of this shift of land use from highly remunerative

[1]While analyzing the vulnerability to income shocks below, this issue is addressed by assuming that net income from cash crops drops by 50%.

Table 5. Optional land allocation.

Scenario[a]	Farm income ($)[b]	Upland rice (ha)	Lowland rice (ha)	Horti-culture (ha)	Bamboo (ha)	Maize (ha)
1A	553	0.00	0.08	3.44	0.00	0.98
1B	752	2.06	0.08	0.00	1.40	0.05
2A	431	1.22	0.08	1.40	1.40	0.05
2B	615	0.61	0.08	2.42	0.29	0.78
3A	538	0.00	0.66	1.50	0.00	0.98
3B	652	0.90	0.66	0.00	0.03	0.96
4A	378	0.23	0.42	1.11	0.00	0.96
4B	410	0.12	0.42	1.30	0.00	0.96

[a]For a description of scenario, see Table 4. [b]Exchange rate: US$1 = VND12,000.

horticultural crops to upland rice. The cash crop area is reduced as part of the upland area is diverted to rice production. More than 80% of the annual rice consumption requirements are met from uplands, with some supplementation from lowlands. The total output of upland rice is 1,483 kg. After meeting the rice consumption needs of Period 1, the balance of this total output is carried forward to the subsequent periods. In this scenario, the food security constraint prevents farmers from fully exploiting the opportunity for income gains from cash crop production.

How vulnerable are the households if they adopt the market-based strategy as exemplified in Scenario 1A relative to the food security strategy of Scenario 2A? Under the given conditions of Scenario 1A, the market-based strategy is superior as food needs are met while generating cash income. Relative to the food security–based strategy, farm income increases by 28%. Such opportunities for income growth through market-oriented land use can be an important escape pathway out of poverty. However, the market-based strategy can increase the vulnerability of "falling back" into poverty or falling even deeper into poverty. For example, if the gross margin from horticultural crops were to fall to half of its value relative to Scenario 1A, households would be barely able to purchase rice because of income shortfalls of nearly 50%. Collapse of the market price of cash crops is not an uncommon phenomenon in developing countries with poorly developed marketing infrastructure and institutions. This has happened in several instances in Vietnam (Vietnam Development Report 2004). A way of reducing this vulnerability is to provide self-insurance by producing the required food. This is the strategy currently used by most households in poorly accessible uplands.

How would Scenario 2A change if improved technologies that double the current yield of upland rice were available? This situation is examined in Scenario 2B. All rice needs are met from rice production from within the farm, but this can now be done by growing upland rice on half of the area relative to Scenario 2A. This means that part of the land and labor resources formerly tied up in the production of upland rice is now released for growing horticultural crops that generate cash income. Farm

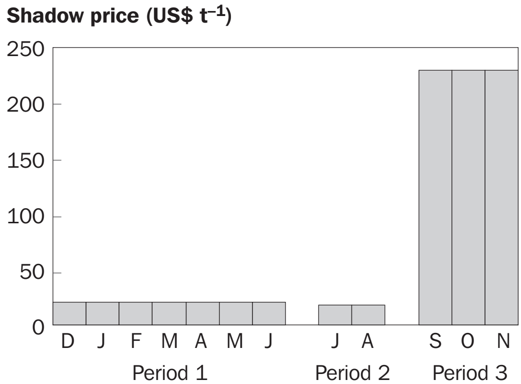

Fig. 1. Shadow price of rice during different months.

income increases by 43% relative to Scenario 2A, assuming that farm-gate prices of horticultural crops remain constant. Improvements in upland rice technology can thus lead to a reallocation of resources toward cash production by relaxing the food security constraint. Also, a shift in land use toward perennial horticultural crops can generate environmental rewards in terms of reduced soil erosion. However, this effect is not included in the model.

Scenario 4 demonstrates a process similar to that of Scenario 2 examined previously. As households have relatively larger lowland holdings, rice needs for Periods 2 and 3 are met from rice production in lowlands. Hence, food production in uplands is less critical under this resource endowment pattern. However, enough upland rice still needs to be produced to meet the food needs during Period 1, in which rice cannot be obtained from the market (or when rice is too expensive to purchase). In effect, the "shadow price" of rice is much higher during the lean Period 1 than during Periods 2 and 3. This is demonstrated in Figure 1. Once the consumption needs for Period 1 are met, the shadow price of upland rice drops sharply, and its production beyond consumption needs is not economical. Thus, Scenario 4 demonstrates the "time value" of upland rice and explains why, under poorly functioning rice markets, the production of upland rice is important even for households that may have access to some lowlands.

Conclusions

As demonstrated in Scenarios 2B and 4B, improvements in the productivity of upland rice when rice markets are poorly functioning lead to a reduction in the area of upland rice and an expansion of area under cash crops. This result was also supported by the econometric analysis presented in Chapter 6. Higher productivity means that less land and less labor are needed to meet food needs. The surplus resources are used to generate income through cash cropping or by engaging in some other form of income-generating activity. Environmental benefits also arise if the land released is used for growing crops that help reduce soil erosion by providing a better ground cover such as fruits and timber. Thus, the strategy of raising the productivity of food crops can be critically important for both income growth and environmental protection. As discussed earlier, the vulnerability of households to food insecurity and poverty is also reduced to a certain extent in the process. Rice productivity improvement can thus be an important strategy for escaping from poverty while assuring food security. Improvements in household food security can thus facilitate and reinforce the process of commercialization rather than negating this process as is believed in some policy circles.

The implication of this chapter is that a more gradual approach that is based on enhancing food security first before launching a major commercialization program for uplands is likely to be more successful in bringing about the desired change (von Braun and Kennedy 1994). Examples abound where commercialization programs that did not give due consideration to food security have performed poorly in the uplands of Vietnam and elsewhere. Therefore, as shown in both the econometric and normative analysis, a superior strategy is to help farmers achieve household food security while gradually facilitating the process of commercialization. The vulnerability of poor subsistence households with little marketing experience would tend to increase significantly if they were left to fend for themselves in a poorly functioning market place.

CHAPTER 8
Long-term implications for food security and poverty in uplands

In the last chapter, the impacts of population growth and commercialization were analyzed using a comparative static framework. However, the socioeconomic conditions and relationships that were found in the survey may change over time because of the dynamic aspects of population growth, investment, technical change, and social differentiation. Increasing population pressure is an important factor affecting household allocation decisions for land and labor.

This chapter will concentrate on two dynamic aspects of the impacts of population growth and commercialization on poverty and food production. Decreases in the land-person ratio resulting from population growth may induce changes in technology and intensify the use of labor and other inputs. Such induced changes in technology may have a negative impact on food security and equity. Similarly, improvements in access to markets are expected to increasingly commercialize the production system. Simulation of the effects of these changes on food production and labor absorption in uplands can provide some insights into the nature of interventions needed for upland development. In this chapter, we use a scenario analysis based on static simulation to investigate the likely effects of increases in population pressure and improvements in market access.

Simulation method

The static simulation approach used has two basic components. The first is the projection of population growth for the next 20 years. Population growth is assumed to be exogenous. Both the labor supply and food demand increase as a result of population growth. These are projected using a population demography model and a constant consumption demand per capita, weighted for different age groups and gender.

The second component is the projection of agricultural output, given the changing land-labor ratio. This is achieved using the current relationship between the land-labor ratio and agricultural productivity. The projection is "static" as this relationship between the land-labor ratio and agricultural productivity is assumed to remain unchanged. Thus, changes in the land-labor ratio for a household from one quartile group to the next result in a new cropping combination and labor use that are practiced by households that were already in that quartile group.

The demographic component

Population pressure is an important factor influencing the intensification of uplands. This may take the form of shorter fallow periods, longer cropping cycles, and changes in cropping patterns. These processes indirectly affect crop yields. As presented in an earlier chapter, high population growth in the Northern Uplands is the result of local population growth and the resettlement of lowlanders in uplands. Most of these resettlement programs implemented during the 1960s and 1970s have been recently slowed down or completely phased out. However, a combination of high birth rates and lower mortality due to improvement in health services has kept the rate of population growth at more than 2% among highland communities.

Food demand and the labor supply of a given population depend on age and gender composition. Children and older people contribute to food demand without adding to the labor supply to the same extent as adults do. Similarly, consumption demand and labor-supplying capacity also vary by gender. Thus, a population demography model that can keep track of different age cohorts and gender over time is needed for the purpose in hand. For brevity, it was assumed that neither immigration nor emigration will occur in the region during the simulation period and the currently observed demographic parameters (fertility and death rates) will continue to remain unchanged.

The population of the Northern Uplands in the base year of 1999 was taken from the Statistical Yearbook 1999. As this yearbook does not classify the total population by sex and age group, this classification for the Northern Uplands is achieved using the percentage ratio in the rural area applicable for 1993 as reported in the Inter-Censal Survey. Appendix Table A.1 presents the 1993 rural population classified by sex and age group together with corresponding fertility rates. These age and sex structures are applied to the base-year population to obtain the gender and age composition for 1999 (Appendix Table A.2). National fertility rates in the rural area based on the results of the Inter-Censal Demographic Survey of 1993 were also applied for the Northern Uplands and adjusted to generate the latest reported population growth rate of the region of 1.4% per annum[1] (GSO 2003).

The number of females in their reproductive age groups and respective fertility rates are used to derive the total number of births, which are then classified into the number of males and females using the assumed sex ratio of 0.49:0.51. Survival rates adopted from the West Model Life Table[2] are used to estimate the age and gender composition. The applicable survival rates for Southeast Asian countries in Ueda

[1]It is to be noted that this population growth rate is much lower than the historical growth rate of over 2% per annum. Also, many remote provinces in the Northern Uplands have population growth closer to 2% per annum even though the overall population growth rate for the Northern Uplands is 1.4% per annum.

[2]Coale-Demeny West models. See UN (1967). UN Manual IV: Methods of estimating basic demographic measures from incomplete data, ST/SOA/Series A/42, New York, 1967, p 94.

(1980) were used. Projections of male and female populations in five-year intervals for the next two decades are shown in Appendix Tables A.3 and A.4. A summary of the projected total population for 2009 and 2019 and corresponding number of labor equivalent and consumer units[3] is presented in Table 1.

The population of the Northern Uplands is projected to grow from the base-year value of 10.7 million to 12.4 million in 2009 and 14.5 million in 2019 (Table 1). This increase corresponds closely with the growth rate of 1.4% per annum for the Northern Uplands recently reported by the General Statistical Office for 1995-2002. Given the population structure with a high proportion in the young-age cohorts, the growth rates of consumer units and adult equivalent units of the region are expected to be higher than the general population growth rates. The respective growth rates of 2.0% and 2.3% per annum for the consumer units and adult equivalent units derived from the population projection in Table 1 are used for simulation.

The land-labor ratio corresponding to the projected population is derived by assuming that there is no significant area of new land available for opening. This is a reasonable assumption under the current situation in the Northern Uplands. The distribution of projected population by land-labor ratio quartiles for 2009 and 2019 is shown in Table 2. In 1999, 25% of the population fell into the group of smallest land-labor ratio (least amount of land), but, 20 years later, 54% of the population will be in this land-poorest group. This distribution of land-labor ratio is based on the assumption that there will be no significant growth in nonfarm employment opportunities to absorb this increased population. This is a somewhat restrictive assumption and, to the extent that labor dependency on agriculture decreases because of outmigration and the growth of nonfarm employment, the shifts in the land-labor ratio will be less than what is projected here. The implication of this for the qualitative aspect of the result is discussed later in this chapter.

Crop production component

The current cropping systems of the region are subsistence-oriented in basic food crops, that is, rice, maize, and cassava. While lowland fields are invariably planted to irrigated rice, the shares of upland area planted to upland rice, maize, and cassava ranged from 77% to 91%. The proportion of area planted to major cash crops is 3% to 4% in lower land-labor ratio quartiles and 20% in the top land-person ratio quartile (see Table 3). The differences in land use, labor use, and yield across these quartile groups capture the effect of the varying land-labor ratio. The bottom quartile represents the highest population pressure on land and the top quartile represents the lowest population pressure. In general, labor use per unit of land and yield increases

[3]Labor equivalent refers to the amount of full-time agricultural labor provided by an adult male in the age group of 15–54. The labor supply from males of other age groups and from females is converted to the labor equivalent unit using the conversion factors used in Vietnam. Consumer equivalent similarly refers to the food consumption requirement of an adult male in the age group of 15–54. For other age groups and for women, respective weights commonly used in Vietnam are applied to convert to their consumer equivalents. See notes of Tables 3 and 4 in Chapter 5 for a definition and computation of consumer and adult equivalent units.

Table 1. Projection of population by sex and age groups, consumer units, and adult equivalents for the Northern Uplands, 1999-2019 (× 1,000).

Age group	1999				2009				2019			
	Males	Females	Consumer units[a]	Adult equivalent units[b]	Males	Females	Consumer units[a]	Adult equivalent units[b]	Males	Females	Consumer units[a]	Adult equivalent units[b]
0–4	821	692	303	0	686	669	271	0	748	729	295	0
5–9	773	660	717	143	629	614	621	124	716	700	708	142
10–14	679	576	912	251	798	675	1,070	294	667	652	957	264
15–19	591	540	996	1,131	760	650	1,247	1,410	618	605	1,072	1,223
20–24	509	493	879	1,002	664	565	1,088	1,229	780	662	1,276	1,442
25–29	479	468	830	947	574	527	969	1,100	737	634	1,213	1,371
30–34	395	385	684	780	492	478	851	970	641	548	1,053	1,190
35–39	270	274	476	544	460	452	799	912	551	509	933	1,060
40–44	180	185	319	365	376	369	653	745	468	459	812	927
45–49	153	167	278	320	253	260	448	513	431	429	753	860
50–54	150	166	275	316	164	173	294	337	343	345	602	688
55–59	158	148	269	184	134	152	248	171	221	236	399	275
60–64	125	134	225	122	123	144	231	126	135	150	247	134
65–69	92	111	175	95	118	119	207	111	100	122	192	104
70–74	57	75	113	0	80	95	152	0	79	102	156	0
75–79	37	55	78	0	47	64	95	0	60	69	112	0
80+	25	47	60	0	16	25	34	0	23	31	46	0
Total	5,494	5,176	7,588	6,200	6,373	6,031	9,278	8,044	7,319	6,982	10,824	9,679
Total population	10,670				12,404				14,302			

[a]The number of consumer-equivalents is computed by using multiplicative coefficients of 0.2, 0.5, and 0.75, and 1 for males and 0.2, 0.5, 0.7, and 0.75 for females for the age groups ≤5 years, >5 and ≤9 years, >9 and ≤14 years, and >15 years, respectively. [b]The number of adult-equivalents is computed by using multiplicative coefficients of 0, 0.1, 0.2, 1.0, 0.6, and 0.47 for both males and females for the age groups ≤5 years, >5 and ≤9 years, >9 and ≤14 years, >14 and ≤54 years, >54 and ≤59 years, and >59 years, respectively.

Table 2. Distribution of sample population by land-labor ratio quartile, 1999-2019.

Land-person ratio quartile (ha per adult equivalent)	% share of households	Share of sample population (%)[a]		
	1999[b]	1999[c]	2009[c]	2019[c]
< 0.152	25	26.0	37.8	54.5
0.152–0.228	25	24.7	25.3	23.2
0.229–0.354	25	24.9	22.6	14.6
> 0.354	25	24.4	14.3	7.7
Total	100	100.0	100.0	100.0

[a]Based on the growth rate of 1.4% per annum corresponding to the population projection calculated in Table 4 in Chapter 5. [b]Households are grouped into quartiles based on land area per adult equivalent applicable to the household. The number of adult equivalents per household is computed using multiplicative coefficients of 0, 0.1, 0.2, 1.0, 0.6, and 0.47 for both males and females for the age groups ≤5 years, >5 and ≤9 years, >9 and ≤14 years, >14 and ≤54 years, >54 and ≤59 years, and >59 years, respectively. [c]This refers to the percentage share of population for each household quartile.

Table 3. Crop area, labor input, and yield (baseline year = 1999).

Item	Land-labor ratio quartile				
	Bottom	Second	Third	Top	All
Area shares of upland crops (%)					
Upland rice	41	51	44	35	40
Maize	28	29	33	34	32
Cassava	15	11	10	8	10
Annual cash crops	3	4	9	20	13
Home garden	12	6	3	3	5
Labor use (days ha^{-1})					
Lowland rice, wet season	322	315	293	302	309
Lowland rice, dry season	306	306	311	295	306
Upland rice	313	294	255	241	273
Upland maize	233	210	196	172	197
Upland cassava	261	247	247	228	243
Yield (t ha^{-1})					
Lowland rice, wet season	3.34	3.10	2.92	3.06	3.12
Lowland rice, dry season	3.20	3.22	3.25	3.26	3.22
Upland rice	1.51	1.45	1.57	1.58	1.53
Upland maize	2.20	1.84	2.58	2.33	2.23
Upland cassava	11.75	11.07	9.78	9.12	10.47

Table 4. Average production of major food crops and per capita caloric intake.

Item	Baseline 1999	2009[a]	2019[a]
	(Index: 1999 = 100)		
Population	100	116	134
Labor force	100	122	143
Consumer unit equivalent	100	130	156
Labor input in crop production	100	103	107
Food crop production			
Scenario 1[b]	100	103	106
Scenario 2[c]	100	110	121
Scenario 3[d]	100	119	142
Scenario 4[e]	100	126	158
Per capita caloric intake			
Scenario 1[b]	100	82	68
Scenario 2[c]	100	92	86
Scenario 3[d]	100	92	85
Scenario 4[e]	100	101	103

[a]Projection based on agricultural population growth of 1.4% per year calculated in Table 4 in Chapter 5. [b]Yield of lowland and upland food crops remains unchanged. [c]Yield of lowland rice increases by 2% per annum and yield of upland food crops remains unchanged. [d]Yield of upland food crops increases by 2% per annum and yield of lowland rice remains unchanged. [e]Yield of lowland rice and upland food crops increases by 2% per annum.

with declining land-labor ratios for upland rice, maize, and cassava. These findings are in general agreement with the Boserup hypothesis. The adjustment process may take the form of longer cropping cycles, shorter fallow, and higher input of labor per unit of land.

Impact of increasing population pressure on labor use, food crop production, and calorie intake

Decreasing land-labor ratios due to population growth result in the movement of the household from a higher to a lower land-labor quartile. The effect on land use and food production can be simulated under this assumption using the information contained in Table 3. For example, if a household moves from the top land-labor quartile to the third quartile as a result of population increase, crop productivity and land use will also change to that representing the third quartile. A new production scenario can then be developed by aggregating the responses of households across the various land-labor quartiles.

Under the assumption of no major changes in exogenous technology and the existing farming systems, labor use in food crop production is expected to increase only 3% by 2009 and 7% by 2019, while the labor force of the same population is ex-

Table 5. Effect of various scenarios on poverty reduction from the baseline level (percentage points).

Scenario	Bottom quartile	Second quartile	Third quartile	Top quartile	Overall
50% increase in upland rice yield	7[a]	9	7	4	6
50% increase in lowland rice yield	6	7	14	15	11
100% increase in upland rice yield	12	18	16	9	14
100% increase in lowland rice yield	8	16	29	27	20
50% increase in noncrop income	2	6	2	5	4
50% increase in upland and lowland rice yield	13	19	20	19	18
50% increase in noncrop income and upland and lowland rice yield	12	28	25	22	22

[a]To be interpreted as a 7 percentage points reduction in poverty from the baseline level.

pected to increase by 22% by 2009 and 43% by 2019 (Table 4). Obviously, agriculture alone will not be able to effectively absorb this rapidly growing labor supply. With no exogenous change in food production technology, food output in 2019 will increase by only 6% (Scenario 1), resulting in a decrease in the per capita calorie intake to 68% of the baseline value. Per capita calorie intake will decrease even under the assumption of exogenous changes in food productivity, except for Scenario 4, in which the yield of both upland crops and lowland rice is assumed to simultaneously increase at 2% per annum relative to the benchmark value for each quartile. It is worth noting that, during the benchmark year of 1999, a large proportion of households were not able to fully meet their food requirements. Thus, even Scenario 4 represents a situation that is only marginally better than the status quo.

What are the likely effects on poverty of alternative scenarios for productivity growth and income generation? The results show that an increase in upland rice yield will generate greater equity effects (as evaluated in terms of the extent of poverty reduction of lower income quartiles) than an equivalent increase in lowland rice yield. For example, a 100% increase in upland rice yield will reduce the incidence of poverty in the lowest income quartile group by 12 percentage points while a similar increase in lowland rice yield will reduce the poverty of this group by 8 percentage points only (Table 5). The total effect on poverty reduction is higher, however, with improvements in lowland rice yield. This indicates that rice productivity improvement as a strategy for poverty reduction involves a trade-off between the overall poverty reduction and the poverty reduction of the lowest income groups.

The results also indicate that, under the baseline land-use system and income structure, a 50% increase in noncrop income will have only a modest effect on poverty reduction. The poverty impact of such an increase in noncrop income is less than that of a 50% increase in the yield of upland and lowland rice simultaneously. This effect is basically due to the small proportion of noncrop income in the baseline situation. Even under the last scenario of simultaneous increases in noncrop income and

Table 6. Changes in land allocation and income per household affected by market access improvement.

Item	Poor market access	Improved market access	Percentage of change
Upland rice area in total upland area (%)	42	40	–5
Maize area in total upland area (%)	32	40	+25
Maize yield (t ha^{-1})	2.1	2.6	+24
Off-farm income (US$)	65	81	+24
Cash income ($)	204	308	+51
Income from livestock ($)	86	128	+50

rice yield by 50%, the overall poverty ratio will still remain high. This indicates that poverty, especially among the very low income groups, may be governed by limited resource endowments (such as land, labor, and human capital) of the poor and agricultural productivity improvement alone may not be sufficient to lift them above the poverty line. Broader interventions to raise the overall income-earning capacity of those people may be needed to overcome the deeply entrenched poverty.

The effect of improved access to markets is similarly projected by assuming that, with improvements in access to markets, farm households with poor access to markets would adopt the land-use pattern observed in areas with better access to markets (Table 6). Thus, environmental variations and other factors that affect land-use patterns are assumed away in these simulations. The simulation results indicate that the proportion of upland area devoted to upland rice will decrease slightly from 42% to 40%. The area under maize will expand slightly. Most of the increase in income will come, under the assumption made, from cash crop production and livestock. Thus, improvements in market access are likely to result in a substitution of upland rice by maize and other cash crops. This is also expected to raise overall income.

These scenario analyses based on the static model used provide some insights into the likely impact of different interventions on land use and poverty. Such "what-if" analyses can also be helpful in assessing a range of policy options for upland development. A limitation of this approach, however, is that the results are derived on the assumption that "other things remain the same" and, hence, are unable to capture the dynamic feedback resulting from various interventions. In particular, the population pressure on agriculture will be lower than what is projected if out-migration or expansion of nonfarm employment absorbs much of the labor growth. The additional sources of income will help reduce the projected poverty level. Any improvements in agricultural technologies for food production, even under the scenario of an increase in other sources of income, would continue to have an important role in reinforcing poverty reduction.

Summary

This chapter used a simplified population projection model to estimate the population size, consumer units, and labor equivalents expected in 2009 and 2019. The population is expected to increase by 34% of the base-year value by 2019. However, the demographic composition in the base year, in which the share of the younger age group is high, implies that labor equivalent and consumer unit equivalent values will grow by 56% and 43%, respectively, by 2019. Substantial increases in food production and employment opportunities would be needed to maintain the baseline year value of consumption and employment.

Using a static land-use model based on the baseline pattern grouped according to land-labor quartile, the simulation results show that labor absorption in agriculture under existing technology will be too small to absorb this increased population. Improved labor-intensive technologies and nonfarm employment opportunities would need to be developed to absorb the growing labor force. Failure to do so is likely to result in a major out-migration to already heavily populated urban centers.

Increases in productivity of upland crops by at least 2% per annum are needed to keep per capita calorie consumption at the baseline level. In the face of rising population, per capita food availability is likely to decrease over time without such technologies. Thus, there is a need to develop better agricultural technologies.

The simulation of the effect of various interventions on poverty reduction indicates that improvement in upland rice productivity will have a larger poverty reduction effect among poorer households. Thus, research aimed at developing improved upland rice technologies would tend to have some equity effect. However, productivity improvement of lowland rice will have a larger impact on lowering the average poverty rate. The results also show that agricultural productivity improvement can generate substantial poverty reduction effects although this alone will not be able to eliminate deeply entrenched poverty. A broader set of interventions that improve the access of households to productive employment opportunities is needed together with agricultural productivity enhancement to reduce overall poverty in the Northern Uplands.

CHAPTER 9

Toward a research and policy agenda for upland development

In this concluding chapter, the situational analysis conducted and the questions that were raised at the beginning of this research are revisited in the light of the results obtained. The discussion in this last chapter ultimately aims to put the findings of this case study in the larger context of the economic development policy in Vietnam. To this end, recommendations are submitted for designing policies, strategies, and research programs that are compatible with the pro-poor growth paradigm for achieving socially inclusive and regionally balanced development. Such a paradigm is deemed necessary for designing strategies that are able to significantly reduce food insecurity and vulnerability to poverty of households in the Central and Northern Uplands of Vietnam.

In the following, the overall status of Vietnam's development policies is briefly revisited and then the findings from this research are interpreted in a wider development policy context and lastly some recommendations are submitted toward a research agenda for sustainable development of upland agriculture.

Revisiting the overall picture

Before setting out the wider implications of this study, it is useful to revisit some related agricultural development policy issues in Vietnam. The current performance of agriculture is a direct result of the policies and strategies that have been introduced by the government of Vietnam since the late 1980s. These policies have been clearly geared toward market reform and aggregate economic growth. Like in many other developing countries and emerging market economies, regional development concerns have played only a secondary role. Reduction of regional disparities was sought through a policy of redistribution of income and transfer payments to backward regions. Although this policy was not very successful in making development more equitable, as evidenced in the current high rates of rural poverty as found in this study, income redistribution strategies still very much occupy the mindset of national-level policymakers. Also, planning procedures are often not flexible enough to fully reflect the real-world conditions in the remote rural areas for designing effective rural development strategies.

To understand the bias toward achieving aggregate economic growth that still exists among some policymakers in Vietnam, one needs to examine the performance of the economy in the recent past.

Vietnam's impressive economic growth during the past decade is the result of a series of policy measures that have gradually moved the country toward a market-based economic system. In the high-potential agricultural areas, poverty reduction was largely facilitated by the *doi moi* policy reforms and can be linked to the effects of land redistribution that gave farmers greater incentives to increase productivity. However, although the de-collectivization policy has generally increased efficiency of the farming sector and has generated one-off gains, the impact of these reforms may have largely been exhausted by now. When disaggregating the positive overall picture into regional strata, the economic growth-based achievements are much less impressive in some regions. As this research has shown, for example, farmers in the Northern Uplands who rely on the production of upland rice in unfavorable areas have had few opportunities to improve their family livelihoods. Although market-based opportunities for income growth are emerging, especially with the implementation of targeted programs such as Program 135, the pace of change is not adequate enough to result in any substantial reduction in poverty. A large proportion of farmers in upland areas remain food-insecure and extremely poor despite the general improvement in food supply at the national level and lower food prices in urban markets.

By and large, the assumption has been that poverty will decline if economic growth will continue at high rates for a long time. While in general this may be true, reliance on this policy ignores the vulnerability of poor households to external shocks. Caused by ecological, economic, or political disruptions, external shocks can worsen the already existing interprovincial disparity in welfare and economic development. There is little doubt that the existing regional pattern of poverty and the growing vulnerability of poor rural households hamper prospects for development. A good example is the emergence of some recent external shocks such as the drop in coffee prices. Hence, even in those provinces in Vietnam where rapid economic progress has occurred, vulnerability of rural households to fall back into poverty has been shown to be high (Justino and Litchfield 2002). Further advances in poverty reduction will therefore much depend on appropriate measures to establish effective and efficient safety nets for poor farmers.

Conclusions to be drawn from the results of this research

In general, the results of this study reinforce the observations that, in the remote upland areas and less favorable ecological environments in Vietnam, poverty is likely to remain high and, perhaps more importantly, vulnerability to poverty may even increase. This conclusion must of course also be seen from the viewpoint of developments outside the agricultural sector and thus cannot be disconnected from issues that were not examined in this study. However, it will be useful to put the results of this study in the perspective of broader development issues.

First, the government has acknowledged the problem of regional disparity and has been active in implementing pro-poor development strategies such as the National Targeted Programs on Poverty Reduction. These programs include infrastructure spending in remote areas (Program 135) as well as targeted programs for micro-credit, health insurance, education, sedentarization, and agricultural extension. The government regards these programs as the cornerstone of its antipoverty strategy in upland areas and has committed some two billion dollars over a five-year period. However, experience has shown that the impact of these programs has been uneven. In this regard, the dominance of the central planning approach raises some questions, for example, is adequate attention given to the concept of participatory planning, to indigenous preferences, local knowledge, and natural resources? Furthermore, quality of governance, reliability of the legal framework, efficiency of the budgetary system, and the service orientation of public administration are critical factors for success. Here, the danger remains high that well-intentioned reforms and poverty reduction programs will fall in jeopardy to vested interests or will be hampered by bureaucratic bottlenecks.

Second, the progressing integration of Vietnam with the world economy will generate further growth in private business. This development will take place primarily in urban centers and will accelerate ongoing rural-urban migration. Although this process can have positive effects on rural poverty reduction, it can make the rural poor more vulnerable because the proportion of their household income that is affected by business cycles and global economic shocks will increase. In addition, globalization of the economy will raise relative wages of skilled labor and will therefore potentially widen the gap between educated and uneducated parts of the population, who tend to live in those areas. These general development trends underline the two major conclusions from this research.

First, the results of the analysis have shown that a policy of rapid commercialization of upland farming in remote areas of Vietnam is unlikely to be successful in reducing poverty. A rapid modernization of upland agriculture requires incentives that attract farmers into growing cash crops whose markets are often volatile. As shown by numerous previous research on case studies of the commercialization of agriculture around the world, the achievement of food security must be a component of efforts that strive to strengthen the market integration of small-scale farmers in developing countries (von Braun and Kennedy 1994). Inadequate market institutions, lack of infrastructure, insufficient insurance markets, and weak communal safety nets create a risky socioeconomic environment that can make the rural poor more vulnerable despite short-term successes in reducing income-poverty. Also, the consumption constraints may restrict farmers' cropping choices and hamper the process of income growth. In view of this experience, a strategy of gradual market integration, which is accompanied by the development of locally adaptable technologies for food crops, is recommended. The second conclusion of this study is that, despite the impressive growth in rice productivity and improved export capacity, upland rice continues to play a decisive role in the food security strategy for the poorest rural households in the upland areas of Vietnam. This result does not necessarily correspond with the view held by many central-level policymakers who tend to blame upland rice for some of the serious environmental problems observed in mountainous areas. Although the environmental question has not been addressed in this research, the analysis by means of a household model using mathematical programming (Chapter 7) has demonstrated that, for people who eke out a living in these harsh environments, subsistence production remains a vital food security strategy. Even though upland rice may constitute only a small part of the overall food intake, it is an essential component of the livelihood of poor households because it meets food needs during the "hungry months" in the seasonal calendar when the food supply from the more productive lowlands is inadequate.

In summary, the viewpoint that the growing supply of rice and declining rice prices are sufficient indicators of food security ignores the reality of food market conditions in the upland areas of Vietnam. As long as the connection of upland farm households to food markets remains weak and as long as the risk of market failure is high, production of upland rice will remain a vital part of their livelihood strategy. Hence, a strategy toward modernization and commercialization of upland farming will be more successful if it incorporates public support for the development of upland rice technologies that facilitate resource transfers to other farm and household activities. In the next section, some recommendations for a research and policy agenda are offered.

Recommendations for a research and policy agenda

Before deriving some recommendations toward an action framework of agriculture in the Northern Uplands of Vietnam, the question of why past policies have largely failed in reducing poverty in these marginal areas is revisited briefly. In order to come up with realistic recommendations, it is also informative to assess the rationale, structure, and conduct of these past policies.

As pointed out earlier, it is important to understand that in the past the central government vigorously promoted a market-based development strategy. This strategy was very much in line with the overall economic growth paradigm that was dominating development policy thinking in Vietnam during the 1990s. However, the success of a policy for reducing food insecurity and poverty to induce upland farmers to quickly move into cash crops in areas with poor access to markets has been limited.

Why then has the government of Vietnam not paid more attention to a strategy to support investment in resource conservation and improving the productivity of subsistence agriculture, which is now being followed by some countries in Asia? A major reason for not pursuing a more socially inclusive strategy of upland development can be seen in the complex socio-cultural situation that characterizes the human population in these upland areas. Integration and the identification of the role of the socially and politically marginalized ethnic minorities in Vietnamese society are a complex socio-cultural and political problem that may sometimes overburden development planners whose horizon is more geared toward quantitative planning targets in terms of growth in output and productivity. As a result, misguided perceptions regarding upland agriculture tend to color policy decisions. For example, such misperceptions are responsible for blaming deforestation and environmental degradation of uplands solely on shifting cultivators and have led to the banning of shifting cultivation.

The second reason is a limited understanding of the complexity of livelihood strategies applied by the poorest among upland households. This is particularly pronounced as regards the role of upland rice in the livelihood systems of rural households. Development planning that is geared toward achieving aggregate targets in food production and supply and that ignores the seasonal and time dimension of food production and availability can ultimately lead to a misjudgment and undervaluation of upland rice's contribution to poverty reduction. Often, government policies have promoted cash crop production prematurely and discouraged farmers from growing food crops.

In order to promote a change in the way upland agriculture is looked upon in the context of a national development policy, four main recommendations are proposed. The first outlines how a more food security–conscious strategy of agricultural commercialization can be linked to the larger framework of a pro-poor growth and a pro-active social protection strategy. The second relates to the need to increase investments in agricultural research for raising productivity in uplands. The third recommendation refers to the principles that should be observed when research on upland agriculture is conducted. The fourth recommendation relates to new research issues that have emerged from the results of this study.

Upland development and pro-poor growth (Recommendation 1)

To put the concept of "pro-poor growth" into practice requires a change in the classic economic development paradigm. According to UNDP (2004), growth can be considered to be pro-poor "*if it uses the assets that the poor own, if it favors the sectors where the poor work, and if it occurs in areas where the poor live.*"

Foremost, enabling macroeconomic policies are needed to achieve pro-poor growth. These include fiscal, trade, monetary, and sector policies. For the latter, choices must be made regarding the share of the limited public resources allocated to basic economic and social services to the agricultural sector and to rural areas (McKinley 2003). There is little doubt that, if public funds are allocated on the basis of private economic rates of return, upland areas will invariably lose out to the high-potential areas. However, uplands serve important ecological functions that can generate positive externalities for productive growth in high-potential lowland areas. In addition, developing countries are now increasingly realizing that economic and social development is the key to solving some of the politically sensitive issues in uplands. A more regionally inclusive public policy framework for upland development is necessary and may also soon become politically acceptable.

Research investment for technology development in uplands (Recommendation 2)

Increased investments in agricultural research to develop suitable technologies are needed for uplands. This recommendation is based on the results of econometric and simulation analyses. Population growth in the uplands will ultimately lead to a decline in labor productivity on existing farmland, reduce fallow periods, and push cultivation to marginal lands. An effective way of counteracting this is through improved technologies that raise the productivity of land and labor. Such productivity enhancements will create a strong foundation of food security upon which various income-generating activities can be built (UN Millennium Project 2005). As shown in the empirical part of the study, potential environmental benefits are also likely to result, as productivity enhancement on existing land will reduce the pressure to expand food crop production to ecologically fragile marginal areas.

An important feature that distinguishes the livelihood strategies of upland farmers is their relative endowment of sloping uplands and wetland paddies. This resource endowment structure provides an opportunity for using a landscape management–oriented strategy for agricultural research and technology development in the uplands. At the landscape level, increased efforts to raise the productivity of wetland paddies will help reduce intensification pressure on the sloping uplands. This can result in positive environmental effects, as pressure to expand food production to marginal areas will decrease. For households that have access to both sloping upland rice land and wetland paddies, increasing the productivity of the latter can encourage a diversified use of sloping uplands by relaxing the food security constraint. Thus, the overall issue of *increasing* food production while conserving the resources in upland areas needs to be cast in the context of landscape management where opportunities for increasing the productivity of limited pockets of favorable areas are fully exploited while alternative land-use options, including food production for the more fragile parts of the landscape, are developed. The difference in land endowments of upland households also provides a basis for more effective technology targeting, with improved upland rice technology being more attractive to those who rely on sloping uplands for meeting their food needs.

Debate is ongoing in the development economics literature about the economic justification of research investment in the less favored environments of developing countries (e.g., Barghouti and Hazell 2000, Byerlee 2000, Otsuka 2000). There is also a widespread view among many policymakers and development planners that such investments yield low payoffs and results are subject to a high degree of uncertainty. On the other hand, it is gradually becoming recognized that the Asian highlands are in fact a critical arena for development (Rambo et al 1995). Not only are some 25 million people living in these areas with a high risk of intensifying political problems as resource competition is becoming more severe, but there is also growing recognition of the interdependency between upland resource conservation and productivity growth of lowland systems. Looking at the marginal rates of return to infrastructure and technology investment in China and India, Fan et al (2000) found that agricultural R&D in less favored areas compared well to other investments such as roads, irrigation, and education, and that overall such investments have greater potential to lift people out of poverty than further public investments in the high-potential areas. Advances in modern sciences have also increased the probability of success in developing technologies suited to these marginal environments. In addition, improved technologies that are ready for farmer adoption and those that are in the pipeline offer opportunities for generating significant environmental and poverty impacts in the uplands (Pandey 2005). The required investment in developing, validating, and disseminating improved agricultural technologies hence seems highly desirable.

Principles to conduct upland agricultural research (Recommendation 3)

The diversity and variability of upland systems imply that there cannot be a silver bullet technology. A basket of options rather than a package of technologies is needed. Research must provide the very principles on which localized solutions can be developed on the basis of local resources and indigenous knowledge. The kind of R&D investment and the types of technologies needed for sustainable agricultural development should be geared toward achieving a productivity increase in the context of sustainable management of natural resources. As shown by past experience, agricultural development of upland areas cannot rely on technology transfer from the lowlands. Appropriate upland agricultural technologies need to take account of the complexity of subsistence crop and livestock systems, including upland rice. Unlike in the lowlands, research in upland environments must focus on technologies and approaches to protect the natural resource base. Given the multiple livelihood activities of upland farmers that include food crops, cash crops, and livestock, such research must focus on improving the productivity of the overall farming systems.

Developing localized solutions requires a decentralized and participatory approach (Ashby et al 2000) and an integrated natural resource management (Harwood et al 2006) approach to technology development. Such a need is more pronounced in uplands, where suitable approaches and technologies for community management of resources such as local streams, forests, and agricultural land are needed for both productivity enhancement and long-term protection of these resources. Participation also means new ways of research-extension-farmer linkages in which the ultimate goal is not just the adoption of a few turn-key technologies but also the empowerment of local decision makers, including farmers, to make better management decisions. Although participatory approaches are increasingly accepted by international centers and donor agencies, the institutionalization of participatory approaches in national agricultural research and extension systems (NARES) is yet to occur, especially in countries where socio-political systems had encouraged a "top-down" mindset in the past.

New issues in socioeconomic research (Recommendation 4)

The results of this research are in line with the changing paradigms emerging in the field of development economics that take a revised view of the classic debate on the growth-equity trade-off. Results are also in line with the changing priorities of the major development organizations toward a stronger focus on poverty reduction. New approaches and tools in socioeconomic research are needed to tackle these emerging issues of linkages among agriculture, natural resource management, and regional development.

Analyzing the micro impact of macro policy changes is an important area for such research. The rationale for such a topic emerges from the need to more effectively link interventions in the agricultural sector with macro policies. Therefore, studies are needed that integrate macro, meso, and micro aspects within a common framework. Specific issues that are of concern are, for example, how are changing perceptions of the role of agriculture affecting policy formulation? What are the likely impacts of external shocks on policy responses, especially in the context of trade liberalization? What factors contribute to regional convergence or divergence in growth processes? What are the likely impacts of changes in macro policies on the vulnerability of households to income shocks? What safety nets and policy safeguards are needed to reduce this vulnerability?

Analysis of the emerging patterns of regional disparities is an important area of research. General pattern analysis based on aggregate data and complemented by specific rural case studies and comparative analyses across the Greater Mekong Subregion could shed more light on the processes, the macro-micro linkages, and the conditioning factors that determine success or failure.

To inform and influence the policy process at the national level, future socio-economic research in agriculture must go beyond the household-level analysis. The integration of the macro, meso, and micro level into a common framework can help to better represent regional issues in national policy decision-making. At the same time, these empirical questions that can be examined with such a framework offer the opportunity for challenging theoretical work.

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Appendix tables

Table A.1. Vietnamese rural population by age group, sex, and female fertility rate, 1993.

Age group	Total (× 1,000 persons)	Males (× 1,000 persons)	Females (× 1,000 persons)	Female fertility rate
0–4	7,738	3,969	3,769	
5–9	7,173	3,656	3,571	
10–14	6,202	3,175	3,027	
15–19	5,318	2,581	2,737	0.0299
20–24	4,437	1,984	2,453	0.1707
25–29	4,292	1,994	2,298	0.1802
30–34	3,449	1,601	1,848	0.1361
35–39	2,447	1,119	1,328	0.0920
40–44	1,649	755	894	0.0464
45–49	1,489	652	837	0.0133
50–54	1,511	663	848	
55–59	1,572	716	856	
60–64	1,279	573	706	
65–69	1,021	432	589	
70–74	662	270	392	
75–79	467	178	289	
80+	364	120	244	
Total	51,070	24,441	26,629	

Source: 1989 Population Census and Inter-Censal Survey of Rural Population, 1993.

Table A.2. Population by age group, sex, and female fertility rate, Northern Uplands, 1999.[a]

Age group	Total (× 1,000 persons)	Males (× 1,000 persons)	Females (× 1,000 persons)	Female fertility rate
0–4	1,508	821	692	
5–9	1,429	773	660	
10–14	1,250	679	576	
15–19	1,130	591	540	0.0299
20–24	1,003	509	493	0.1707
25–29	947	479	468	0.1802
30–34	780	395	385	0.1361
35–39	546	270	274	0.0920
40–44	365	180	185	0.0464
45–49	322	153	167	0.0133
50–54	318	150	166	
55–59	306	158	148	
60–64	260	125	134	
65–69	204	92	111	
70–74	133	57	75	
75–79	93	37	55	
80+	73	25	47	
Total	10,668	5,493	5,175	

[a]Total population of the region was taken from the Statistical Yearbook 2000. Age group structure, sex ratio, and fertility rate were based on the 1989 Population Census and Inter-Censal Survey of Rural Population, 1993.

Table A.3. Population projection for the Northern Uplands, males (× 1,000).

Age group	Base population 1999	Survival rate[a]	Projected population 2004	Survival rate	Projected population 2009	Survival rate	Projected population 2014	Survival rate	Projected population 2019
Number of births[b]	696		745		795		815		
0–4	821	0.9218	642	0.9287	692	0.9353	743	0.9418	767
5–9	773	0.9794	804	0.9821	630	0.9844	681	0.9866	733
10–14	679	0.9920	767	0.9928	798	0.9935	626	0.9942	677
15–19	591	0.9909	673	0.9917	760	0.9924	792	0.9931	622
20–24	509	0.9865	583	0.9876	664	0.9886	752	0.9896	784
25–29	479	0.9837	501	0.9851	574	0.9863	655	0.9876	742
30–34	395	0.9821	470	0.9837	493	0.9851	566	0.9865	647
35–39	270	0.9788	387	0.9806	461	0.9822	484	0.9839	557
40–44	180	0.9728	263	0.9749	377	0.9769	451	0.9788	474
45–49	153	0.9630	173	0.9654	254	0.9676	365	0.9698	437
50–54	150	0.9476	145	0.9503	165	0.9529	242	0.9954	363
55–59	158	0.9241	139	0.9272	134	0.9301	153	0.9331	225
60–64	125	0.8892	140	0.8927	124	0.8961	120	0.8996	138
65–69	92	0.8385	105	0.8426	118	0.8467	105	0.8509	103
70–74	57	0.7659	70	0.7705	81	0.7752	92	0.7799	82
75–79	37	0.6646	38	0.6696	47	0.6748	54	0.6800	62
80+	25	0.4231	16	0.4278	16	0.4328	20	0.4379	24
Total	6,190		6,660		7,184		7,716		7,436

[a]Survival rates for 1999 correspond to expectation of life for males and females of Vietnam of 60.6 and 64.8 years, respectively. Survival rates of the projected years were taken from the West Table assuming an improvement in life expectancy. [b]The number of births for the base year is based on the general fertility rate of 0.1087 calculated from fertility rates of females at child-bearing ages of 15 to 49 in Table 1 of Chapter 5 and a sex ratio of 0.49 for males and 0.51 for females. The number of births for the projected years 2004, 2009, 2014, and 2019 are based on simulated general fertility rates of 0.1014, 0.0924, 0.0870, and 0.0797, respectively, in order to approximate a growth rate of 1.4%.

Table A.4. Population projection for the Northern Uplands, females (×1,000).

Age group	Base population 1999	Survival rate[a]	Projected population 2004	Survival rate	Projected population 2009	Survival rate	Projected population 2014	Survival rate	Projected population 2019
Number of births[b]	669		715		763		783		
0–4	692	0.9352	626	0.9416	674	0.9476	723	0.9534	746
5–9	660	0.9819	679	0.9846	616	0.9868	665	0.9890	715
10–14	576	0.9928	655	0.9937	675	0.9945	613	0.9953	662
15–19	540	0.9921	571	0.9930	651	0.9939	671	0.9947	609
20–24	493	0.9890	534	0.9902	566	0.9913	645	0.9924	666
25–29	468	0.9862	486	0.9876	527	0.9890	560	0.9903	639
30–34	385	0.9840	461	0.9856	479	0.9871	521	0.9885	553
35–39	274	0.9812	378	0.9830	453	0.9846	472	0.9862	513
40–44	185	0.9773	268	0.9792	370	0.9809	444	0.9826	464
45–49	167	0.9713	180	0.9732	261	0.9750	361	0.9768	434
50–54	166	0.9610	160	0.9631	173	0.9652	252	0.9672	349
55–59	148	0.9450	157	0.9475	152	0.9501	164	0.9526	240
60–64	134	0.9189	136	0.9222	145	0.9254	141	0.9287	153
65–69	111	0.8767	117	0.8808	120	0.8849	128	0.8890	125
70–74	75	0.8102	90	0.8149	96	0.8198	98	0.8247	106
75–79	55	0.7119	53	0.7172	64	0.7227	69	0.7282	72
80+	47	0.4595	25	0.4654	25	0.4707	30	0.4759	33
Total	5,845		6,293		6,809		7,339		7,078

[a]Survival rates for 1999 correspond to expectation of life for males and females of Vietnam of 60.6 and 64.8 years, respectively. Survival rates of the projected years were taken from the West Table assuming an improvement in life expectancy. [b]The number of births for the base year is based on the general fertility rate of 0.1087 calculated from fertility rates of females at child-bearing ages of 15 to 49 in Table 1 of Chapter 5 and a sex ratio of 0.49 for males and 0.51 for females. The number of births for the projected years 2004, 2009, 2014, and 2019 are based on simulated general fertility rates of 0.1014, 0.0924, 0.0870, and 0.0797, respectively, in order to approximate a growth rate of 1.4%.