Occasional Papers of the Program on Environment

1993

Paper No. 15

Too Many People, Too Little Land:

The Human Ecology of a Wet Rice-Growing Village in the Red River Delta of Vietnam

edited by

Le Trong Cuc and
A. Terry Rambo

with the assistance of

Kathleen Gillogly

EAST-WEST CENTER

Too Many People, Too Little Land:

The Human Ecology of a Wet Rice-Growing Village in the Red River Delta of Vietnam

edited by

Le Trong Cuc *and* A. Terry Rambo

with the assistance of

Kathleen Gillogly

Report of the SUAN-EWC-CRES Workshop on Sustainable Rural Resources Management and Biological Diversity Conservation held in Hanoi and Thai Binh Province from 15 to 26 July 1991.

A joint research activity of
the Southeast Asian Universities Agroecosystem Network (SUAN);
the Program on Environment (ENV), East-West Center;
and
the Center for Natural Resources Management and Environmental Studies (CRES), Hanoi University

East-West Center
Program on Environment
1777 East-West Road
Honolulu, HI 96848

Occasional Paper No. 15
1993

Library of Congress Cataloging-in-Publication Data

SUAN-EWC-CRES Workshop on Sustainable Rural Resource Management and Biological Diversity Conservation (1991 : Hanoi, Vietnam, and Thái Bình, Vietnam)

Too many people, too little land : the human ecology of a wet rice-growing village in the Red River Delta of Vietnam : report of the SUAN-EWC-CRES Workshop on Sustainable Rural Resource Management and Biological Diversity Conservation, held in Hanoi and Thai Binh Province from 15 to 26 July 1991 / edited by Le Trong Cuc and A. Terry Rambo, with the assistance of Kathleen Gillogly.

p. cm. -- (Occasional paper ; no. 15)

"A joint research activity of the Southeast Asian Universities Agroecosystem Network (SUAN); the Program on Environment (ENV), East-West Center; and the Center for Natural Resources Management and Environmental Studies (CRES), Hanoi University."

Includes bibliographical references.

ISBN 0-86638-157-0

1. Human ecology--Vietnam--Nguyên Xá--Congresses. 2. Agriculture--Environmental aspects--Vietnam--Nguyên Xá--Congresses. 3. Rice--Social aspects--Vietnam--Nguyên Xá--Congresses. 4. Sustainable agriculture--Vietnam--Nguyên Xá--Congresses. 5. Sustainable development--Vietnam--Nguyên Xá--Congresses. 6. Environmental degradation--Vietnam--Nguyên Xá--Congresses. 7. Nguyên Xá (Vietnam)--Social conditions--Congresses. 8. Nguyên Xá (Vietnam)--Economic conditions--Congresses. I. Le, Trong Cuc, 1940- . II. Rambo, A. Terry. III. Gillogly, Kathleen. IV. Southeast Asian Universities Agroecosystem Network. V. Program on Environment (East-West Center) VI. Hanoi University. Center for Natural Resources Management and Environmental Studies. VII. Title. VIII. Series: Occasional paper (Program on Environment (East-West Center)) ; no. 15.

GF669.5.S83 1991
304.2'09597--dc20 93-23834
CIP

Le Trong Cuc is Deputy Director of the Center for Natural Resources Management and Environmental Studies, Hanoi University, Vietnam.

A. Terry Rambo is Director and Senior Fellow with the Program on Environment, East-West Center. He also serves as the Coordinator of the East-West Center Indochina Initiative.

Kathleen Gillogly is a doctoral student in the University of Michigan Department of Anthropology. She has participated in several Southeast Asian Universities Agroecosystem Network (SUAN)–Program on Environment workshops in Laos and Vietnam.

Printed in the United States of America

CONTENTS

FIGURES AND TABLES

Figures

Tables

PREFACE

The Red River Delta of northern Vietnam is one of the most densely settled rural areas in Asia. More than thirteen million people are crowded onto a surface area of less than 15,000 km^2 for an average density of about 900 persons/km^2 (2,340 persons/mi^2).[1] Densities range from a low of 317 persons/km^2 in Ha Son Binh Province to a high of 1,065 persons/km^2 in Thai Binh Province. Density calculated in terms of cultivated land is even higher in Thai Binh, which has 1,529 people/km^2 of farm land (654 m^2/person). Virtually every square centimeter of land is intensively used in the struggle to obtain enough food and fuel to sustain this vast and still growing population.

Given these difficult circumstances, the Vietnamese are doing a remarkably successful job of managing the very limited resources of the delta to meet human needs. During favorable weather, grain production is approaching the limits of what is biologically possible, in some provinces averaging more than 9 t/ha/yr, although the delta-wide average is much lower. Some households are better off than others, but economic differentiation within the villages is still relatively limited. Basic social services of health and education are accessible to virtually the entire rural population. Environmental degradation, particularly water pollution and reduction of wild species, is severe but existing agricultural practices display a high level of sustainability.

Yet only 50 years ago, the Red River Delta, with a population density then only one-half of present levels, was considered by its French rulers to be a hopeless case for rural development, an area condemned to perpetual poverty by its mass of tradition-bound peasants struggling to survive on minuscule plots of land (Gourou 1936:557). In 1945, the nightmares of the colonialists were fulfilled: The Red River broke through its dikes and submerged much of the delta. As many as two million people died in the flood and from the famine and epidemics that followed it (Nguyen The Anh 1985).

---

[1]Only a few areas elsewhere in Asia support comparable densities: the Pearl River Delta in southern China had a density of 638 persons/km^2 in 1986 (Luo and Lin 1991:107); Java and Madura, the most densely populated islands of Indonesia, had 755 persons/km^2 in 1985 (FEA 1991:458), although according to Geertz (1963:33), a few ecologically favored districts in Java have densities of nearly 2,000 persons/km^2. Bangladesh, which is frequently referred to as the most crowded country in Asia, had 726 persons/km^2 in 1988 (FEA 1991:227), although six of its rural districts had densities in excess of 1,150 persons/km^2 (Dutt and Geib 1986:169).

Since that terrible time, living conditions have improved, reflecting the success of post-independence development efforts. After achieving independence in 1954, the Vietnamese government implemented many rural development policies intended to transform relations between the people of the delta and the natural environment. Not all of them were successful, but basic needs for survival are now assured every resident. Today, only the elderly remember the terrible living conditions endured by all but the wealthiest peasants before the August revolution.

The present study was undertaken to better understand how the Vietnamese manage rural resources to meet their survival requirements on a sustainable basis under such extreme population pressure and land scarcity. The current situation in the Red River Delta offers a preview of what human-environment relations may come to be like in future years elsewhere in lowland Asia as populations continue their run-away growth.

Le Trong Cuc
A. Terry Rambo

ACKNOWLEDGMENTS

We thank Mrs. Dao Thi Nhat, vice-chairwoman of the People's Committee of Thai Binh Province; Mr. Pham Quy Nhan, chairman of the Committee of Science of Thai Binh Province; Mr. Tran Anh Thu, vice-chairman of the People's Committee of Dong Hung District; Mr. Nguyen Xuan Phuoc, chairman of the People's Committee of Nguyen Xa Village; and Mr. Nguyen Van Chu, director of the Cooperative, for their help in arranging the field research and for giving us valuable information. The government of Nguyen Xa Village was very helpful to us. The villagers provided guides, and hamlet leaders facilitated meetings. Most especially, we thank the farmers of Nguyen Xa for welcoming us into their homes and for answering our questions so patiently.

Dr. Vo Quy, director of the Center for Natural Resources Management and Environmental Studies (CRES), Hanoi University, and personnel from CRES did their usual phenomenal job in organizing this workshop. They navigated the complex routes of getting permission for research, arranged excellent living conditions, translated, showed us the sites, and, most of all, did first-rate research. Following the workshop, they also assisted in the editing of the field research reports. We thank them.

Major funding for this workshop was provided by a grant to the East-West Center from the John D. and Catherine T. MacArthur Foundation. Additional support was provided by a grant to the EWC from the Rockefeller Brothers Fund. CRES received support for this activity from the International Development Research Centre (IDRC) and the Interchurch Fund for International Development (ICFID).

Administrative and logistical arrangements for the workshop were the responsibility of Ms. Jeanne Hamasaki of the EWC Program on Environment (ENV) Program Office and Ms. Maureen Murakami of the ENV Fiscal Office. They handled an enormous volume of paperwork with efficiency and good humor. Mrs. Marilyn Li, ENV project assistant, ensured that necessary documents reached the proper people in a timely manner. The SUAN Secretariat at Khon Kaen University helped with travel arrangements, including the task of finding hotel rooms in Bangkok for the SUAN team. We thank Dr. Terd Charoenwatana and Mr. Keith Fahrney for all the help they gave us. Throughout the long and complex process of organizing this workshop, invaluable administrative assistance was provided by Mrs. Minh Kauffman of the Mennonite Central Committee in Bangkok. Dr. David Thomas, Deputy Representative for Thailand, Mrs. Sunanthana Kampanathsanyakorn, and Mrs. Sisamorn Plengsiri of the Ford Foundation's Bangkok Office were most generous in helping to solve numerous last-minute logistical problems prior to the SUAN team's departure for Hanoi.

Initial draft reports of the research teams that comprise Chapters 3–10 were completed during the workshop by the SUAN team coordinators. These drafts were then intensively edited by Kathleen Gillogly and combined into a preliminary workshop report. This report, in turn, was extensively reorganized and revised by Le Trong Cuc and A. Terry Rambo, who also prepared the introductory chapters and the conclusion.

Hy Van Luong reviewed an earlier draft of the manuscript and made many useful suggestions for revisions that have aided us in producing the final version.

Major assistance in preparing the final report was provided by Ms. Nghiem Phuong Tuyen, with the assistance of Ms. Joyce Kim. Michael DiGregorio prepared Figures 1.1, 9.2, and 9.3. Final editing was done by Mrs. Helen Takeuchi, ENV senior editor. Editorial assistant Daniel Bauer designed and produced the report.

BACKGROUND OF REPORT

LE TRONG CUC AND A. TERRY RAMBO

WORKSHOP ORGANIZATION

This report is the product of research carried out during the SUAN-EWC-CRES Workshop on Sustainable Rural Resources Management and Biological Diversity Conservation held in Hanoi and Thai Binh Province from 15 to 26 July 1991. The workshop was jointly organized by the Southeast Asian Universities Agroecosystem Network (SUAN), the Program on Environment of the East-West Center (EWC), and the Center for Natural Resources Management and Environmental Studies (CRES) of Hanoi University. Le Trong Cuc, deputy director of CRES, and A. Terry Rambo, EWC senior fellow, served as workshop coordinators. Manu Seetisarn of the Multiple Cropping Center, Chiang Mai University, was the senior SUAN representative.

Research was focused on Nguyen Xa Village in Dong Hung District, Thai Binh Province. The village was selected because it was the most densely populated village in the most densely populated province in the entire delta. (A more detailed description of the delta as human habitat is presented in Chapter 1.) The duration of the workshop was 14 days. Two days were devoted to team organization and planning of the data collection strategies to be employed in the field. Seven days were spent in data collection in Nguyen Xa Village and Dong Hung District in Thai Binh Province. The remainder of the time was spent traveling, meeting with officials, writing reports, and presenting and discussing findings.

Participating in the workshop were 40 researchers from Indonesia, Laos, the Philippines, Thailand, Vietnam, and the United States, including 8 representatives from CRES and 20 students in the CRES post-graduate course on Resources Development and Environmental Impact Assessment (see Appendix A for the list of participants). In keeping with the interdisciplinary character of human ecology research, participants represented many disciplines in the natural and social sciences including agricultural science, anthropology, ecology, economics, linguistics, livestock management, sociology, and soil science.

RESEARCH CONCEPTS AND METHODOLOGY

Since the concepts (human ecology, agroecosystem analysis) and methodology (rapid rural appraisal) employed in this research have already been described in detail in an earlier report (Le Trong Cuc, Gillogly, and Rambo 1990), they will only be briefly reviewed here.

Human Ecology

This research employed the "systems model of human ecology" (Rambo 1983) as its main conceptual framework. In this model, human society and the natural environment are conceptualized as two distinct systems: the social system and the ecosystem. Together, these comprise the human ecosystem. Each of these systems has its own coherent structure and internal dynamics, and much of what occurs within the boundaries of each system can be satisfactorily explained in terms of internal interactions among its components. Research focusing on matters internal to the social system is the normal province of social scientists just as the structural and functional characteristics of ecosystems are normally studied by natural scientists. Many important problems can be studied wholly within the boundaries of only one system and can be understood without employing the interdisciplinary perspective of human ecology. The influence of rainfall and temperature on rice yield, for example, is a problem that can be studied by a plant physiologist in collaboration with an agroclimatologist without the help of a sociologist. Conversely, the influence of kinship on allocation of land within the village social system can be studied by a sociologist and a geographer without the assistance of an agricultural scientist or ecologist.

Much of what goes on inside each system is influenced, however, by its interactions with the other system. Thus, the population density achieved in a particular society is influenced by the biological productivity of its ecosystem. The Red River Delta can support such a large population because its soil, water, and climatic conditions permit sustainable production of two rice crops each year. In contrast, the mountains of Tay Nguyen support much lower densities because of unfavorable agroecological conditions, especially poor soils. Realization of the maximum productive potential of any ecosystem depends strongly on the character of the technology available to the society.

Introduction of new technology (e.g., electrical irrigation pumps, high-yielding rice varieties) has greatly increased the productivity of wet rice agriculture in the delta.

The goal of human ecology research is to understand the interactions that occur between human social systems and their ecosystems. Particular attention is paid to the flow of energy, materials, and information between the two systems and to the competitive and mutualistic relationships that exist among the various components of these systems. The ultimate objective is to explain how structural and functional characteristics of each system are influenced by interactions with the other system. It is assumed that any component of either system may possibly be influenced by its interactions with one or several components of the other system ("everything is related to everything else"), but it is not assumed that all relationships are equally important or worthy of study. The goal of research guided by the systems model of human ecology is *not* to produce detailed holistic descriptions of every relationship between every component of both systems.

The systems model of human ecology is useful to the extent that it directs the thinking of researchers toward the search for significant relations between social and ecological systems. The search for such relationships should not be conducted blindly as an exercise in mindless empiricism, however. Instead, it should be guided by ideas and principles already well understood in the literature of the natural and social sciences. Darwinian evolutionary theory is a particularly valuable source of such concepts. Many of the central organizing ideas in ecology (e.g., competition, limiting factors) are ultimately derived from evolutionary theory. The social sciences have their own bodies of concepts and theory that are equally rich, if somewhat less coherent, sources of guidance for designing human ecological research.

In the Red River Delta, for example, ample evidence suggests that supply of energy is a critical limiting factor. Government officials invariably state that grain production is the central policy issue; farmers report that they sometimes suffer shortfalls in food supply; land use patterns reveal that rice growing takes priority over other uses. Supply of water, on the other hand, is much less limiting than in other systems, although much energy must be used to control the flow of generally abundant supplies. It is a basic principle of community ecology that intensity of competition increases as the outer limits of availability of any critical resource in a system are approached. No great insight is required to recognize that energy flow relations are highly significant in the human ecology of the delta and that competition is intensive between individuals and species to capture the limited supply of energy flowing within the ecosystem. This competition occurs both within the social and ecological systems and between the two systems. Despite the existence of an acute fuel-wood shortage, almost no trees are grown on the bunds around the fields. Trees would shade some of the rice plots and reduce grain yields, a loss of food energy that the farmers cannot afford. Within the village social system, allocation of farm land among households is a major source of concern. In extreme scarcity, even minor variations in quantity and quality of land held by different households can have profound consequences for their ability to produce sufficient food. Elaborate rules and procedures have evolved to ensure that land allocation among households is relatively equitable. Individual households still covertly compete, however, in the attempt to maximize their share of land and other resources.

Competition for energy also occurs between the social and ecological systems. The available land area cannot produce sufficient energy to meet the needs of the human population for food and fuel, as well as to support enough buffalo to provide adequate draft power. Intensive cropping to meet human food needs results in almost no land being available as pasture. There is also direct competition between use of rice straw as fodder for buffalo and as cooking fuel. Faced with this interspecies competition for biomass energy, the farmers keep fewer buffalo than they need to plow all of their fields. In place of buffalo, teams of men and women sometimes hitch themselves to the plows and harrows with ropes and drag them through the heavy soil using human muscle power alone. The farmers have opted to substitute their own labor power for that of buffalo, thus maximizing the share of biomass energy available for direct human use in the short term. But having fewer buffalo reduces the amount of manure available for the rice fields. At present, the shortfall is made good with chemical fertilizer, but the loss of economic assistance from Russia to Vietnam is causing fertilizer prices to increase rapidly. If farmers can no longer afford to purchase enough urea and potassium, soil fertility will decline, with a consequent reduction in the productivity of rice plants. The amount of solar energy captured per hectare may fall, with dire consequences for the supply of human food and fuel in future years.

AGROECOSYSTEMS ANALYSIS

If the human ecology perspective helps to guide researchers toward studying critical interactions between people and the environment, agroecosystems analysis focuses its attention on assessing performance of the system as measured in terms of several key emergent properties as these are displayed by different levels in the agroecosystem hierarchy.

Emergent properties are attributes or outputs that come into existence only because of the interaction of components of a system at a specific level within the hierarchy (Conway 1984). The yield of a rice field, for example, is an emergent property (productivity) that represents the ultimate outcome of complex interactions among different components within the boundaries of the field-level agroecosystem. It reflects the genetic potential of individual plants, the competition for light, water, and nutrients among individual rice plants, the competition between rice plants and weeds, the impact of insect predation and disease, and many other factors. One cannot predict productivity based simply on the genetic potential of the rice variety. It is necessary to understand all of the critical interactions occurring within the field to explain the size of the harvest.

Properties selected for study in any particular agroecosystem are wholly a reflection of the researchers' interests. In SUAN applied research, attention is focused on properties of critical concern to farmers and development policymakers. Past SUAN research has emphasized six properties. Of these, *productivity* and *sustainability* have received most attention. *Autonomy*, *solidarity*, *equitability*, and *stability* have been less thoroughly studied. Recently, *adaptability, diversity,* and *resilience* have been added to the list of properties that are sometimes investigated in SUAN workshops. The various properties will be discussed further in relevant chapters.

The Red River Delta can be conceptualized as being composed of a nested set or hierarchy of social and ecological systems. Systems at different levels in the agroecosystem hierarchy may display quite different performances in terms of the same properties. At the field level, for example, diversity may be quite low, with rice the dominant species. Diversity at the landscape level may be considerably higher, reflecting the presence of trees in homegardens, fish in ponds and rivers, and livestock that depend on resources drawn from several different kinds of field-level systems. There may be very high solidarity at the village level and low solidarity at the household and district levels. In discussing system performance in terms of various properties in this report, we have attempted to always specify the hierarchical level to which we are referring.

Research Methodology

The research reported here was primarily done using the methodology that has come to be known as *rapid rural appraisal*, or RRA (Khon Kaen University 1987). RRA has many positive attributes, but our choice of this methodology was dictated by the limited time available in which to do the research and not by a belief that RRA is always and everywhere the best and most productive method of data collection. Indeed, we all recognized that it was an unsatisfactory method for gathering information on complex matters such as allocation of land and other resources among households and factionalism within the village, real rather than target production levels, and assessment and collection of taxes. RRA may provide hints and indicators relating to such questions, but long-term participant observation would be necessary to develop a clear picture of the internal workings of the village social system.

These limitations on RRA were to some degree off-set because we had the advantage of using some of the extensive historical and statistical records and data sets that exist for different system levels in the delta. These included long-term climatic data at the district and province levels, population data at the village, district, and province level, health data, land allocation and yield data, and tax records at the household and village level. Much more information exists than time allowed us to record or analyze, but we want to emphasize the potential value of this abundant documentation for future research. There are also many published scientific reports on the delta. The works of French scholars like Dumont, Henry, and Gourou are still valuable sources of insights and information. Since 1954, Vietnamese scientists have conducted extensive research on soils, hydrology, agroclimatology, and crop performance. They have also written detailed ethnological descriptions of village organization and the culture of the peasantry. We have made as much use of this body of information as time constraints and difficulties in obtaining access to often hard-to-locate documents allowed.

Unique to this workshop was the organization of data collection teams primarily focusing on specific agroecosystem properties (e.g., sustainability, equitability) instead of the past SUAN practice of organizing teams focused on system components (e.g., soil, water management). Seven teams focused on properties: productivity and stability of crops; productivity and stability of livestock and fish; sustainability; biological diversity; autonomy and solidarity; equitability; and resilience. One team was responsible for providing an overview of the village level agroecosystem and another focused on demography and labor. It should be noted that because each of the teams worked largely independently, collecting information from different sources, there is not always full agreement on every point, especially statistical information on production, taxation, and income. The editors have attempted to reconcile these diverse accounts but admit to less than total success.

REPORT ORGANIZATION

This report consists of eleven chapters. Chapter 1 presents an overview of environmental conditions in the Red River Delta. Chapter 2 offers an overview of Nguyen Xa Village and its agroecosystem; Chapter 3 is on demography and labor; Chapter 4, autonomy and solidarity; Chapter 5, equitability; Chapter 6, biodiversity; Chapter 7, productivity and stability of crops; Chapter 8, the role of livestock; Chapter 9, resilience to hazards; Chapter 10, sustainability. The report ends with Chapter 11, which examines prospects for sustainable development in the villages of the delta.

1. AN OVERVIEW OF THE RED RIVER DELTA ENVIRONMENT

LE TRONG CUC
TRAN DUC VIEN

The low-lying land of the Red River Delta provides an ideal environment for wet rice cultivation. Over the millennia, farmers of the delta have progressively refined and intensified their cultivation practices. At the same time, they have brought the physical environment of the delta under their control, in response to natural hazards, population growth, and historical conditions. This chapter introduces the environment of the Red River Delta, which provides an essential background to understanding the specific situation of Nguyen Xa Village.

POPULATION

Although the Red River Delta encompasses only a little over 5 percent of Vietnam's total natural area, its population is 21 percent of the country's total. The census taken in 1989 (Table 1.1) showed a delta population of 13.6 million. More than 83 percent live in rural areas. The average density in the lowlands of the Red River Delta is 923 persons/km^2. From 1987 to 1990, the average growth rate was 1.4 percent per year. Tables 1.1 and 1.2 show population data from 1985 to 1989.

PHYSICAL ENVIRONMENT

Geography

The Red River Delta embraces six provinces: Hanoi, Hai Phong, Ha Nam Ninh, Ha Son Binh, Hai Hung, and Thai Binh (see Figure 1.1). The lowlands of the Red River Delta cover an area of 14,700 km^2. In terms of topography and hydrology, the lower levels of the Midlands are a part of the Red River Delta as well, totaling 17,321 km^2 of natural area. The Red River Delta resembles a triangle whose top is Viet Tri, its bottom the coastline of the Tonkin Gulf stretching 150 km along from Hai Phong to Ninh Binh, with each side about 180 km long. Its geographic coordinates are 20°00'–21°10' N and 105°50'–106°50' E.

Table 1.1 Population Estimates of the Entire Red River Delta (million persons)

Province	1985	1986	1987	1988	1989
Hanoi	2.77	2.82	2.88	3.09	3.05
Hai Phong	1.30	1.31	1.35	1.48	1.45
Hai Hung	2.22	2.28	2.31	2.53	2.44
Thai Binh	1.53	1.54	1.57	1.71	1.63
Ha Nam Ninh	2.91	2.95	2.99	3.21	3.16
Ha Son Binh	1.07	1.07	1.08	1.84	1.84
Total	11.80	11.97	12.18	13.86	13.57

Source: Department of Statistics (1992).

Table 1.2 Rural Population Estimates of the Red River Delta (million persons)

Province	1985	1986	1987	1988	1989
Hanoi	1.76	1.78	1.81	1.89	1.97
Hai Phong	0.90	0.90	0.91	0.96	0.99
Hai Hung	2.09	2.15	2.18	2.35	2.62
Thai Binh	1.45	1.42	1.43	1.53	1.55
Ha Nam Ninh	2.66	2.70	2.74	2.98	2.83
Ha Son Binh	1.01	1.01	1.02	1.64	1.66
Total	9.87	9.96	10.09	11.35	11.62

Source: Department of Statistics (1992).

Topography

The Red River Delta can be divided into three topographic sections, as follows:

1. At the fringes is a section of low hills and mountains alternating with valleys, stretching from the lowlands of the Red River Delta, flanking the low hills surrounding the Red River Delta that encroach into the southern parts of Vinh Phu, Bac Thai, and Ha Bac provinces and a part of Ha Son Binh Province. The maximum altitude of this part does not exceed 10 m above the sea, and its average inclination is 18° to 22°. The hill soils are fertile and concretion occurs in some places. The hill surface areas are now seriously eroded and barren, however.

2. The central part occupies the largest area, with elevations ranging from 3 to 5 m, comprising Bac Ninh, Hai Hung, Ha Dong, and Ha Nam Ninh provinces, and a part of Thai Binh Province. This

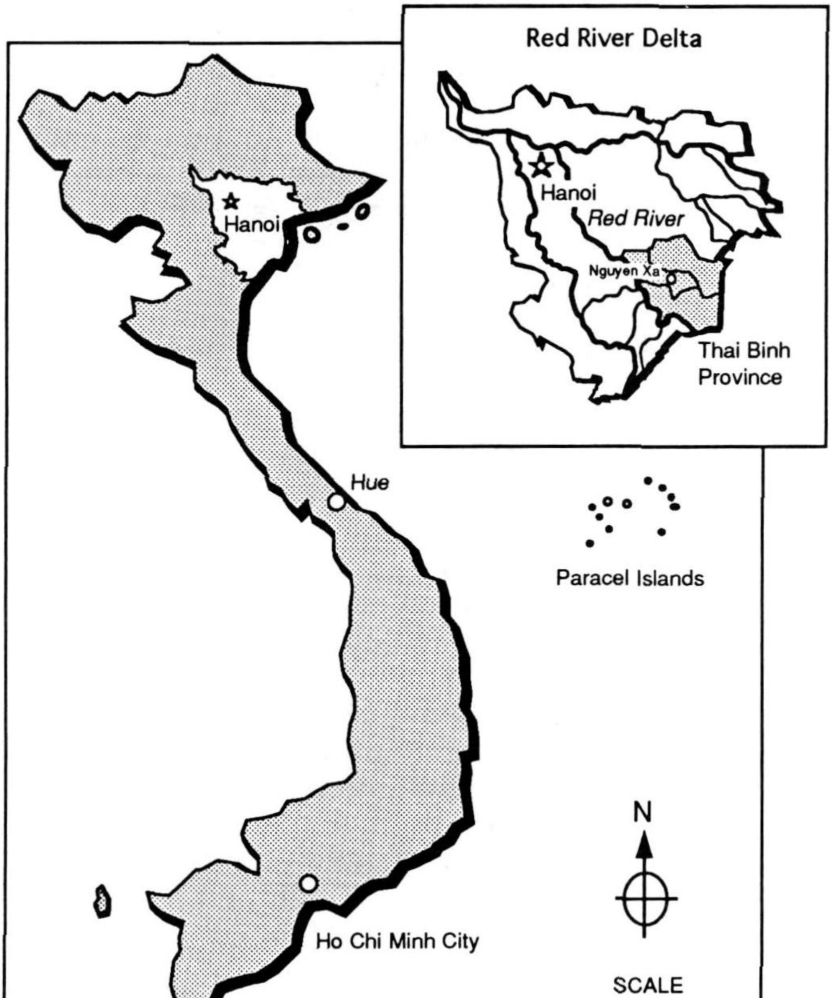


Figure 1.1 *Vietnam and the Red River Delta.*

is an ancient, stable, and relatively flat part of the delta, which first experienced alluvial deposition. Natural deposits of alluvia from the Red River no longer take place because the large low-lying area is interlaced by dike systems.

3. The coastal part (Thai Binh and Ha Nam Ninh provinces) has the youngest alluvial soils in the Red River Delta. It is very flat, currently experiencing alluvial deposits and sea encroachment.

Climate

The climate of the Red River Delta is tropical monsoon, influenced by ocean climate. The delta has two distinct seasons: dry and rainy. The rainy season is from April to October with 80–100 rainy days providing 1,450–1,650 mm of rainfall. This is 80–85 percent of the yearly rainfall. The highest rainfall (300–350 mm) occurs in August. The dry season is from November to March with 40 rainy days providing less than 150 mm of rainfall. The lowest rainfall (8–20 mm) occurs in December and January. Total average yearly rainfall is 1,600–1,800 mm. The potential evaporation is between 900 and 1,000 mm/yr. Average humidity is 82–88 percent. During February and March, the northeast and southeast monsoons bring moisture from the ocean, causing mists and drizzles and making this period the wettest in the year.

Total average radiation is 120 kcal/cm^2/yr. The highest radiation takes place from May to December (12–14 kcal/cm^2/mo). The lowest radiation occurs between January and March (3.5–6.5 kcal/cm^2/mo). The yearly average temperature is 23° C. The maximum average temperature is 40° C, and the minimum average is 5° C. Total temperature is 8,500° C. For about 90–100 days, the temperature is below 20° C, which favors temperate crops and facilitates the growth of winter crops. Average temperature in excess of 28° C ranges from 30 to 90 days during June to August. Total sunny hours are 1,640 hr/yr. Sunny hours during the winter crop-growing season are about 23–25 percent of the total.

Hydrology

The hydrology of the Red River Delta is dominated by the Red River and the Thai Binh River systems. The Red River originates from Yunnan (China), enters Vietnam through Ha Khau, then flows into the sea through Ba Lat estuary. The portion that runs through Vietnam is 500 km long, forming a large basin of 86,300 km^2. In Vietnam, the Red River system consists of the Da (Black), Lo (Clear), and Thao (Red) rivers. The Da River's capacity takes approximately 48 percent of the system, the Lo River 27 percent, and the Thao River the rest.

The Red River's flow is high, with an average of 120 billion m^3 of water per year and a peak volume of 158 billion m^3 of water per year. In the flood season (from June to October), the river carries 73 percent of its total capacity (21 percent in August). In March, the volume is a low 2.6 percent.

The Red River carries a large amount of very rich alluvium. Its alluvial content averages 1.31 kg/m^3, 3–3.5 kg/m^3 in the flood season, and 0.5 kg/m^3 in the dry season. The pH varies between 7 and 7.4. Total nitrogen is 0.175 percent and total potassium 0.038 percent. Available nitrogen is 0.5 mg/100 g soil; phosphorus, 1.17 mg/100 g soil; and potassium, 1.06 mg/100 g soil. Humus content varies from 2.76 to 3.48 g/m^3.

The Thai Binh River system consists of the Thuong, Cau, and Luc Nam rivers. The Thai Binh River's capacity and alluvial amount are lower than those of the Red River. The alluvial content contains a moderate amount of phosphorus, and its potassium content is much lower than that of the Red River. For this reason, the soil deposited by the Thai Binh River system is more acid and less fertile than in other parts of the Red River system.

Besides the Red River and the Thai Binh River systems, an extensive network of artificial rivers and channels has been constructed so that water flows in or drains out of the delta.

NATURAL HAZARDS

Flooding is the most dramatic hazard in the Red River system. The delta is under the hydrologic pressure of the Red River system, which is subject to intense precipitation. This precipitation causes erratic and unpredictable flooding. In the flood season, the river level can rise above the dikes, resulting in floods that wreak great damage to humans and their property.

The book *Annals of the Grand Viet* lists 74 years in which great floods occurred on the Red River during the period 997 to 1775. From the tenth to the nineteenth centuries, dikes have broken in 188 years. From 1775 to 1884 alone, the delta was struck by disasters 18 years due to breakage in dikes. In 1491 (*Tan Hoi*, Lunar Calendar), water rose 1 m above Kinh Thien Palace in Thang Long. In 1713 (*Quy Hoi*, Lunar Calendar), the dike system of Bac Bo was breached. In 1829 (*Quy Suu*, Lunar Calendar), 11,000 houses were carried away and 530 people drowned in Nam Dinh. In unceasingly inundated areas, the local people relocated and villages became marshes. In 1893, almost all provinces in the Red River Delta were flooded. Since then (*Quy Ti*, Lunar Calendar), the legend about the dreadful "*Quy Ti* Flood" has haunted the people of the delta. In 1915, a flood covered 221,000 ha of paddy fields, and in 1944–45, the most devastating floods of all occurred, resulting in the death of as many as two million people. In 1971, another large flood submerged 250,139 ha in the delta.

During their reclamation and protection of the land, the people of the Red River Delta constructed an extensive water control system to channel the river. They built dikes to prevent water from flooding their fields and a system of *ke* (stone embankments) to strengthen the dikes and direct flows to prevent erosion.

At the end of the ninth century, the first dike of 8.5 km long was constructed surrounding Dai La Wall. In 1077, the Ly Dynasty built a 30-km dike along the Nhu Nguyet River (the Cau River). Under the eighth Ly Dynasty, the Co Xa dike was built to keep water out of the capital city of Thang Long. In 1103, the Ly Dynasty adopted the first dike regulations. The king encouraged dike construction and established important dike systems. In 1218 (*Mau Than*, Lunar Calendar), King Tran Thanh Tong sent an imperial edict calling on his people to build defensive dike systems. In 1248, under the Tran Dynasty, the local dike systems were linked into a single closed system that has essentially remained until today. King Tran Thai Tong appointed a mandarin to be responsible for consolidating and maintaining the dike system. A coastal dike system that kept salt water out was constructed in 1464 under King Le Thanh Tong. In 1661, King Huyen Tong promulgated a regulation that every year in October the mandarin in charge had to supervise the dike system, and repair activities had to be started in mid-January and completed in March. Subsequent dynasties continued to observe these regulations.

Generation by generation, the inland dike system developed to its current length of 7,764 km, and the coastal dike system to its length of 2,048 km. These systems culminated in maximum control against threats of flood. However, since construction of the closed dike system, the delta has been isolated from the natural deposition and extension of the Red River system. Gourou (1931) said that the Red River Delta died at its adulthood because of the dike system. Furthermore, due to the heavy sediment load carried by the Red River, there is continuing aggradation of its channel so that today the level of the river in rainy season is several meters higher than the surrounding plains. Despite continuous efforts by the government to maintain and strengthen the dikes, threats of flooding remain real. Villages are built on the highest available land, and house platforms are raised with earth excavated from lower areas. The ponds created by these excavations serve as catchments that somewhat help to control local flooding. The modern Vietnamese government also pays much attention to dike protection activities through its Central Committee for Flood and Typhoon Prevention and Dike Protection.

AGRICULTURAL LAND USE IN THE RED RIVER DELTA

Almost all cultivated land is used to grow rice. Only a small proportion remains for cash or other crops (see Table 1.3). There are two distinct crops: the winter/spring crop from November and December to May and June, and the summer/autumn crop from May and June to October and November. The present improved irrigation system helps local people in controlling the factors of cultivation. In addition to the two traditional crops, local people now grow early spring/summer crops and very early summer crops that favor heat-tolerant winter crops. Various crop varieties and crops that can grow in water-deficit conditions have been imported, based on biological and ecological timing and

Table 1.3 Land Use in the Red River Delta

Soil Type	Within Provincial Boundaries[1] (1,000 ha)	Within Boundary of 71 Districts (1,000 ha)
Annual crops		
Rice cultivation	626.1	732.5
Three crops	47.3	65.2
Two crops	473.6	538.9
One crop	65.9	84.0
Nurseries	39.3	44.4
Perennials/trees	15.1	18.3
Grass land	20.3	9.4
Lakes and ponds	49.4	53.8
Newly reclaimed	2.8	3.5

[1]Some parts of the district do not lie within a provincial boundary.

technological selection. There are two groups of winter crops: (1) early winter tropical-derived crops (maize, soybean, sweet potato, onion, and garlic), which can be planted between September 20 and October 10; (2) late winter temperate zone-derived crops (potato, cabbage, kohlrabi, and wheat), which can be planted from October 20 to November 20.

Studies have been conducted on the adaptability of winter crops to soil conditions (with soil classifications of high land, low land, low-lying land) and on crop and rice adaptability to the chemical and physical properties of soil in typical ecological zones. These serve as a base to scientifically classify cropping systems. Short-term varieties have been identified so that crop scheduling can be arranged to suit a new crop system in the alternative cultivation system (see Table 1.4). Rice varieties of different growing periods are classified as follows (also see Table 1.5):

1. Very short-term varieties such as CN2 with a growing period of less than 100 days can be grown as an early summer crop.

2. Short-term varieties such as NN75-10(XI), CR203, and IR64 with a growing period of 100–120 days can be grown as an early summer crop and a late spring crop.

3. Medium-term varieties with a growing period between 120 and 140 days are sensitive to temperature conditions but not sensitive to short-time daylight. They are grown as an early summer and a summer crop. Varieties such as NN8, VN10, C37, VN20, 1820, V15, V14, and C22 are grown as *chiem xuan*, or winter/spring and spring crop.

4. Long-term varieties with a growing period of 140 days include both groups that are sensitive to sunlight and groups not so sensitive to short-time daylight. They are *moc tuyen*, IR42, C10, U9, U17, and Masuri—all grown as summer crops.

This assortment of rice varieties grants farmers many pieces with which to form the fabric of new farming systems, taking advantage of all possible niches.

Table 1.4 Niches of Spring/Fall Rice Varieties

Rice Crop	Crop Scheduling: Sowing	Transplanting	Harvesting	Farming System	Length of Growing Season	Soil Type
Winter/Spring Crop						
Winter	20 October to 10 November	20 December to 31 January	Before 10 June	Winter	Winter	Low lying
Late winter	1–20 November	January	Before 15 June	Two rice crops	Late winter	Low lying
Early spring crop	10–20 November	Late January	June	Two rice crops	Long term	Low lying
Main spring crop	25 November to 5 December	February	June	Two rice crops; one cash crop	Medium term	For cash crop cultivation
Late spring crop	Late January to early February	Late February to early March	June	Two rice crops; one cash crop	Short term	For cash crop cultivation
Summer Crop						
Very early summer crop	25 May to 5 June	15–25 June	Late September	Two rice crops; one early spring crop	Very short term	
Early summer crop	Late May to early June	Late June	Early October	Two rice crops; one cash crop	Short term	For cash crops
Main summer crop	10–20 June	10–15 August	November	Two rice crops	Medium term	Not for cash crops
Late summer crop	Late June to early July	August	November	Two rice crops	Short term	Low lying

Table 1.5 Crop Calendar of Widely Used Rice Varieties in the Red River Delta

	Month											
Rice Crop	1	2	3	4	5	6	7	8	9	10	11	12
Winter	++++				- -	- -				**	*	++
Late winter	++++				- -	- -					***	
Early spring crop	++					- - - -					**	
Main spring crop		++++				- - - -					*	*
Late spring crop	**	**++	++			- - - -						
Very early summer crop					*	*++			- -			
Early summer crop					**	**++				- -		
Main summer crop						**		++			- - - -	
Late summer crop						**	**	++			- - - -	

Note: See Table 1.4 for a schedule of rice crops.

* = 7 days sowing

+ = 7 days transplanting

- = 7 days harvesting

2. NGUYEN XA VILLAGE AND ITS AGROECOSYSTEM

A. Terry Rambo
Le Trong Cuc
Kathleen Gillogly

As one of several thousand villages in the Red River Delta, it is impossible to claim typicality for Nguyen Xa Village. Indeed, it was selected as our field site because it represented the extreme case of agrarian population density and human pressure on natural resources. In this chapter we present a brief overview of the village social system and its agroecosystem. Much of the material presented here is dealt with in greater depth in succeeding topical chapters.

THE VILLAGE SOCIAL SYSTEM

Nguyen Xa Village is an ancient community with a long and rich history. Elderly individuals within the community have experienced life under three regimes: the French colonial government, the Japanese occupation, and independent Vietnam. They have experienced the societal upheavals of World War II, the great famine of 1945, the war of liberation, the post-independence land reforms, the struggle in the South to unify the country and the American bombing of the North that accompanied it, the post-1975 period of intensive collectivization, and, most recently, the rapid and far-reaching changes in economic policies accompanying the *doi moi* reforms. Not surprisingly, the village displays great complexity in its patterns of cultural practices and social organization. In this brief introductory account, we cannot begin to capture the multiple facets of this peasant social system. Instead we have focused on describing those aspects of demography and social and political organization that most directly influence human management of resources and the environment.

Demography

Nguyen Xa Village has a de facto population of 6,512, a figure that includes teachers and a cadre from other places who are temporarily assigned to the village but who are not considered residents for purposes of land allocation. As of the end of first quarter 1991, 6,438 persons were classified as residents. We have used this figure to calculate densities since it represents the number of people who are wholly dependent on local resources for their survival and who are eligible to shares of communal lands.

Population Density. With a total surface area of approximately 430 ha, Nguyen Xa Village has a population density of 1,497 persons/km^2.[1] This is higher than the provincial average of 1,065 persons/km^2 and exceeds the average for Dong Hung District of 1,122 persons/km^2. Of the total surface, more than one-fourth (113 ha) is used for houseplots and homegardens, roads, and public facilities, leaving only 316.5 ha of agricultural land (Table 2.1). Thus, there are 2,030 persons/km^2 of cultivated land. Each hectare must support 20.3 persons. This represents only 490 m^2 (5,272 square feet) of cultivated land area for each inhabitant of the village.

Nutritional density (which is calculated in terms of the cultivated area times the number of crops harvested per year) is somewhat lower at 1,097 persons/km^2 or 9 persons per hectare of cropped surface (1,111 m^2 per person).[2]

Population Structure and Dynamics. An age-sex pyramid for the village is presented in Figure 3.2, Chapter 3 of this volume. Noteworthy is a deficit of males aged 20–24 and a shortage of both males and females aged 40–49. The shortage of young males may be the result of short-term out-migration to serve in the military, to pursue higher educational opportunities, and to work in Eastern Europe. The reduced size of the older cohorts of both sexes is attributable to mortality and forgone births resulting from the great famine of 1945 and to casualties during the Second Indochina War (Pham Xuan Dai 1990:24). Despite disproportionate male war losses, the sex ratio is relatively well balanced with females constituting 51.8 percent of the population.

The overall shape of the pyramid indicates the extent to which there has been a major decline in fertility over the past 20 years. Its base is atypically narrow for a rural population in a developing country. The birthrate in the village has dropped steadily over the last decade, falling from a high of 30.3 births per 1,000 persons in 1982 to 19.8 in 1990. This decline is partly attributable to the family planning campaign that has been pushed with increasing intensity by the provincial, district, and village governments since the mid-1980s. There is a family planning

Table 2.1 Nguyen Xa Village Land Use

Category	Area (ha)	Percentage
Agricultural land (crop land plus ponds)	**316.5**	**73.7**
Crop land	305.4	71.1
Two rice crops	286.8	66.7
Rice nursery (also planted with two rice crops)	16.2	3.8
Field crops only	2.4	0.6
Ponds	11.1	2.6
Land for specific uses	**113.0**	**26.3**
Irrigation canals[1] and roads	70.0	16.3
Housing and homegardens	43.0	10.0
Total	**429.5**	**100.0**

Source: Nguyen Xa Village Cooperative Office.

[1]Main canal = 5 km; lateral canals = 28 km.

clinic in the village, and use of contraceptives and other means of birth control is widespread. The death rate has also decreased, dropping from 8 per 1,000 or more in the early 1980s to 4.8 in 1990. This mortality decline has partially offset the decline in births so that the population growth rate has remained in excess of 1.5 percent per year. At this rate, the village population will increase by 35 percent in 20 years. The very large and rapidly growing number of young adults seeking to establish new households places heavy demands on limited land, both rice fields and sites for houses. The village social system is being severely strained to meet these additional demands against a fixed resource base.

Social Organization

The social organization of Nguyen Xa is basically similar to the pattern common to villages in the Red River Delta (Gourou 1936; Diep Dinh Hoa 1990; Toan-Anh 1968). Its traditional form was that of a closed corporate community (Rambo 1973), and even today it retains certain characteristics of that type of peasant social organization.

Nguyen Xa Village is unusually large among villages of the Red River Delta. Despite this, the people of Nguyen Xa have displayed a high level of solidarity in that, despite various reorganizations (for instance, the number of cooperatives has ranged from one to sixteen from 1958 to 1968), they have maintained themselves as one village. As will be discussed at greater length in Chapter 4, the village has good reason to keep its various factions together, sometimes based on lineage and communal house, and sometimes on hamlet. Maintenance of solidarity against the outside world gives it higher autonomy in relation to the central government.

The basic units of social structure within Nguyen Xa Village are the family and household, neighborhood, and lineage. In addition, there are various informal and formally recognized associations that bring together people with similar interests. The political structures of the village government and the Cooperative are also key in structuring people's lives. Altogether, these social and political structures tie people into a web of social relationships and obligations that unite—and sometimes divide—village society.

The basic social unit is the family. Organization is patrilineal and post-marital residence is patrilocal—that is, children receive their family name and social identity from their father, and newly married couples live with the husband's parents. Households are composed of conjugal couples, their children, the wives of their sons, and the children of these couples. Traditionally, this was referred to as "one roof" (*noc*), and the people living under one roof were considered a unit. Under current policy, the Cooperative considers each conjugal couple a separate household for purposes of land allocation. Cooperative policy is to allocate residential land only when there are three or more families under one roof. To accommodate this constraint, families may add onto their existing houses—two-story houses are very popular. Others may use money to expedite the process of residential land allocation. When possible, newly formed couples move out of the husband's parents' household as soon as they can.

The neighborhood is one of the central social structures in the village. Despite the importance of "blood" relations, many activities take place among hamlet and lane co-residents. These activities include labor exchange, hamlet security, and, in the pre-Liberation days, maintenance of a Taoist shrine. Other significant mutual aid occurs on the occasion of weddings and funerals. The Cooperative built on this organization when it formed production brigades. Similarly, vestiges of production brigade organization remain today in the land preparation groups for plowing and harrowing on a neighborhood level.

Lineages link people to others within the same village, and in the past were the basis for factionalism in the village. In those days, there were three different *dinh* or communal houses—each formed by different lineages. Each of these *dinh* was associated with socioeconomic groups in society: the mandarinate and the farmers; the newer wealthy and the artisans or traders; and the non-citizens and the poor. It is not clear to what extent these traditional cleavages still exist today. The lineages are also highly significant in extending people's ties outside the village. Because a large proportion of the village people are traders, lineage ties give people access to resources and information throughout the region and even on a national level.

Village Government

The village government is relatively small in relation to the total population. The Village People's Committee and the village Cooperative each employ 13 cadre. In addition, four health workers and three nursery school attendants are paid by the village for a total of 33 employees. Since the number of cadre is considerably reduced from the past (i.e., before 1989), each remaining cadre is now expected to do the work of three or four.

Salaries are very low. The chairperson, Cooperative leader, and party secretary each receive 21,600 *dong*/mo. Low-level cadre receive only 13,700 *dong*/mo. The engineer for the Cooperative is paid slightly more—28,000 *dong*/mo. The cadre receive the same allocation of land as other villagers. When asked why they worked as cadre despite the low wages of which they had complained, they replied that they had to serve because they had been selected by the people. Presumably there are unofficial benefits associated with these posts that at least partially compensate for the low official salaries. In addition to the current cadre, about 30 retirees receive small pensions, of which the highest is 13,000 *dong*/mo.

School teachers are paid directly by the district government. Primary education through grade five is free (although parents pay fees for supplies), but secondary school children pay "tuition" to help supplement the small official salaries of the teachers.

Taxation

Taxes on land are the primary revenue source for the village government. Taxes include a number of specific charges for irrigation, electricity and water, and security that represent user fees rather than true taxes. They are collected by the village government as part of a single assessment, however, so we have included them as taxes in this discussion. Land is taxed at different rates according to presumed productive capacity and its assignment to different management categories or funds. For example, land in the First Land Fund is taxed at 28 percent of paddy yield for spring crops. (The 28 percent tax is divided as follows: electricity and water, 5 percent; security, 1 percent; central government, 13 percent; and irrigation fee, 9 percent.) This rate applies only to production up to the target yield assigned to the plot by the village. If the farmer obtains a yield higher than the target, there is no tax on the surplus. For this reason, farmers prefer to get plots of lower-rated land because it is easier to improve them and thus exceed the assigned production target. Farmers must pay tax at the full level regardless of whether they achieve good production or not. In years when crops fail due to major natural disasters, however, the national government may reduce the tax assessment.

Land in the Second Land Fund is taxed at 65 percent of its estimated productive capacity. Twenty-eight percent goes for the same services as are taxed for the First Land Fund, while the remainder goes to the Cooperative development fund, which is also used as emergency food reserve for the village. Five Percent Land (also known as "family land") is taxed at 15 kg of paddy/*sao* (415.5 kg/ha) per crop.

In addition to land and production taxes, "contributions" (*gop*) are levied on each household for the agricultural development fund, the village social and economic fund, and the Cooperative development fund. The village collected 198,900 kg of paddy as taxes on land in 1990.

Taxes are also levied on livestock that are slaughtered and sold within the village. The tax per pig is 15,000 *dong* and 20,000 *dong* for a buffalo. Livestock sold alive to buyers from outside the village are not taxed. Fees are collected at time of slaughter. The village does not collect taxes on animals killed for ceremonial purposes, although it is technically supposed to do so. The village collected 6 million *dong* from livestock taxes in 1990.

Businesses and shops are also taxed. This is collected for the district, which returns 15 to 20 percent to the village. In 1990 the total collected was 10 million *dong*, of which the village received two million *dong*.

THE VILLAGE AGROECOSYSTEM

At first sight, the village landscape appears to be an undifferentiated one, composed simply of several dense clusters of houses half-hidden behind bamboo hedges and surrounded on all sides by flat expanses of paddy fields. In the far distance, other villages, visible only as dark green groves of bamboo, break the otherwise smooth line of the horizon. As one grows more familiar with the locality, subtle variations become more evident. Although rice is the dominant crop produced in Nguyen Xa Village and most of the cultivated land is used for paddy fields, the village agroecosystem contains several distinct subsystems (ecosystems or land use units). These include cultivated fields (wet rice fields and vegetable fields), houseplots and homegardens, roadsides and dikes, fishponds, canals, and rivers (see Figure 2.1). Table 2.1 presents data on the area occupied by different land use units within the village.

Each type of land use unit supports a distinctive community of plants and animals. Together with the abiotic components of soil and water, these comprise an ecosystem. All of these ecosystems are anthropogenic in origin, reflecting the fact that farmers' decisions (i.e., by responding to government directives and market information, and acting on individual preferences and needs) determine the way in which each land use unit is managed and, hence, the community that it supports. Competition among different species, both within each ecosystem and among different ecosystems within the landscape, remains significant, but its outcome is largely determined by human decisions and actions rather than natural selection.

Ecosystems in the Nguyen Xa Village Landscape

This section describes each of the major ecosystems that make up the village landscape. Information is presented on the area occupied by each unit, and the plant community and associated animals that it supports. Its interaction with other units is discussed, and factors influencing management decisions are explored.

Cultivated Fields. There are 303 ha of paddy fields and 2.4 ha of vegetable fields. The government classifies land into seven categories, which are intended to reflect potential productivity. This potential is estimated in terms of physical factors including elevation, water-control quality, and soil type. Seventy percent of the village land is considered to be high

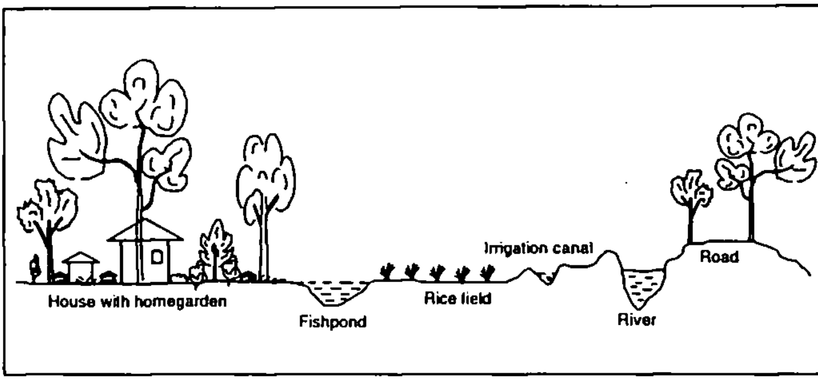


Figure 2.1 *Cross-section of Nguyen Xa landscape.*

elevation; 25.8 percent, very high elevation; and the remainder, middle elevation land. There is no low or very low land, which would be subject to high flood risk. More than 90 percent of the fields are serviced by an irrigation system and yield two rice crops per year. Soils are loamy, ranging from light to heavy in texture. Heavy loams are considered the poorest soil because of high acidity levels.

There are 65 ha of Class I land, 100 ha of Class II land, and 140 ha in Classes III–VII. When land was allocated as Fund I land to individual households, each household was supposed to receive one plot in each of the three major classes. Since some households also lease additional plots of Fund II land, there is considerable fragmentation of holdings. The modal household farms six separate plots, with the number of plots per household ranging from 1 to 9. This fragmentation, although contributing to maintaining a high level of interhousehold equitability, removes a not inconsiderable area from productive use in the form of small bunds constructed to demarcate each household's field. This loss is made more serious by the very small size of most plots. Individual plots range from 24 m^2 to 1,512 m^2. The median field is less than 400 m^2, with 90 percent of plots less than 1,000 m^2 (Figure 2.2).

Two rice crops are grown each year in most paddy fields, the winter/spring crop (*vu chiem xuan*), which is transplanted in late December to February and harvested in June, and the summer/fall crop (*vu he thu*), which is transplanted in late June to August and harvested in late September to October. During the dry winter season, a third crop of sweet potatoes, Irish potatoes, or soybeans and other vegetables is planted on higher fields, and corn is grown on lower-lying land. Some

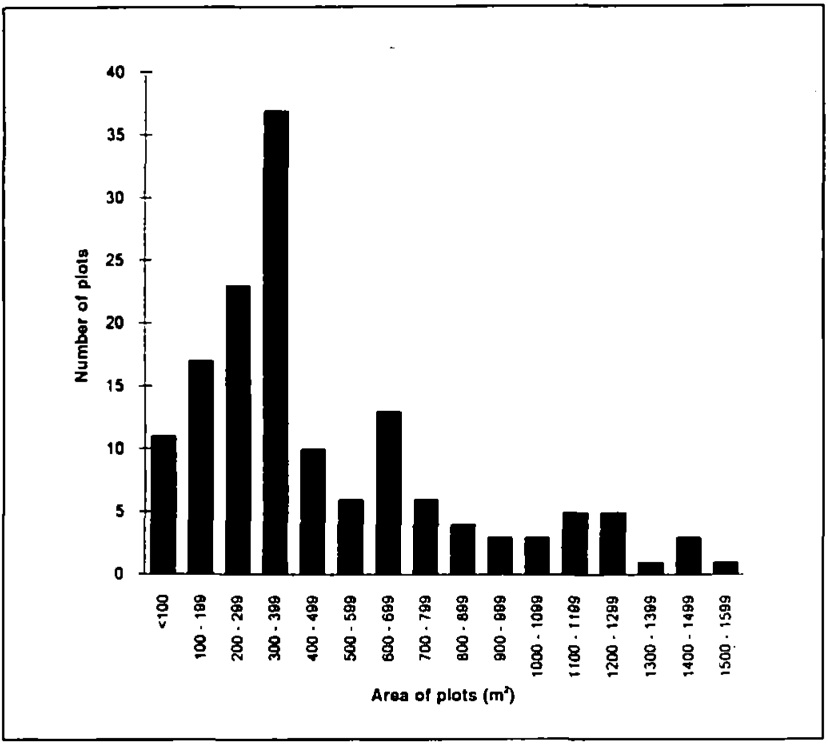


Figure 2.2 *Distribution of plot size of rice fields: Sample of 31 households* (Source: *Village records*).

fields (16.2 ha) are first used as nurseries for rice seedlings and are then used to grow rice following the transplanting.

Cultivation of irrigated rice requires skillful management and is extremely labor intensive. At the beginning of the planting season, the carefully leveled fields are flooded to soften the soil. They are then plowed with wooden plows pulled by buffalo or human workers. Following the plowing, the fields are carefully hoed by hand to break up clumps and turn under any remaining ratoon rice plants and weeds. They are flooded for a second time and then harrowed. Compost is then worked into the soil by hand and the surface patted smooth in preparation for transplanting. Transplanting is meticulously done, sometimes with strings stretched across the field to guide the placement of the seedlings into perfectly straight rows. Weeding during the growing season requires continuous effort. Harvesting is done by hand with sickles, and the paddy and straw are carried to the houses on shoulder poles. All tasks must be performed as rapidly as possible since fitting three crops into each year requires extremely tight scheduling. To save precious time, maize for the winter catch crop is sprouted in nurseries and then transplanted into raised beds that have been hurriedly prepared in the newly harvested paddy fields.

The plant community of the paddy fields is a relatively simple one with nonglutinous rice the dominant species. There are currently four main varieties of rice grown in the village for the spring crop. Of these, three are high-yielding varieties: VN10 is planted on about 70 to 80 percent of the area; CR203 is planted on 5–10 percent of the area, especially on higher areas and areas used earlier in the season as nurseries; CH3 is a drought-tolerant variety that is planted on 5 percent of the area. A traditional variety of glutinous rice (*lua nep*) is grown on about 5 percent of the area. For the fall crop, CR203 is dominant, covering 80 percent of the area. Glutinous rice covers 15 percent; CH3 about 3 percent, mainly on higher land; and MTL58 about 2 percent of the paddies with the best soils. The farmers strive to maintain varietal diversity on a temporal rather than a spatial basis. Each year, new varieties released by the provincial rice-breeding station are tested on 5 *sao* of land owned by the Cooperative. Seed from those varieties that perform well are then given to selected farmers to multiply in their own plots, with the village buying back the seed at a price of 1.2 kg of paddy for each kilogram of seed. The varieties grown in the fields are thus gradually replaced every 5 to 10 years. Further temporal diversity is practiced by growing sweet potatoes, Irish potatoes, corn, and soybeans as winter season catch crops in some of the paddy fields.

The periodic flooding and drying of the fields, accompanied by repeated cultivation of the soil, ensure that the environment within the field is kept in an almost constant state of flux, making it an unsuitable habitat for most wild species.[3] A number of unidentified weed species that grow spontaneously in the paddies are collected by farmers to feed buffalo and pigs. Several species of algae occupy the surface of the water in the fields. The fall crops include *Chara, Oscilatoria, Anabaena*, and *Nostox*. The most common algae varieties in the spring crop are *Spyrogira, Oscilatoria, Nostox*, and *Cynlindropermum*. Azolla was formerly widely cultivated during the spring crop as a source of green manure. One kilogram of plants introduced into a paddy at the beginning of the growing season would yield 300 kg of nitrogen-rich green manure. However, cultivation of Azolla has declined considerably since land management was placed in the hands of individual households.[4] Since only a limited area is now available to reproduce Azolla during the winter, "seed" quantities are insufficient to supply all the fields. Farmers also say that since irrigation water flowing through their fields carry away much of their Azolla to benefit other farmers downstream, it is not worth the time and effort to maintain it. Some farmers, however, still raise Azolla, and others purchase "seed" from them for use in their fields.

Almost all of the solar energy captured by vegetation in the paddy field is directly consumed by humans and livestock or used as fuel for human purposes. Only the energy contained in the small biomass of algae and the roots of rice plants remains in the field after harvesting. Organic matter is returned to the fields in the form of compost and green manure, but very little energy is available to support non-human consumers with the exception of micro-organisms. This is reflected in the impoverished state of the animal community of the paddy fields.

After harvesting and before transplanting, flocks of domestic ducks are herded to the fields to glean the stubble and eat insects and weeds. Only a few wild animal species, most of them represented by small populations, reside in the cultivated fields. Crabs, which live in holes in the small bunds between the paddies, are quite abundant despite the constant pressure of human predation. Fish are rare because of the short period that the paddies are flooded, fishing pressure, and, perhaps, pesticide toxicity. Frogs were relatively abundant in the flooded paddies. Recently, the local population was almost eliminated by overhunting when the Chinese market reopened, greatly raising the price farmers received for frogs. Various insects that prey on rice are present but rarely in large numbers. Brown planthoppers are the most serious pests but are kept under control by cultivation practices and limited use of pesticides. Only a few small sparrow-like birds were observed flying over the paddies. Insect-eating bats are active at night.

Houseplots and Homegardens. Every resident household is entitled to a houseplot of 240 m^2. Some households have considerably larger plots—in some cases based on pre-revolutionary titles, and in other cases recently assembled by purchasing land from others. Houseplot land is considered fee-simple property; it is heritable and, by informal village rules, can be bought and sold. No tax is paid on houseplots.

The houseplots and gardens are raised more than 1 m above the natural surface to provide protection against floods. The soil is mostly very sandy alluvium excavated from low-lying areas next to the settlement area. Most of the surface of each houseplot is taken up by the house and associated structures such as the kitchen, the toilet, and the pig pen, and a paved courtyard used for crop drying. There is considerable variation in the size and quality of houses: the poorest have tamped earth floors and walls, and thatch roofs; the most expensive are two-story masonry structures with tile floors and roofs. Various ornamental plants are grown in pots on verandas. Cats are present in a few houses. House flies are the most common wild animal species. A few house lizards were also observed on interior walls and ceilings.

Homegardens are not as highly developed in Nguyen Xa Village as they are in some other areas of Vietnam. They are certainly not exemplars of the highly integrated VAC system (*vuon-ao-chuong* or garden-fishpond-livestock pen) promoted by the government in its rural development program. The diversity and density of plant species in the gardens are relatively low, although the gardens contain the most diverse plant community in the village system. The following number of species was recorded: 24 fruit trees, 14 vegetables, 5 staple crops, 16 ornamentals, 18 spices and medicinal plants, and 12 miscellaneous plants (see Chapter 6). Ponds are not located within the houseplots and are thus poorly integrated into the garden system. Buffalo are sometimes kept in stables at the edge of the village rather than by the houses. Pigs are kept on the houseplots but are fed primarily with feed brought from paddy fields and ponds. Their manure is recycled to the paddies rather than the garden. A few chickens range freely through the gardens. Some households keep ducks and pigeons. Wild species, other than a few sparrows and butterflies, are virtually absent.

The form of the homegardens reflects the specific ecological and economic constraints operating in Nguyen Xa Village. Space for homegardens on the houseplots is severely limited. The house and paved courtyard commonly occupy most of the central area of the houseplot, leaving only a narrow perimeter strip (1–3 m wide) for garden use. Shading by the house and neighboring structures further limits the suitability of available space for planting many species. The shortage of space and light is reflected in the architecture of the gardens. Trees are generally short (< 5 m) and are widely dispersed rather than densely planted. There are almost no emergent large trees to form an upper layer canopy. Except for a few coconut palms, few trees exceed the roof height of a single-story house. It may be that tall trees are considered undesirable because of their vulnerability to wind damage during the frequent typhoons that strike the village.

Roadsides and Dikes. The roadsides that connect the village to the district and the tops and sides of the major dikes along the irrigation canals are covered with native grasses. The grass grows thickly but is of low nutritional quality. This grass can be freely grazed by any villager's cattle. Grazing pressure is severe, and the grass rarely achieves a height exceeding 3 or 4 cm.

Publicly owned strips along the main roads are planted with trees that belong to the village. The most common species are *xa cu* (*Khaya seneganensis*) and *bang* (*Terminalia cattapa*). Eucalyptus, coconut palms, kapok, bamboo, and *xoan* (*Melia azedarach*) are planted beside the smaller roads and paths within the village. On a special day right after the Tet New Year holiday, members of the various village associations help plant trees on public lands. The wood is used for construction of village projects. The stocking density is relatively low. Many stretches of roadsides have 20–50-m gaps between trees even when there is adequate space to plant many more of them. Although it would seem possible to considerably increase the tree biomass by more intensive planting, there are management problems in trying to do so. Village officials complain that people cut the trees illegally.[5]

Only a few wild-bird species inhabit the trees. Tree sparrows are most common. There are also a few bulbuls to be seen. Hunting pressure from boys who use rubber catapults is severe. No other arboreal animal species was observed.

Ponds. Ponds cover 11.1 ha in the village. The ponds are largely artificial in origin—depressions that were created when farmers dug out soil to raise the level of their houseplots. There are two types of ponds: (1) to raise fish and (2) to grow aquatic plants for pig fodder. Fish include various species of carp, tench, and tilapia. Plants grown in the fodder-producing ponds include water hyacinth, lotus, *pistia*, and *salvinia* for pig fodder and water spinach (*rau muong*) for human consumption.

Although ponds are distributed to individual households to manage, not all families have access to one. Fear of fish theft is a constraint on fish raising and is one reason most ponds are used for fodder production. People dislike adding pig manure in ponds to feed the fish because the water is also used for bathing and washing clothes.

Canals and Rivers. The village is bounded on its northern and eastern corner by the Tien Hung River, one of many secondary channels that branch off from the Red River as it nears the sea. Its turbid waters, heavily charged with sediment during the flood season, flow into the village through the Thong Nhat Canal. Electrically driven pumps at five stations along this canal lift water into the many small lateral canals that distribute it to the fields. Excess water flows through the village and back into the river where the canal intersects it at the Nguyen Bridge. The irrigation water brings some nutrients into the system as suspended and dissolved sediments. Nutrients leached from chemical fertilizers and pesticide residues are exported downstream.

Canals and rivers are an open access resource. Anyone can fish in them, and fishing pressure is very heavy. People can also freely build bamboo cages for raising fish. The lower banks of the rivers and canals are planted to taro (*mung* or *Calocasia* sp.), while shallow water areas are devoted to water spinach (*rau muong*, kangkong, *Ipomoea aquatica*) wherever space is available. Aquatic weeds such as water hyacinth are also collected for use as pig food and green manure.

Draft Animals. In the village there are 97 buffalo, of which 6 are breeding stock, and 10 cattle. Both buffalo and cattle are used for plowing, although cattle are not as strong as buffalo. The village is short between 15 and 20 head to meet its minimum draft animal requirement. Despite this shortage, the number of buffalo has declined from 128 head in 1988.

Shortage of fodder is the main factor limiting livestock numbers. There is no grazing land other than the very limited area of grass growing along the roadsides and dikes. This is an open access resource that is being used to maximum capacity. The grass there is cropped very short like putting greens on a well-kept golf course.

Buffalo manure is highly valued for use in rice fields, but the supply is insufficient to meet the need for organic fertilizer. Curiously, given the scarcity of this resource, people do not collect dung that drops on the roads and dikes where the buffalo graze. At least some of these nutrients are taken up by the grass and thus recycled within the system.

STRUCTURE AND FUNCTIONING OF THE VILLAGE AGROECOSYSTEM

The various ecosystems are interlinked to form the village agroecosystem by flows of energy, materials, and information. The irrigation water, the livestock, and the human population function as vectors linking the several ecosystems together, as well as tying the village agroecosystem into other external systems (Figure 2.3). The village system is not wholly a closed one. It interacts with higher level ecological systems, especially the watershed, and with higher level social systems as represented by external markets and the district and provincial governments. It is highly dependent on a continuous in-flow from higher level systems of materials (e.g., irrigation water and chemical fertilizer), energy (electric power and gasoline), and information (new rice varieties) for its continued successful functioning.

Humans are the dominant animal species in the village landscape and function as a key vector linking together its various subecosystems. Human goals and human actions strongly shape the landscape. It can be argued that demographic factors—more than social, economic, or political considerations—are the preeminent determinants of the structure and functioning of the village agroecosystem. Humans directly use much of the energy available in the system and control the flow of nutrients and other materials within the system.

Energetics

Meeting the metabolic requirements of the human population places extremely high demands for energy on the agroecosystem.[6] Because of their great numbers, humans directly consume much of the solar energy that is fixed by photosynthesis in the various plant communities within the landscape. Another large part of the plant biomass is consumed by livestock. Much of the rest of the available plant biomass energy is consumed as fuel for cooking and food processing. Rice straw is the principal fuel used for cooking. Fuel is so scarce that even the tiny green shoots trimmed from the tops of rice seedlings, when they are prepared for transplanting, are carefully collected and dried for use in kitchen stoves. Also used are dry maize stalks and fallen leaves and branches from trees in the gardens.

Additional energy in the form of food, coal, electrical power, and

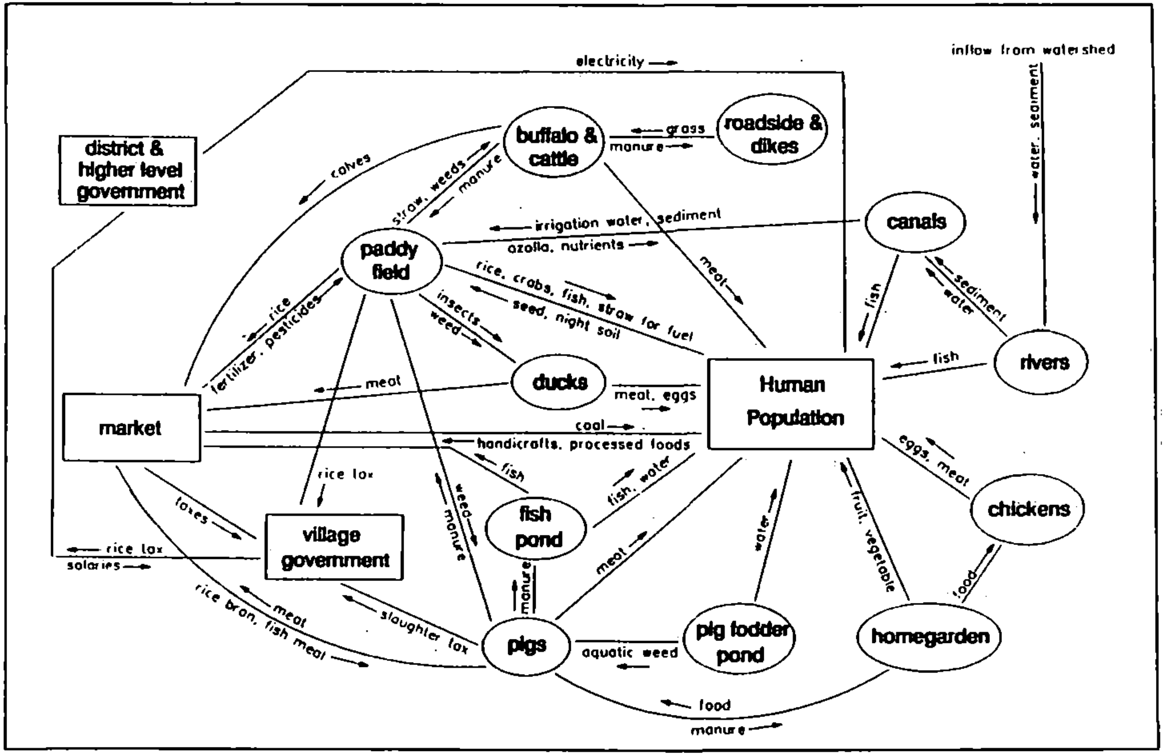


Figure 2.3 *Nguyen Xa Village agroecosystem.*

gasoline is imported from outside the boundaries of the village system. No estimates are available of the quantity of food imported, but the total energy value is probably quite small. An estimated 1,000 tons of coal dust is purchased from dealers in the district each year. The dust is mixed with mud to form briquettes that are used for fuel. Each year, 190,000 kwh of electricity is used within the village. This is only 29.5 kwh/capita (in the United States, per capita consumption of electricity was 8,312 kwh in 1971 [Cook 1976:236, Table 9.9]). About one-fourth of this electricity is used to run irrigation pumps. Most of the rest is consumed by individual households for lighting and to run small appliances. Almost every household has at least one table fan; some have radios, televisions, and refrigerators.

Each year the Cooperative purchases 6 tons of gasoline, which is mostly used to run the supplementary irrigation pumps. Total consumption of imported energy is 7.1×10^9 kcal/yr, or 3,024 kcal/capita/day. Data on locally produced biomass energy (mostly rice straw) used for cooking are unavailable, but consumption is unlikely to exceed a few thousand kcal/capita/day. The village is thus a low-energy society when these consumption rates are compared to the 1972 U.S. per capita consumption of 219,000 kcal/day and the world average of 37,400 kcal/capita/day (Cook 1976:245, Table 9.18).

Most of the energy imported into Nguyen Xa Village is derived from nonrenewable fossil fuels. If this quantity of energy had to be totally supplied by growing fuelwood, a 161-ha woodlot would be needed.[7]

Material Flows

Critical material flows within the village agroecosystem are those of nutrients, water, and construction materials.

Nutrients. Although not a completely closed system, there is a high level of nutrient recycling within the village agroecosystem (Figure 2.3). Most crops and crop residues are consumed by the village population, fed to livestock, or burned for fuel. Almost all manure, night soil, and ashes from fires are returned to the fields as organic fertilizer. The major causes of nutrient loss from the system are exports of pork, rice, and processed foodstuffs, and leaching and drainage. Inflows of additional nutrients to the system occur in the form of chemical fertilizer, sediments in irrigation water, dissolved chemicals in rainfall, and local biological fixation of nitrogen. Nutrient inflows and outflows appear to be roughly in balance (Chapter 10).

Water. Supply of water for domestic use and human consumption is a major problem. Many households use water from the ponds for bathing and doing laundry. The water is heavily polluted by surface run-off from the settlement. Pig manure is also added to some of the ponds as supplementary food for fish. The village doctor reports that women suffer numerous skin infections that he attributes to bathing in polluted water. Some households have deep wells drilled as part of a UNICEF project. A simple hand pump is used to draw water from more than 60 m below the surface. Construction of the well, pump, and storage tank costs about 300,000 *dong*. The farmers say that, although the water is completely safe to drink because it is free of micro-organisms, it does not taste pleasant. Furthermore, the water has a very high iron content, which discolors clothing. Contamination with pesticides and nitrates leached from the fields into the groundwater may also have occurred, but the extent of such pollution has not been tested. A few households have concrete cisterns to catch rainwater from house roofs. The water quality is excellent but cisterns are expensive to build, costing more than 1 million *dong* per unit—a sum that only the wealthiest households can afford.

Construction Materials. Supplies of materials such as soil, brick, tile, cement, and wood for house construction are scarce and expensive. Soil must be dug from surrounding fields to raise the level of new house sites above the height of floodwaters. Poorer families also continue to make the walls of their houses using the traditional rammed earth construction method. All other construction materials must be imported from outside the village. Brick and tile are produced at nearby villages that specialize in ceramics and are transported by bicycle to Nguyen Xa Village. Cement comes from the factory at Haiphong. Limestone rock is imported from quarries in the hills of Ha Nam Ninh Province and made into plaster in the village. Timber is transported by truck from the rapidly depleting forests of the Midlands.

FACTORS INFLUENCING BIODIVERSITY OF THE VILLAGE AGROECOSYSTEM

Before human settlement, the landscape would have been primarily composed of forested swamps and seasonally flooded areas supporting a variety of plant communities with a high species diversity. Today, most of the area is an artificial seasonal swamp where a single plant species—rice—is dominant. Under natural conditions a diversity of aquatic organisms (fish and crustaceans), insects, and birds would have been the most abundant animals. Today, humans are the dominant animal species. Only a handful of other species are successful competitors with people in the village agroecosystem. The food web is an extremely simple one with only a few trophic levels. The landscape is the ultimate anthropogenic system, with its form and species composition almost entirely determined by human decisions and actions.

Human transformation of the landscape is not willful or random. People change the landscape in certain ways in order to achieve culturally sanctioned objectives. These include fulfillment of material goals, especially production of sufficient food, fuel, and shelter to meet basic human needs, and attainment of ideational objectives, particularly the shaping of nature to fit aesthetic preferences and religious prescriptions. The choices people are able to make, however, are strongly constrained by ecological realities, especially the intense pressure exerted by a large population on a small area of land.

The need to produce food to support this population is the primary determinant of land use. Rice production has the highest priority, and all land that can possibly be used for paddy fields is planted to rice. The canal system used to irrigate the paddies necessarily takes a considerable area out of production. But since the fields were allocated to individual households, farmers have been cutting into the sides of canal dikes and large bunds in order to increase the size of their paddies. This has reduced the grazing area for draught animals. It also precludes planting windbreaks on the bunds because there is now barely room for a single individual to walk along the top to gain access to the fields. It is unlikely that further space can be gained for rice through this practice without causing dangerous weakening of the dikes.

The need to find space in which to live is the second most important determinant of land use. As the population grows and families build houses for newly formed couples, the area available for homegardens shrinks. Farmers express concern about where their children will live in the future since it is impossible to further expand the surface devoted to housing without encroaching onto the paddy fields. Families that can afford to do so are expanding vertically rather than horizontally by building two-story dwellings.

Finding space for burials is also a very real problem. Graves are usually located on small patches of higher land that are not suitable for rice cultivation. Most graves are simple mounds of earth that after a few years merge back into the fields. Wealthier families are increasingly likely to construct elaborate concrete tombs that will last for decades. A large plot of land near the village headquarters is also devoted to the district military cemetery which contains 1,500 graves.

Public facilities—such as the headquarters for the village People's Committee, the Cooperative store, the school and its playing field, and the cultural affairs building—and the two-lane paved road that passes through the village also cover a considerable area of land. The small paths that connect individual houseplots to the rest of the village are already very narrow and probably cannot be narrowed further.

The existing landscape is the outcome of numerous tradeoffs between use of land for food production, infrastructure in the form of irrigation canals and dikes and roadways, housing for the living and gravesites for the dead, and public facilities. So intense are the competitive pressures that no space remains for natural communities. Even the margins of the district military cemetery have been planted with sweet potatoes by its groundskeeper.

Endnotes

1. In 1989, the national density for Vietnam was 195 persons/km^2. Ho Chi Minh City with 1,883 persons/km^2 and Hanoi with 1,428 persons/km^2 had the highest population densities. Thai Binh Province was the only primarily rural area to exceed 1,000 persons/km^2. Gia Lai-Kontum Province, in the Central Highlands, represented the other extreme on the density scale with only 34 persons/km^2 (UNICEF 1990: 9–10, Table 1.5).

2. Of the land used for rice, 272 ha are double-cropped and 16.2 ha are used for nurseries plus two rice crops. A third catch crop is grown on approximately 120 ha of paddy land. Major crops are sweet potatoes (43 ha), maize (36 ha), Irish potatoes (29 ha), and soybeans and other vegetables (11 ha). The 2.4 ha of higher land devoted

exclusively to vegetables is assumed to yield four crops per year. The total area cropped per year is thus 706 ha for a cropping intensity index of 2.31.

3. A study by Ali (1990) of fish populations in double-cropped wet rice fields in the North Krian area in West Malaysia notes that "only those species that can tolerate, modify, or adapt their requirements to extreme physical and chemical variations survived and thrived." Only 7 species were found in the Malaysian paddy fields compared to the 18 fish species found in single-cropped paddy fields in Northeastern Thailand. "Zoogeographically, there should be no differences between the aquatic species inhabiting the Mekong region and Northern Peninsular Malaysia. Yet, five of the species listed (for Thailand) are rare and endangered while another five are not present in Peninsular Malaysia" (Ali 1990:217).

4. The decline of Azolla cultivation is all the more striking because of the prominent role it once played in the village economy. According to Gourou (1936:393), Nguyen Xa Village was one of a handful of villages in the delta that were primary centers for production of Azolla. Its inhabitants had the specialized knowledge needed to grow the delicate fern during the summer when it normally is killed by the heat. They would produce large quantities of "seed" plants to sell at very high prices in November. This "seed" would be purchased by other villages that specialized in its multiplication for resale to yet other villages. In some areas it passed through three stages of multiplication before being sold to farmers in a large area in the lower delta. Several villages in the Canton of Co Quan, Phu of Tien Hung, Thai Binh Province, that were in the first stage in this reproduction relay obtained their seed plants from Nguyen Xa.

5. As one travels from Thai Binh through Ha Nam Ninh toward Hanoi, a greater number of trees are in evidence. There are relatively thick lines of casuarina on dikes in the fields, evidently planted as windbreaks. This is in an area where rice is less productive because of deeper water. Population density is considerably lower than it is in Thai Binh so there may be less competition between trees and rice for space within the landscape. One village located near the road about 50 km before Hanoi had a very well-maintained line of 10–15-m tall trees (eucalyptus, casuarina, and an unidentified broad-leafed species) planted along about 2 km of dike paralleling the highway. The trees ended abruptly at the boundary of the village, although the dike did not appear to become narrower. It would be interesting to know why this village has such a successful tree-planting project.

6. The extraordinary position that the human population occupies in the trophic structure of the village agroecosystem becomes evident when it is recognized that it has a live-weight biomass of some 248.3 t (577 kg/ha of village land). In temperate ecosystems in North America, wild mammal species display biomasses ranging from a few grams to 20 kg/ha (Odum 1971:165, Figure 7-1). There are approximately 14 kg/ha of plant-eating animals of all species in the Amazon rainforest. East African savannas, which are thought to have the highest animal biomass of any natural terrestrial system, support 100–300 kg/ha of large herbivores (Hutterer 1982:51). (The biomass of the village population was estimated by multiplying the number of individuals in each age/sex cohort times the average weight for individuals in that cohort. Average weights are taken from the study by Duong Hong Huy [1968: 10–11] of 101 females and 64 males in Co-Man Village in Quang Nam Province in Central Vietnam.)

7. Eucalyptus plantations in the tropics yield 10 t/ha/dry-weight fuelwood having an energy value of 4.4×10^7 kcal (Bormann, Smith, and Bormann 1991:19). Nguyen Xa Village does not even have 1 ha of free land to use for fuelwood production.

3. DEMOGRAPHY AND LABOR

PETER XENOS
TRAN THU PHUONG
LUU THI THAO
VU XUAN TRUONG

The study area illustrates the difficulties that can arise from rapid population growth when a critical resource such as agricultural land is in short supply. Throughout the Red River Delta, there is evidence of the effort and skill that have been devoted to raising the productivity of the land, almost always by opting in favor of labor intensification over other kinds of technology. There is widespread recognition that, relative to other production inputs, and especially relative to land, there is much surplus labor in the delta, in Thai Binh, and in the district and village of our study. This section is concerned with the demography of the study area, including the demographic roots of the current labor surplus situation, as well as the changes that are now under way in response to it.

VIETNAM'S DEMOGRAPHY: NATIONAL, REGIONAL, AND PROVINCIAL

National and Regional

Vietnam has a long history of population growth and the expansion of agriculture into new areas. Two significant elements in this history are (1) an historical movement southward out of the Red River Delta heartland to areas of greater agricultural opportunity, thus relieving population pressure; and (2) the sharp acceleration of population growth in Vietnam's agricultural areas to unprecedented levels. It is not necessary to review this history in any depth here. The resulting very great differences in population density between northern, central, and southern Vietnam, and between the mid-to-upland zones compared to the alluvial basins, are readily apparent (see the map provided with the country's 1989 population census report [CCSC 1990:Map III.8]).

The historically unprecedented rapid population growth in recent decades has brought these regional differences into sharper focus and has increased population densities in the two main river deltas to extremely high levels. Pierre Gourou (1931), writing in the late 1920s, described an overall Red River Delta population density of some 430 persons/km^2, and Yves Henry (1932:21–26) discussed the 1931 Thai Binh population density of 593 persons/km^2. Today, however, the population density in the delta is well over double its earlier levels.[1] Continual population growth is certain to fundamentally destabilize the system.

Thai Binh as a National Forerunner

As was pointed out during our initial briefing by province officials, Thai Binh's density is the highest of the predominantly agricultural provinces; remarkably, it nearly matches the levels of urban Hanoi and Ho Chi Minh City. But Thai Binh leads the country in other respects as well. Nationally, the population growth rate has begun to decline, and in the 1980s the birth rate began to drop, just as the death rate had done earlier. According to the 1989 census, the national birth rate was 31 or 32 per thousand persons and the death rate was 8 or 9 per thousand persons by the late 1980s. The rate of natural increase of population (the difference between birth and death rates) was 22–24 per thousand (CCSC 1990:39). The national intercensal population growth rate for 1979–89 was 2.1 percent per year.

The corresponding progress of Thai Binh Province toward lower mortality, and then lower fertility, is outlined in Table 3.1. According to these data provided by the Thai Binh Committee on Population and Family Planning, the provincial population first exceeded one million persons somewhat prior to 1960, exceeded 1.5 million by about 1985 (mid-year), and was at 1.67 million at mid-1990. The provincial birth rate, which was well over 40 per thousand up to the 1950s, had declined to the mid-30s by the 1970s (according to these data, much of this drop occurred in the 1960s, but this cannot be verified). Further decline was slight until the 1980s, when a second period of rapid fertility decline occurred.

The death rate is recorded as being relatively low by the 1960s, though this seems unlikely because of the moderate population growth rate at that time (e.g., 1.4 percent per year from 1960 to 1970). The recorded annual births and deaths between 1961 and 1969, together with the annual population totals, suggest an annual out-migration rate fluctuating between 20 and 30 per thousand persons. This rate of out-

Table 3.1 Basic Demographic Estimates for Thai Binh Province

Year	Mid-Year Population	Births	Birth Rate	Death Rate	Rate of Natural Increase
1955	981,567	46,133	47	13	3.40
1960	1,138,603	53,514	47	13	3.40
1965	1,250,223	43,757	35	6	2.94
1970	1,307,947	37,930	29	5	2.41
1975	1,415,906	45,308	32	5	2.68
1980	1,410,390	42,311	30	8	2.18
1985	1,531,377	33,833	22	7	1.54
1986	1,539,540	35,461	23	6	1.63
1987	1,569,175	37,239	23	6	1.68
1988	1,596,674	36,750	23	6	1.58
1989	1,636,412	35,409	22	6	1.60
1990	1,673,553	37,851	23	5	1.70

Source: Committee on Population and Family Planning, Thai Binh.

migration would counter four-fifths of the measured natural increase. We cannot determine whether such a heavy out-migration actually occurred from the province, or if the death rates were actually higher than the recorded levels. The general outlines of these observations is supported by supplementary information, especially from the latest census: provincial levels of the total fertility rate (TFR) are particularly low in Thai Binh Province—near the levels for Hanoi and Ho Chi Minh City (CCSC 1990:Map III.1)—and the level of infant and child mortality is also relatively low (Map III.3).

But whatever the initial levels and the paths of decline, it is clear that both mortality and then fertility have shown major declines in Thai Binh. The combined result was at first to increase the provincial population growth rate, which had reached 1.8 percent per year during 1985–90. Now that the death rate has reached a very low level in Thai Binh, while the birth rate is relatively low and still declining, a slight lessening of the population growth rate should soon begin to be evident. These Thai Binh provincial population growth rates are lower than the national intercensal rate (1979–89) of 2.1 percent (CCSC 1990:26). The difference reflects the province's lower fertility as well as some out-migration.

Throughout these dramatic changes, the long-run direction of Thai Binh's population has been steadily upward. The long-term perspective in Figure 3.1 emphasizes the trend of population density, which is proportional to the trend of population growth. It bears repeating that the Thai Binh population density in 1990, about 1,168 persons/km^2, is 2.7 times the delta-wide density level that so impressed observers such as Pierre Gourou and Yves Henry writing at around 1930, and double Thai Binh's 1931 density.

Planning and resource allocation in Thai Binh Province have, over the decades, focused on both parts of the population/resources balance. There has been considerable improvement to total output, and certainly to output per unit of cultivated land. Most recently, efforts have turned to sharply reducing the rate of population growth and ultimately to achieving population stability. We turn now to some of the main features of contemporary delta demography with Thai Binh Province as the illustration and will draw on the district and village-level data and household interviews collected during our research there. We are especially interested in the effects of government policies and actions on demographic change, including the following important policies:

1. Very effective public health and mortality control, including control over episodic mortality;
2. Careful allocation of land and other productive resources to achieve the maximum equity and productivity possible, including:
   - provision of a floor or minimum level of living where necessary;
   - mechanisms for adjusting resources to changes in the demographic composition of families during the family cycle;
   - special allocations of land where deemed appropriate;
3. A recent effort to advance the ongoing fertility decline by vigorously linking childbearing to land allocation and various state services;
4. Attention to permanent out-migration to the south or New Economic Zones (NEZs) to improve the population/resources balance.

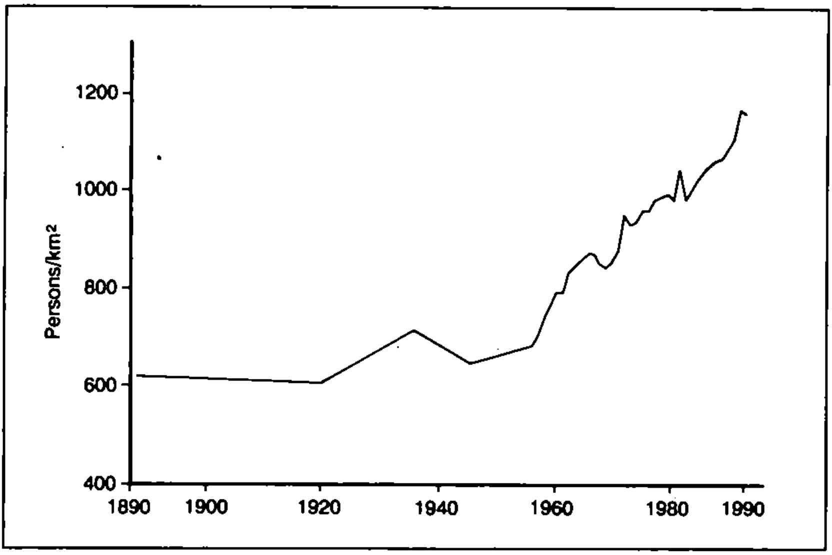


Figure 3.1 *Population density in Thai Binh Province: 1890–1990.*

THE LOCAL DEMOGRAPHY OF THE DISTRICT AND NGUYEN XA VILLAGE

Dong Hung District is near the geographic center of Thai Binh Province, and its current population density of 1,122 matches that of the province as a whole. This is an almost entirely agricultural population as is shown in our subsequent discussion of major economic activities of the district's labor force. With 1,555 persons/km^2, the village of Nguyen Xa, one of 45 villages making up the district, has, in turn, the highest population density of all the Dong Hung villages.[2] A closer examination of demographic change at the district and village levels provides a more refined picture of the aggregate changes taking place over a much larger geographic area. Moreover, we can relate these changes to information obtained during our interviews with village households.

Changing Birth, Death, and Migration Rates

Table 3.2 provides annual birth and death rates during the 1980s for the province, district, and village levels. (At the district and village levels, these data do not seem to be available for the period prior to 1980.) Birth

Table 3.2 Birth, Death, and Net Migration Rates for Thai Binh Province, Dong Hung District, and Nguyen Xa Village

	Thai Binh Province			Dong Hung District			Nguyen Xa Village		
Year	Birth Rate	Death Rate	Migration Rate[1]	Birth Rate	Death Rate	Migration Rate[1]	Birth Rate	Death Rate	Migration Rate[1]
1981	27.4	8.5	NA	22.5	7.5	NA	21.3	7.1	NA
1982	28.1	8.3	NA	27.4	9.2	NA	30.3	7.4	–90.7
1983	28.3	8.6	NA	24.8	8.4	NA	29.1	7.7	73.3
1984	24.9	7.5	NA	23.7	8.7	NA	24.6	8.8	–15.3
1985	25.9	6.6	NA	20.8	7.4	NA	24.8	9.2	27.9
1986	22.8	6.3	NA	19.6	6.7	4.5	20.2	6.5	1.1
1987	23.8	6.3	NA	19.6	7.2	–2.4	18.7	7.3	–18.8
1988	23.0	5.8	NA	19.0	6.1	–1.0	21.0	6.7	–9.1
1989	21.5	5.5	NA	19.6	5.8	5.3	20.9	4.9	48.7
1990	22.6	5.4	NA	21.5	5.3	7.9	19.8	4.8	–3.8

Sources: Province: Committee on Population and Family Planning;
district and village: Committee on Population and Family Planning and district records.
NA = not available.
[1]Village net migration is measured by the residual method.

rates apparently declined throughout the 1980s. They began at a slightly higher level for the province than for the district, whereas the village rates near 1980 seem to be distorted, perhaps reflecting data problems. But all three series moved downward, and by 1990 they fell in the range of 19.8 to 22.6 per thousand, with the lower rate the more local the level. The death rates also moved downward albeit only slightly from the already low levels in 1980. In 1990 the village death rate was slightly below the district rate, which, in turn, is below the provincial rate. All these rates are somewhat below the corresponding national levels.

These rates from district statistics are consistent with our own observations in a wide range of households from most of the hamlets in the village. This evidence, discussed below, includes responses regarding children ever born by duration of marriage, and attitudinal responses concerning family planning. Low mortality is strongly suggested by the pattern of our household responses, including the very infrequent reference to infant or child loss.

Patterns of In and Out Movement

The district data also offer some scattered evidence on recorded movement in and out of the district and to and from each village (Table 3.3). The records are maintained on a de facto basis (i.e., persons are recorded where they actually live rather than where they usually live or expect to be at some later time). Thus, young men entering the army are recorded as movers-out, and they are recorded as in-movers should they return.

The district's in- and out-migration is nearly in balance over the short period for which data are available. The out-migration rate is well below the level implied by district officers in their formal briefing (the 8–10,000 cited as moving out of the district each year would yield an out-migration rate of some 50 per thousand persons). As recorded, the magnitudes of both in- and out-movement have been declining. This change may reflect the recent tightening of work opportunities both domestically and abroad, as well as reductions in the size of the national military. The village rates (net rates only) are, on an annual basis, much larger in magnitude—a significant component of population change. But such residually estimated annual rates are notoriously unreliable. The very large annual fluctuations in this series may reflect reality but probably include substantial estimation error.[3] Overall, there seems to

Table 3.3 Migration and Residency in Nguyen Xa

	Dong Hung District			Nguyen Xa Village
Year	Net	In	Out	Net
1981	NA	NA	NA	NA
1982	NA	NA	NA	–90.7
1983	NA	NA	NA	73.3
1984	NA	NA	NA	–15.3
1985	NA	NA	NA	27.9
1986	4.5	23.9	–19.4	1.1
1987	–2.4	28.1	–13.5	–18.8
1988	–1.0	13.9	–14.9	–9.1
1989	5.3	10.3	–4.9	48.7
1990	7.9	14.2	–6.4	–3.8

Source: District records. Nguyen Xa rates estimated by residual method (cf. Table 3.2).

NA = not available.

have been net out-movement early in the decade and net in-movement more recently. The out-movement does not reflect, as one might expect, the national and local campaign to encourage migration to the NEZs. For example, detailed village records for 1989 and 1990 (Table 3.4) indicate, rather, that these net rates reflect movements of young men into the military and of youth of both sexes into higher levels of education outside the village. There is also a significant movement into the village of workers returning from overseas jobs, discharged soldiers, army returnees, and retired government officials. It is important for the village that these retirees do not receive allocations of village agricultural land. The other returnees do. Related to these in-movement data, at the end of 1990 the village had 177 government officials (mostly teachers), 113 government retirees (who receive no land), and 49 active members of the military. Another 64 persons (including 14 women) are disabled military who receive pensions, as well as allocations of land. Small movements such as these, and fine points regarding land allocations, are important in such a land-scarce setting with limited cash incomes. Our household interviews illustrate the importance of these migration experiences for individual or family welfare, and for overall economic differentiation of households. Several of the households with some capital accumulation had managed this due to military service or work in Eastern Europe.

Table 3.4 Recorded Arrivals and Departures, Nguyen Xa

	Arrivals			Departures		
Year	International Workers	From the Military	Retired Officials	To the Army	For Education	For the NEZs[1]
1989	—	20	8	39	25	6
1990	—	23	6	0	28	13
1991[2]	7	29	6	0	—[3]	13

[1]New Economic Zones.
[2]To mid-1991.
[3]Data do not cover the school season of 1991.

Table 3.5 Population Growth Rates

Period	Province	District	Village
1980–85	1.65	NA	2.04
1985–90	1.78	2.16	1.77

NA = not available.

Population Growth Rates

Growth rates for 1980–85 and 1985–90 at each administrative level are listed in Table 3.5. These rates suggest that there may be some inaccuracy (probably underrecording) in the birth and death records at the provincial level, since the growth rates are below the difference between birth and death rates. Another possibility, just as for the decade of the 1960s, is substantial out-migration from the province, but we cannot interpret the data further in relation to these possibilities without additional data and more careful analysis. The district rates have the same problem to a lesser degree. The village rates are only consistent if we accept the existence of some net in-movement, but neither the village records examined nor our interviews suggest this. All these uncertainties and inconsistencies indicate the need for more careful administration of the village and district records, including cross-checking for inconsistency (comparing births, deaths, and migration figures with changes in the total population).[4]

Population Structure in Nguyen Xa

For the village, we have a detailed listing of persons by sex and year of birth, current as of year's end 1990. This information gives us the age-sex data in Figure 3.2 (parts A and B). Whether one looks at the single-year data or the five-year pyramid, there is evidence of a distinct shortage of males aged 20–24, and also a shortage of both males and females aged 40–49. The former may reflect the pattern of out-movement and return just discussed. The latter reflects those who died during the war to liberate the south. The village records indicate that 167 men and 6 women from the village were killed during that conflict. Ninety-two males died during the earlier resistance war. The number of males killed seems to be reflected accurately in the detailed age-sex distribution. The overall age structure of the village constitutes another kind of evidence of the fertility decline that has occurred. For example, the percentage of the population under age 15 is only 32.1, whereas this figure reaches 45 percent and higher in high fertility populations.

Major Economic Activities

As we saw from a variety of perspectives throughout our research, there is a serious surplus of labor in the study area. As further context for this observation, we sought to examine the way the Dong Hung labor force is deployed and especially the degree to which there is involvement in activities outside of agriculture. The limited information we managed to obtain on this topic is reproduced in Table 3.6, since it may be of interest to some readers. The district's account of its labor pool is described by source and by "distribution" (analogous to but somewhat different from a United Nations labor force classification by industry).

In this scheme, available labor is defined by different age ranges for each of the sexes: 18–55 for males, and 18–50 for females. It is not clear why the age cut-off is younger for females, especially considering the longer average life expectancy of females. In any case, the account shows substantially more females than males available for labor. It is likely that the distinct age structure includes more females aged 18–50 than males 18–55 (judging from the Nguyen Xa data discussed earlier; there, 23 percent are females 18–50 and 21 percent are males 18–55). This pattern might reflect a combination of male war losses and male out-migration. But the difference in Table 3.6 is somewhat greater than can be explained by this factor. It is possible that additional bases for inclusion in the table are being employed.

A small number (1.4 percent of the total labor force) are recorded as within the labor ages but unable to work. Another 16.9 percent of

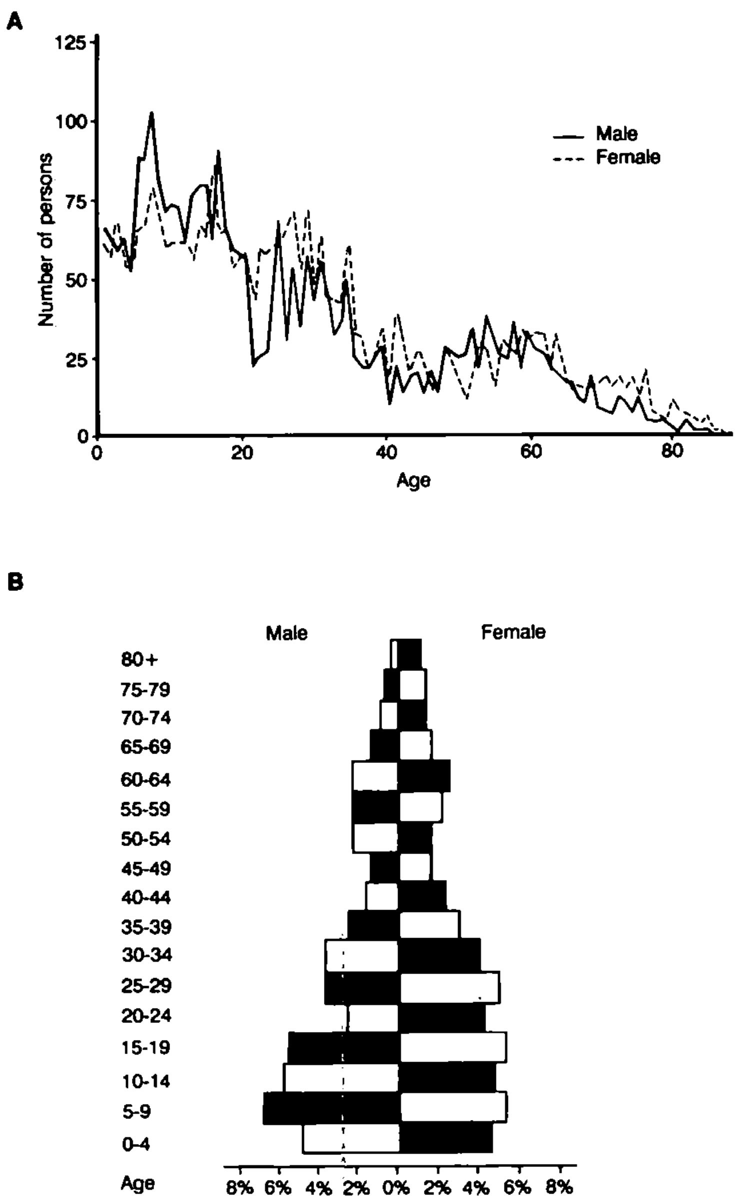


Figure 3.2 *Detailed age structure of Nguyen Xa* (Source: *Nguyen Xa record books*).

Table 3.6 Balance of Labor in Dong Hung District (end of 1990)

Category	Sex: Both	Male	Female
Labor sources			
People in the laboring ages[1]	86,101	35,684	50,417
But not able to work	1,300	519	781
Able to work	84,801	35,165	49,636
People outside the laboring ages[2]	7,094	2,731	4,363
Older (actual number)	7,694	3,128	4,566
Younger (actual number)	7,872	3,128	4,744
Total labor available[2]	91,895	37,897	53,998
Distribution (uses) of labor			
Work in national economic activity			
Material production	88,864	33,774	55,090
Industrial	8,477	2,368	6,109
Construction	3,420	2,037	1,383
Agriculture	68,111	28,245	39,866
Forestry—wood	515	425	90
Transport	787	734	53
Communication	114	58	56
Business	1,771	559	1,212
Other	66	32	34
Nonmaterial production			
Tourism—services	0	0	0
Science	9	4	5
Education	2,631	712	1,919
Art—cultural	301	209	92
Public health—social services—sports	1,463	522	941
State finance—credit—insurance	381	220	161
Government management	498	405	93
Other	320	244	76
Labor reserve	2,968	1,100	1,868
People in school	2,968	1,100	1,868
Colleges/institutes			
Associations			
Other students			
Working at home			
No economic activity			
Graduated, waiting for work			
In labor ages, but with other activities			
Religious	63	23	40

Source: District records.

Note: As in the source, entries and sums do not always correspond.

[1]Ages 18–55 for males and 18–50 for females.

[2]Two persons above working age equal one in the working ages; three persons below working age equal one in the working ages.

available labor is from either old (8.4 percent) or young (8.5 percent) age groups. A weighting scheme (cf. note 2 of Table 3.6) is used to count this labor, apparently on the presumption that it is less productive than labor in the prime working ages. The entries for total labor available include persons in school (apparently among those age 18 or older) and religious functionaries. We could obtain no information on how this overall accounting information is collected or how it is used.

The classification of how labor is being employed shows 74.1 percent in agriculture, 16.5 percent in other forms of material production, and the remaining 6.1 percent in nonmaterial production. The last category is taken up mainly by government services, especially education (46.9 percent) and public health/social services (26.0 percent).

Government employs relatively few people in Dong Hung District, considering the large amount of planning and coordination that takes place. Table 3.7 includes the district's 1987 count of persons employed either by the district or by the villages. This is no more than 5.9 percent of the work force shown on the preceding table. A large part of this state sector is devoted to education or public health. Table 3.8 elaborates health personnel in the district in 1987. They are employed in 1 district center hospital, 6 health stations located in the villages, and 46 village substations (one per village). In the educational system, 2,831 teachers handle more than 47,000 pupils in 259 schools.

There are numerous practical problems with this labor account. The age ranges are not aligned closely with reality. In fact, a large quantity of labor is available from persons over age 50 or 55, and the same is true of persons under the age of 18, often down to very young ages as we often observed during our interviews. The true labor supply is not being assessed effectively. Another serious problem relates to multiple activities. Many, indeed, probably all households, survive by engaging in a variety of off-farm activities, and individuals, alone or in groups, have several economic roles.

THE FAMILIES OF NGUYEN XA

Our research team conducted ten in-depth interviews with households. In addition, a limited set of demographic information was provided on households interviewed by the teams working on other topics. Thus we have based our comments on field notes for 10 households and

Table 3.7 Labor Hired by Dong Hung District

	1987		1990[1]
Category	Total	District	District
Total	5,457	3,640	3,192
Material production	2,261	982	640
Industrial	805	166	80
Construction	279	104	40
Agriculture	537	294	202
Cultivation	460	276	202
Livestock	77	18	0
Forestry—wood	0	0	0
Transport	0	0	0
Communication	69	0	NA
Business	571	418	317
Domestic trade	392	269	224
Food and drink	66	66	NA
Export—import—commercial	40	40	46
Equipment supply	43	43	47
Collection of agri. products	30	30	NA
Other	0	0	0
Nonmaterial production	3,196	2,658	2,551
Tourism services	0	0	0
Science	9	9	0
Education	2,188	2,158	2,041
Art—cultural	109	57	61
Social services—sports	397	290	265
State finance—credit—insurance	231	NA	NA
Government management	178	135	108
Other	91	9	77
Waiting for work	0	0	22

Source: District records.

Note: As in the source, entries and sums do not always correspond.

NA = not available.

[1]Totals not available.

tabular, summary information for a larger set of 51 households.

Nguyen Xa households can be said to be large or small, depending on the perspective one takes. Living arrangements are generally "extended," though this means co-residence in one house in some instances and residence in two or more neighboring houses in other instances. Typically, at marriage, male children take up residence near or in the

Table 3.8 Health Personnel in the District, 1987

Category	Total	District	Village Level
Doctors	140	39	101
Senior nurses	61	31	30
Nurses	48	NS	NS
Hospital—janitorial	5	NS	NS
Traditional practitioners	0	0	0
Subtotal, hospital personnel	254	70	131
Senior pharmacists	3	3	0
Junior pharmacists	9	9	0
Nurse (*duoc ta*)	9	9	0
Chinese medicine	37	5	32
Tester of medicines	7	0	7
Subtotal, pharmacology	65	26	39
Other medical workers	12	NS	NS
Total health personnel	331	NS	NS

Source: District records.

NS = not stated.

same compound as their parents, whereas daughters most often move close to the houses of their husbands' parents. In some households, parents and married offspring with their spouses live together and share resources. In other instances, families function as nuclear units, although they are located nearby.

Our interview households average 4.6 persons. The head of household averages age 55 and his wife 52. Most households consist only of parents and their children, though there are some large three-generation households as well. Marriages occur relatively late, despite the absence of any government efforts to encourage this. Males have recently been marrying at about age 24, and females at about 22. It is not uncommon for a woman in her mid-twenties to be single and living with her parents.

STATE DEMOGRAPHIC POLICIES AND PROGRAMS

Our comments here are limited to policies and programs explicitly directed toward demographic objectives. We emphasize that a much wider range of state policies and programs has demographic impacts (e.g., tax policies, pricing policies), however.

Mortality Control

The health care system in the district is part of a national system that, with limited resources, has had considerable success by placing heavy emphasis on preventive over curative medicine. This approach has achieved much lower levels of mortality and morbidity than is often the case where relatively expensive, hospital-based, curative medicine is the focus of expenditure. The aggregate demographic data indicate low mortality rates, and our household interviews indicated relatively few instances of infant death, for example, even in the poorest of households. These features of the health care system and the mortality regime have made it somewhat easier to encourage fertility control in agricultural households.

Family Planning

Family planning has been actively pursued as a national policy since the early 1960s, and Thai Binh Province has pursued the policy enthusiastically. There is now a provincial office of the National Committee on Population and Family Planning, and contraceptive information is available in health clinics. The main clinics provide services to interested men and women. There is also a media campaign (e.g., Bui Cong Binh et al. 1986) organized by the provincial government and cooperation from a wide range of organizations including, among others, the Ministry of Education, the Communist Youth Organization, and the Women's Union.[5]

The General Secretary of the Committee on Family Planning's Thai Binh office, Nguyen The Lap, feels that the level of activity is still insufficient in relation to the seriousness of the population issue, particularly for Thai Binh. We note that despite the presence of clinics, some at the village level, there does not seem to be much effort to approach village women in their homes. Programs in many other countries have made their greatest advances when such an "outreach" strategy was employed.

Nevertheless, data from the provincial office of the Committee on Population and Family Planning already suggest a considerable achievement (see Table 3.9). Province-wide, there were 227 thousand acceptors of various family planning methods during 1988 to 1990. This is 13.5 percent of the population in 1990, and about 66 percent of the

Table 3.9 Data on Family Planning in Thai Binh and Its Districts, 1988–90

District	Population	Cumulative Acceptors	Cumulative Acceptors: As % of Population	Cumulative Acceptors: As % of Currently Married Females[1]	Birth Rate (%)
Thi Xa	125,000	27,084	21.6	NA	18.2
Quynh Phu	225,000	29,741	13.2	64.9	23.5
Hung Ha	226,000	26,635	11.7	57.5	23.9
Dong Hung	230,000	27,758	12.1	59.5	21.5
Vu Thu	221,000	28,201	12.8	62.9	23.3
Kien Xuong	216,000	25,265	11.7	57.5	21.6
Tien Hai	191,000	29,430	15.4	75.7	23.1
Thai Thuy	249,000	29,259	11.7	57.5	23.5
Province, 1988–90[2]	1,674,000	227,030	13.5	66.4	22.6
Province, 1976–90	1,674,000	866,451	51.7	NA	22.6

Source: Committee on Population and Family Planning.

NA = not applicable; exceeds 100 percent.

[1]Estimated from proportion of population currently married (0.2034) taken from national data.

[2]Data for 1988–90 are comparable with district data; the 1976–90 figures are not.

female currently married population (a rough estimate obtained using the national data on marital structure). Data on current users of family planning methods (taking into account discontinuation) are not available at the district or provincial level (the national level of current use was 43.9 percent in 1989) (Centre for Women's Studies 1990).

We note that Thi Xa (the provincial capital, Thai Binh) had the highest percentage of cumulative acceptors and was well ahead of the rural districts. This reflects the greater information available to urban residents and their proximity to clinics offering family planning services. Dong Hung District is slightly below the provincial average.

Linking Childbearing with Resources and Government Services

The basic system of land allocation distributes this scarce resource on a rough per capita basis (the 5 percent Land; the First Land Fund) and has another mechanism (the Second Land Fund) that is designed to allow for further adjustments to achieve equity, compensate for special circumstances, or provide more land when additional labor is available. In particular, a floor is placed under the absolute level of living. The interesting demographic aspects of this system are:

1. It attempts to adjust for "demographic differentiation"—the shifts in household composition that are often an important source of welfare differences among households. For example, many of the basic costs (in subsistence requirements) of fertility are shared by the entire community. When a couple has another child, they are assigned additional land for farming.
2. It is virtually neutral with regard to living arrangements and related behavior such as marriage decisions. For example, whether a young woman remains single or marries, and whether she remains with her parents or lives with her husband, or with his parents, she receives the same allocation of agricultural land. There is no penalty for early marriage; there is no strong advantage to any particular living arrangement.

In 1989, however, a dramatic new principle was added to the system that forces couples to pay a direct cost for their childbearing. An assessment (the cash equivalent of 200 kg of rice) is levied for any birth after the second one. Also, there is a similar assessment if the interval between the first and second births is under 5 years. Finally, only the first two children are allocated land; the third child and beyond do not receive land. This new principle has been in effect for about 2 years and should now begin to have an impact on childbearing. In addition, a link with childbearing has been or is being introduced in relation to certain other social benefits (e.g., charges for health care costs). Our survey was too short, however, for us to discover how enforcement is carried out in practice.

Our household interviews indicate that couples in Nguyen Xa Village are keenly aware of the new restrictions, and also that they are responding in the desired way. For example, several couples with young children said they were already using family planning methods to avoid a second child until 5 years after the first.

An interesting feature of this incentive scheme is that implementation details are being determined by individual villages, presumably in relation to their perceived population/land balance and the urgency of their population problem.

Out-Migration

The national government has long encouraged pioneering movement to the New Economic Zones, particularly in the southern part of the country where land is more readily available. But, farmers from the Red River Delta have been reluctant to leave their home provinces and villages without considerable inducement. There is now in place a program to subsidize such migration by a cash allocation taken from the social fund of the village of origin, with additional payments from the district of origin and the province of origin. The total payment to a migrant family of about four million *dong* is complemented by services such as transport from the national government.

We noted earlier some discrepancies in district-level estimates of numbers actually moving under these auspices. Our household interviews suggest a relatively low number. We recorded 20 adult siblings of respondents, and all of them were still in the village. And we recorded 24 offspring aged 25 or older; of these, 16 were still in the village, 3 were outside the village but somewhere in the Red River Delta (e.g., Hai Phong), and only 5 were in the south.

A Note on the Future

Economic and social planning in Thai Binh must take into account the inevitability of substantial further population growth in the province, and the likelihood that most of that growth will occur in the village population. A carefully prepared series of projections of the farm population and the resultant demand for agricultural land is an urgent research need, as it would provide a framework within which to think about alternative paths of economic change. For example, an annual growth rate of 1.5 percent (which implies continued declines in the birth rate) would increase the provincial population by 35 percent over the next two decades, and even a low annual growth rate of 1 percent would result in a population increase of 22 percent. Taking into account anticipated trends in fertility, it is unlikely that the province's population could be stabilized at a level below 30 percent or so above its present level—at perhaps 2.18 million people, even if the family planning effort is highly successful. Detailed analysis would indicate the additional pressure that this will place on agricultural land. We believe it would also show that the nonagricultural job creation necessary to absorb the new labor and change this picture significantly is beyond the range of likely trends unless significant changes occur outside the community—in the nation and the world.

FINAL COMMENTS

Our last few observations are concerned with the importance of monitoring and understanding much more thoroughly the Thai Binh, Dong Hung, and Nguyen Xa demographic systems. The rapid rural appraisal (RRA) exercise reported here has revealed the main outlines of a demographic situation that is, perhaps, unique. There is extreme land pressure on agricultural households, powerful state interventions have just been put in place, and the population itself is hard working and well educated. This is a potent combination of circumstances that bears watching.

All three levels of government need improved data systems as part of this effort. This might include integrated recording of births and deaths and changes in total population size, and of these, in turn, with the local recording of migration. Another area for improvement is measurement of the labor pool. The current system wisely follows "usual activity" rather than "labor force" concepts, but age cut-offs and other conventions might be brought in line with national data, for example, the 1989 census (CCSC 1990:Appendix). A third area is family planning program service statistics that should be organized and tabulated in a number of useful ways. Also, it would be valuable to conduct a household sample survey to assess family planning attitudes and practices, knowledge of contraceptive methods, awareness of the family planning services available, and the like. Information could also be obtained on the population's understanding and views of government policies and regulations on family planning. It is especially important to understand responses to the 1989 scheme of assessments for third births or short second-birth intervals.

Endnotes

1. Density levels vary with the areal definition used (cf. Gourou 1931:48). Also see State Department of Topography (1975).

2. This figure is based on the de facto population of the village. When nonpermanent residents who are not eligible for land allocations are excluded, the density is 1,497 persons/km^2.

3. Following is the series of three-year rates: 1982–84, −10.7; 1985–87, 3.1; 1988–90, 12.0.

4. On the general issue of consistency and accuracy, we note the observation of a reviewer, Dr. Hy Van Luong, that the Nguyen Xa Village population totals (5,488 in 1981 and 6,512 in 1991) are not greatly above the level of 4,936 reported by Ngo Vi Lien (1928:273).

5. In practice in Nguyen Xa Village, this means that the village-level associations of these organizations present lectures about family planning and encourage members to practice it themselves or to encourage their family members to do so.

4. AUTONOMY AND SOLIDARITY

Diep Dinh Hoa
Kathleen Gillogly
Le Thi Van Hue
Nguyen Quang Minh
Nguyen Hung Long

The village (*xa*) of Nguyen Xa is divided for purposes of administration into eight hamlets (*thon*). It is designated as both a subdistrict and a village, although its size would usually result in its being divided into several villages within a subdistrict. Village society contains three different sociocultural elements. There are three markets on one day in three different places in the village and, in the old days, there were three communal houses. There are tensions among villagers. Despite these, Nguyen Xa remains one village; in fact, a hamlet administratively designated as part of another village 40 years ago is now petitioning to rejoin Nguyen Xa.

Aside from its administrative designation, what makes Nguyen Xa a village? As a society, the village is held together by a web of social and economic ties and obligations. Some of these relationships also tie the village to other villages, the district, the province, the nation, and the world. Yet, such relationships can be seen as potentially divisive because they compete for individuals' time and energy. In addition, such relationships may make people dependent on one another and on resources or institutions over which they have no control. Finally, there is social and economic diversity among the people and households of Nguyen Xa that indicate differentiation. The task of our team was to determine the outlines of the social institutions that give shape to villagers' lives. As much as was possible, we attempted to determine the relative importance to villagers of these institutions. Finally, we attempted to analyze these institutions and relationships in terms of solidarity and autonomy.

DEFINITIONS

One of the properties of agroecosystems is autonomy. The opposite of autonomy is dependency. Each system depends to various degrees on other systems outside its control. Autonomy is a measure of the extent of this dependency on or independence from other systems. It is defined as the extent to which a system is able to function using only resources over which it exercises effective control. Not all resources are of equal significance, so that certain key resources may exert a disproportionate degree of influence on a group's autonomy. If a community needs some resources to survive, then it is dependent; or, we can say that it has low autonomy. If a community is completely self-sufficient, then we can say that it has high autonomy (Lé Trong Cuc, Gillogly, and Rambo 1990:26).

As the data in this report suggest, there are also two aspects to autonomy/dependence. One is dependence (i.e., being reliant on securing some resources). This is the main aspect considered in human ecology research. The other aspect of low autonomy is in the sense of not having control, of a larger system having the power to compel some behavior, even if it does not do so at a particular time.

The other property we sought to examine is solidarity. This is a measure of the cohesiveness of a community and the extent of its internal control. Specifically, solidarity is a measure of the ability of a social system to make and implement decisions about the management of its affairs. Solidarity may be maintained through formal institutions, such as village government, local customs, or possibly a cooperative, as in Vietnam. It also occurs in practice through ties of kinship and sentiment among people, such as through a sense of moral obligation and duty to one's neighbors and relatives. Solidarity is multidimensional. A community may display high solidarity in regard to some activities, such as irrigation management, and low solidarity with regard to other components, such as pig raising, which is under the control of individual households (Le Trong Cuc, Gillogly, and Rambo 1990:27). The nature of solidarity is complex; lines of solidarity are also potential points of cleavage. For instance, the relationship between hamlet neighbors may be culturally valued and people may work closely together. But conflicts over control of and access to resources may be very intense, because they depend on each other.

THE SOCIAL INSTITUTIONS OF NGUYEN XA

The types of relations in which villagers are involved can be categorized as either social or economic relations. Of the social, we can see ties of kinship—those based on blood or marriage—and ties of friendship—in this case, referring particularly to locality, or perhaps attending school together. Of the economic, we can see ties based on production, on consumption, and on exchange. Only a small proportion of that exchange is commercial.

It is not simple to separate "economic" and "social" ties; they are not discrete categories. For instance, the family is based on ties of kinship, but a family is also an economic unit. Economic relations such as producing rice and regularly sharing meals together have a social basis. Definitions of the family or household, ideas about who should do what sort of work, and so on have cultural meaning; we say that they are socially constructed and validated.

It is useful, however, to divide relations in this way so that we can attempt to analyze how the social and the economic interact. The ways in which production and consumption cross-cut each other and interlock with social ties are important variables in social organization. For instance, households or families in Nguyen Xa tend to produce and consume together as an economic unit. In the Cooperative period, production ties were transferred to the Cooperative level; yet, ties based on consumption (i.e., eating together) remained located on the household.

We can also categorize relationships along a continuum of those that are based on shared or common interests to those that are based on ideas of duty or sentiment. The former can be seen in terms of utility, and the latter in terms of morality. It might seem that economic ties are based primarily on utility, and social ties primarily on morality; but this division is too simple. For instance, strong cultural traditions encourage multigenerational families. But because of the limited land available for residences and Cooperative policy in distributing it, it is also very pragmatic or utilitarian for a young couple and their children to live with the husband's parents. Similarly, loyalty to the Cooperative seems to be based in large part on the utility of the Cooperative in providing technical information and support to farmers, or on being a power base for certain segments of Nguyen Xa society. But the moral basis of attachment to the Cooperative should not be underestimated; many of the older families we interviewed fought for Liberation, lost sons in the Second Indochinese War, and made sacrifices to build and maintain the Cooperatives. This may also be a factor in the continued existence of the Cooperative.

Ideally, we should be able to delineate the relative strength of these relationships. Many factors are involved in the constitution of these ties. We can assume, for instance, that the character of these relationships varies among people of different age, sex, education, wealth, and so on. It has not been possible in this brief fieldwork to ascertain these distinctions. We focused on the outlines of the social institutions in Nguyen Xa and on the formal and ideal aspects of society. How these ties work in practice would have to be determined by longer term fieldwork based on observation of interactions and discussion with people.

Household and Family

The most basic social unit in the web of relationships is the family or household. Parents and children, brothers and sisters, and husbands and wives all hold rights and responsibilities to one another. Solidarity of the household is based on concepts of responsibility and morality, as well as sentiment or affection. It is a matter of pride to fulfill family duties. In addition, family members are economically dependent on one another; they may produce together, and often share the results of production, for instance, eating meals together. Family duties radiate out from the nuclear family, to parents' brothers and sisters, to their children, and so on. For instance, one young married man interviewed spends much time helping out an uncle who has only one daughter.

It is difficult to define household and family in a simple way. The basic rules are that society is patrilineal—inheritance and lineage identity are passed from father to son—and post-marital residence is patrilocal—a married couple goes to live with the husband's parents. The eldest son and his wife should stay with his parents until their death and inherit the house. Ideally, all sons and their families stay with the parents or in the same compound, under the authority of the father. Other factors intervene in the practice of these ideals, however.

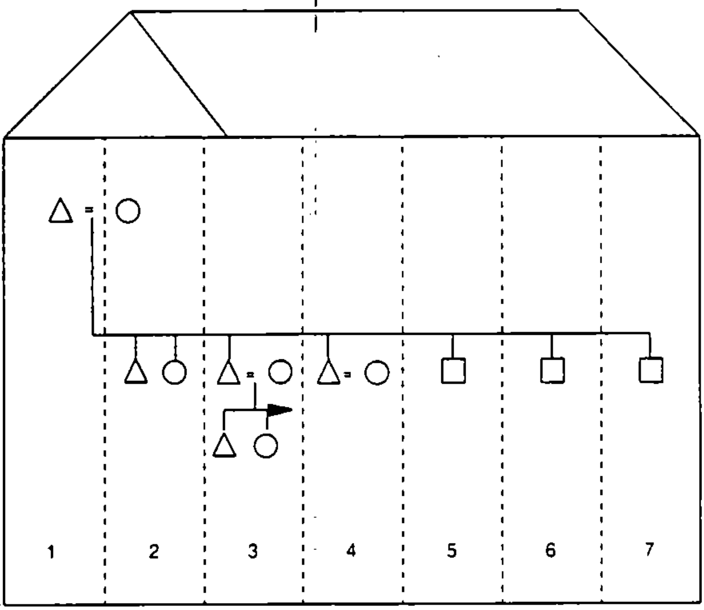
First, there is a disjunction between local practice and Cooperative definitions of a household. The traditional unit is *noc*, a roof. But the Cooperative designates a conjugal couple and their children as a household for purposes of land allocation. In practice, several of such "nuclear" households still live under one roof. They may—or may not—eat together, work together, and pay their taxes in one lump sum. When a number of such households live under one roof, it can resemble a rooming house in which related families have rooms (see Figure 4.1).

Second is land scarcity. A share of residential land of 240 m^2 is allocated to a household only after a registered household has three conjugal couples and thus three official households. All sons may continue to live in the parents' house because of the difficulty of getting land.

A third factor, wealth, intervenes here. Those families with sufficient money to do so might add on to their homes to accommodate the new families of sons (thus the popularity of two-story houses). Those with sufficient land arrange to transfer residential land to their sons on marriage. Some wealthy families buy residential land for their children—or "expedite" the process of residential land (particularly a desirable parcel) allocation to their children.[1] Land can be allocated in any hamlet, and some poor, young couples might, as one district official said, "go live on the dike." Thus, the strength of family loyalty and land scarcity can coincide, by keeping families together; but land scarcity can ultimately act against the ideal of the patrilineal family staying near each other, particularly when the family is poor and cannot choose a desirable parcel.

A fourth factor is lineage status. The ideal of the eldest son remaining with his parents is most true in ancestor-venerating households (i.e., the oldest son of the oldest son of the senior branch); they have a special obligation to carry on the rites. Younger sons of such households, and all sons of other households, are under no obligation to live with the parents.

Directive No. 10 delegates production decisions to the household. The irrigation system is designed in such a way that each plot can be irrigated separately rather than collectively; the water level of one plot need not affect another, so farmers are not dependent on their neighbors' practices. These two factors give households a great deal of autonomy from one another. Also as a result of Directive No. 10, the size of registered households has decreased. It is not clear why this change in policy has had the result of allowing or encouraging smaller households. There are many ways of manipulating the allocation system. For instance, one family paid a "fee" in order to have their 2-year-old son registered in the husband's parent's hamlet, because that hamlet has land of greater fertility.



Noc = Roof, traditional living unit.
1. Nonagrohousehold (retired, trader, artisan, etc.).
2. Agrohousehold, consisting of mother and two children.
3. Agrohousehold, consisting of one conjugal couple, son of 1 and 2, and their children.
4. Agrohousehold, consisting of one conjugal couple, son of 1 and 2.
5. Collective household.
6. Individual household.
7. Nonregistered household.

Figure 4.1 *Households under one* noc.

Affinal Ties

Although the family is bound together internally, family ties also result in extension of the ties beyond the household when daughters and sisters marry and move out, and new wives are brought in. Marriage, in essence, links each household to others in the community. These are the ties of marriage or affinity (in-laws), as opposed to the "blood" ties of the patrilineal family.

The formal, institutional aspects of traditional Nguyen Xa society were strongly patrilineal, and in the early days of the Cooperative only sons were allocated land. A widow with children will continue to stay with her husband's parents. His parents are responsible for her and her children. They consider her as a daughter. She is free to marry again, but not to a man from her husband's lineage (note, however, that a widower can marry his deceased wife's younger sister).

Nowadays, however, daughters are also allocated land. If they marry into another village, they will give up their land in their natal village (it reverts to the Second Land Fund) and be allocated land in their new village, again from the Second Land Fund.

In practice, ties to and between women remain strong. The men we interviewed stated that they had good relationships with their in-laws and would ask for assistance from the wife's family in times of trouble. Wives said that they continued to share food and labor with their own parents and siblings, although the frequency of their visits decreased when they had their own children. Daughter/parent ties can remain very strong. While visiting one man, his middle-aged daughter came to bring food and stayed to help her mother cook. She also knew as much about the productivity of and fertilizer use in her father's rice fields as he did, as she regularly worked on those fields. In another case, one wealthy family stated that their father had bought residential land and built houses for all of his sons and daughters.

The variation in the strength of ties between out-marrying daughters and their parents, and thus between husbands and in-laws, can be related to locality and wealth. The continuing strength of daughter/parent ties must be related to the high rate of village endogamy, or marriage within Nguyen Xa. Data collected by Diep Dinh Hoa indicate that 42 percent (in 1978) to 83 percent (in 1985) of marriages are endogamous (see Figure 4.2).[2] Even marriages with people outside the village tend to occur at least in the same district and often in the same province. About one-half of the people we interviewed, and their adult children, had married within the village.[3] People said that it was simply because the couples knew each other and had more in common. This proximity would facilitate continued close relations between the daughter and her husband, and her parents or siblings.

The woman's parents' wealth seems to be associated with close ties, but it is difficult to say whether the tie aids the well-being of the parents' household; or whether parents' wealth allows them to be generous with their daughters, thus strengthening the tie. Without children—daughters or sons—in the village to help them, elderly couples can be quite poor.

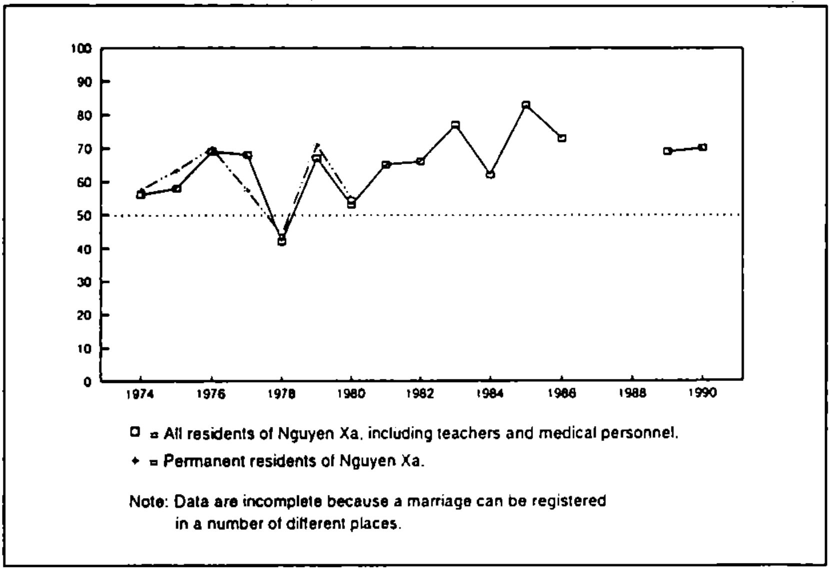


Figure 4.2 *Rates of endogamy in Nguyen Xa Village, 1974–90.*

It is possible that poor households have a higher rate of emigration due to lack of opportunities in the village. This issue in equitability and family solidarity deserves further research to discover if there is any correlation between emigration and socioeconomic status.

Lineages

The third type of kinship-based social unit is the lineage. These are defined as "blood" relations, but they do not have the prominence in daily life that immediate family ties do. The central formal activities of the lineage involve delineating marriage partners and revering and celebrating their common ancestors. Lineages unite many families within the same hamlet, village, and beyond. Many lineages exhibit high solidarity. As such, they have the potential to divide the village because sometimes loyalty to lineage overrides neighborhood, hamlet, and village ties.

Lineages delimit marriage partners through exogamy.[4] Nguyen Xa's size and the number of its lineages enable the high rate of village endogamous marriage. There are approximately 47 Nguyen lineages in Nguyen Xa,[5] as well as other lineage names. In 1982, 27 of the Nguyen lineages constituted about 90 percent of the households in this village.

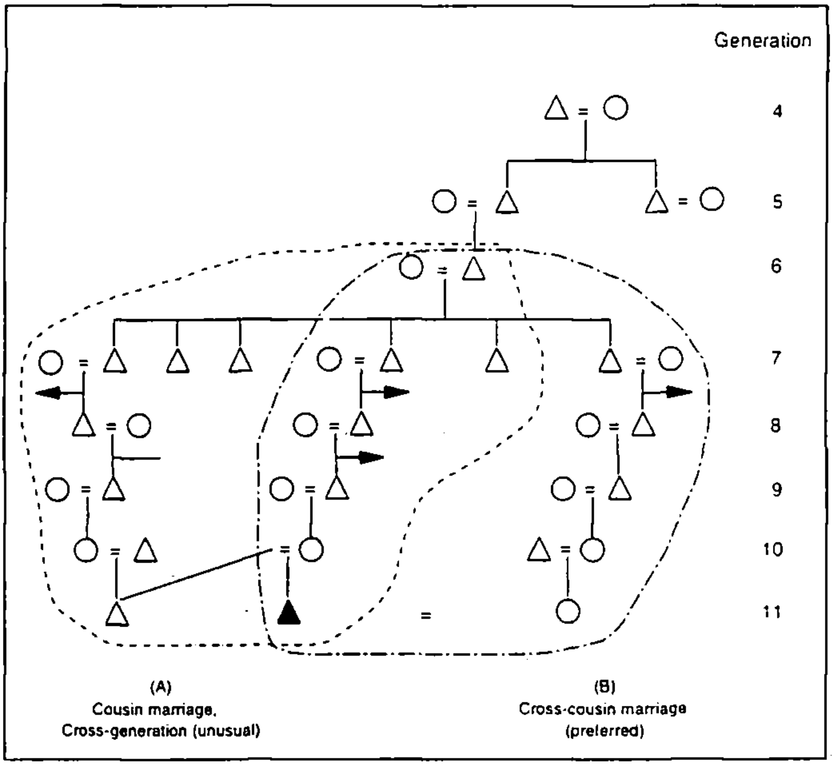


Figure 4.3 *Intermarriage of relatives, Huu lineage, second branch.*

There are three main Nguyen lineages. The Nguyen and Nguyen Trong (or the Cau) and the Kenh or the Nguyen Huy constitute about one-half of the entire population of the village; along with a third, Nguyen Huu, they comprise 800 households, or 50 percent of the households in the village.

There are many ways in which ancestors are venerated. First, households pay respect to the ancestors at their shrine twice in the lunar month. This ceremony is performed by the senior married woman of the household (who is not a member of the lineage). In general, female influence is significant. For instance, when taken to visit the renovated ancestor hall and temple of one lineage, we were shown around by the wife of the man nominally in charge of maintaining the hall and its fishpond. She was the one who opened the doors, explained the meaning of paraphernalia, and demonstrated ritual to us. Furthermore, the apical ancestor of this lineage is a woman who was a nurse to the king. Clearly, while patrilineal, these institutions are not patriarchal. Vietnamese village lineages should not be confused with the Chinese style of lineage.

Second, lineages hold at least one main feast to commemorate their founding ancestor. One will be at *Tet*, the Vietnamese New Year. These feasts are referred to as the "solidarity meal." The feasts are held in the village of the senior male of the lineage, based on age and genealogical seniority (eldest son of the eldest son, and on). Married women told us they attend their natal lineage's feast as well as their husband's.

Third, the death anniversaries of ancestors, besides that of the apical ancestor, are observed. A husband and wife observe the anniversaries of at least ten people in his patrilineage,[6] a woman observes that of six people, and her husband observes two of these in her patrilineage.[7] Each person who attends pays a fee. The fee varies, depending on one's kinship with the lineage. The usual fee quoted in Nguyen Xa is 3,000–5,000 *dong*. But when a woman or her husband attends a death-day feast for her own patrilineal relatives, the fee is 20,000–30,000 *dong* (their minor children can attend with them for free). Although a family may send only one representative, if they attend each of these feasts the outlay could be considerable: 50,000 *dong*/yr by the husband for his family; the same amount by the wife for his family; 60,000 *dong*/yr by the husband for his wife's family; and 180,000 *dong*/yr by the wife for her family. If husband and wife attend each of these death days, the household outlay on behalf of the wife's patrilineage is noticeably greater.[8] Note that Nguyen Xa is reported to have much higher fees, because it is a predominantly trading village and relatively cash-rich. Lineages of poorer villages typically charge 500 *dong* or a duck egg for the men of the patrilineage, and 500 *dong* and a bottle of rice wine for the married women of the patrilineage.

The lineages also have meetings one to four times[9] a year to decide on joint activities, such as building and maintaining lineage cemeteries, contributions to funerals and weddings, and so on. Each lineage manages its affairs and provides services in different ways.

We asked why people observed lineage practices. People spoke of revering the founding ancestor who came to a particular site (e.g., Nguyen Xa), married, and had children. Some people said that they believe the ancestors will grant them wealth, success in business, and a happy life. Others spoke in highly sentimental terms of remembering

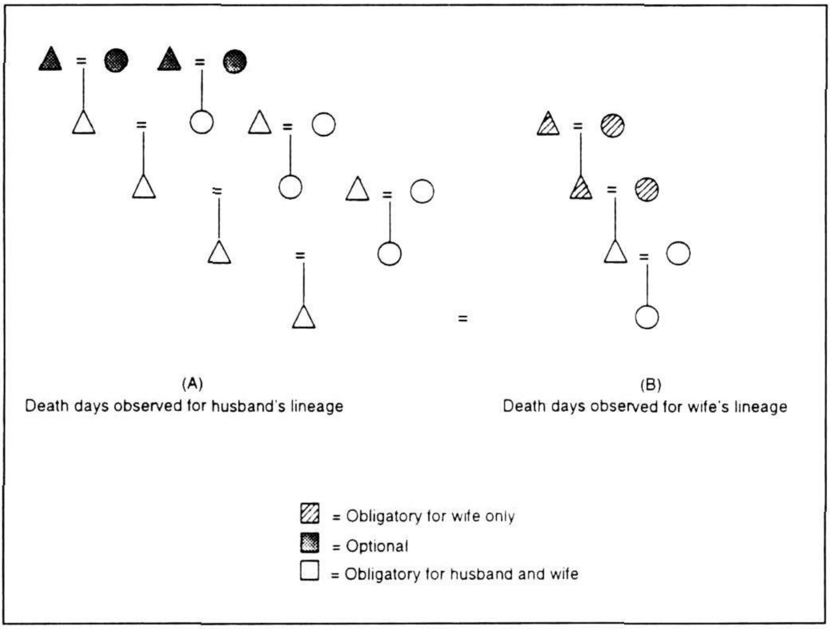


Figure 4.4 *Ancestor death days.*

their forebears, or doing the ceremony not out of "belief" but out of respect for the practices of their parents and grandparents. In this sense, lineages give people a sense of place, of attachment to a location. Consider, also, the emotional significance of burying lineage members in the common cemetery and maintaining that site, or of each household (*ho*) being recorded in the family register maintained by the head of the lineage.

Since most lineages extend beyond the village, the feasts are an opportunity for the children to get to know their relatives from other places; such lineage ties might be useful in trade or government dealings, on the provincial or even national levels. We were also told that if there were no lineages, there would be no one to help at weddings and funerals. Finally, some stated that they would go to a lineage mate to borrow money if their close relations could not help them.

Although lineages were never banned as "superstition," all but four of the halls or temples were destroyed during the war against the French. In 1956, the government began to reallocate land, eventually leading to cooperativization. At this time there were no incentives and very strong disincentives to rebuild halls; lineage land (including fields and fishponds) were taken over. But in the past few years there has been a resurgence of lineage activities. Lineage halls are being renovated; lineages are now agitating for the return of their buildings and land. Lineages that are new to the village since the Cooperative period are also demanding that they be given land for an ancestor hall. This presents a threat to village solidarity, especially given the dearth of land in Nguyen Xa. The significance of lineages and their resurgence deserves further study.

Hamlet and Neighborhood

Social ties are also based on locality. Neighbors generally display fairly high solidarity, strong enough at times to override loyalty to "blood" relations who live some distance away. Neighbors help each other with work exchange, house building, and weddings and funerals, which are the most significant events for all sorts of social exchange. Work tends to be exchanged based on balanced reciprocity, but some asserted that aid should be given purely on the basis of need and ability of the giver to help, not past debts, especially for weddings and funerals.

It is difficult to describe how strong these bonds of friendship must be. But imagine these crowded hamlets, full of children, parents, grandparents. From the moment a child is born, he or she can rarely be alone. From the earliest age, a child is constantly in the company of other children. These bands of children appear to have free range of the hamlet, although not much further. An individual in Nguyen Xa is brought up in a social cocoon—always known, always knowing his or her neighbors. This must bring about close ties of affection and security.

The salience of this social life is illustrated by the reluctance of people to leave Nguyen Xa for the New Economic Zones, despite financial support from the village for those who move. Those who leave tend to return, even if they were doing well economically. The return is not easy. The Cooperative refuses to reallocate land for up to 3 years, and returning families have had to live with relatives and depend on wage labor and the aid of neighbors. What draws people back to Nguyen Xa, despite many economic incentives pushing them out? One woman complained of illness, another about the strange ways of neighbors at new sites, and the lack of friends or lineage mates. In essence, migrants enter a social vacuum, without familiar social and cultural support.

The hamlet is significant in economic and political organization, acting like a small Cooperative (and at times it has been—see section on Village, this chapter). Even as production brigades, hamlets made production decisions together. In the initial devolution of management from the Cooperatives, contracts were made with each production group. Although households are now the basic units of production, vestiges of these hamlet or neighborhood-level organizations remain. Some hamlets, or neighborhoods within hamlets, appear to still have land preparation groups for plowing and harrowing, for which they pay a fee. Some farmers expressed dissatisfaction at having to pay for something their households had sufficient labor to do themselves. There are hamlet and paddy field protection/security groups. The latter is spoken of as hamlet level, but the village appears to at least organize it. The hamlet protection group provides security against robbers or helps to reconcile quarrels. There are also "lane associations," recently revived, where those living along one of the narrow lanes of the hamlet provide security for one another. In the past, each lane had a small Tao temple, but these were destroyed sometime in the 1940s to 1960s and have not been rebuilt.

Hamlets display a certain amount of autonomy in regard to the Cooperative. For instance, the Cooperative will "announce" to hamlet leaders when they will be pumping water and to what depth. According to one hamlet leader, he will then go back and "inform" the hamlet. Then they consult with the elders as to whether this is a good strategy or not, and decide whether to follow the Cooperative's direction. This sort of autonomy in production decisions, as is also true on the household level, is enabled by the irrigation system.

Despite strong intrahamlet relationships, there are some strong interhamlet social linkages as well, since there is no guarantee that couples will be allocated residential land in the same hamlet in which the husband grew up. We also suspect that there is also some potential for conflict over land in the hamlet; hamlet neighbors would most directly compete for resources, especially as land becomes increasingly scarce.

Village and Cooperative. The Cooperative is a key element in the solidarity of this village. The Cooperative provides essential technical information to villagers; it also manages the irrigation system on which all the farmers are dependent. The village and Cooperative also have considerable power, now latent compared to previous times, over villagers' production decisions. The government is the formal landowner, the Cooperative its representative. It allocates land. It collects taxes on agricultural production. It distributes funds and aid to poor families. To understand the relation of Nguyen Xa to the nation, it is necessary to understand the role of the Cooperative in people's lives.

Village Organization. The number of hamlets in Nguyen Xa has not been stable. Similarly, the number of Cooperatives has varied over time. Before 1945, there was one village with six hamlets. Three of these hamlets were associated with particular lineages. After 1945, there were five hamlets (*thon*), all with names different from the former ones. In 1961, there were 15 hamlets. In 1982, the village consolidated the hamlets into 8 (called *thon*) with 23 neighborhoods (*xom*). In these last two changes, names were based on previous designations.

The Cooperative has also undergone similar reorganizations. Starting in October 1958, there was one Cooperative, although most activities appear to have taken place on the *xom* level. But in 1959, it split into six Cooperatives. In 1960, it split still further, to 16 Cooperatives, thus reflecting hamlet boundaries. Sometime later, these were merged into six Cooperatives; in 1965, they were further joined into three Cooperatives, and then in 1968, it became one villagewide Cooperative known as Nguyen Xa.

In short, village, hamlet, and Cooperative organization has generally been flexible, apparently adapting itself to factional divisions within the village. It may be that this flexibility in part accounts for Nguyen Xa's solidarity; no group has been forced out or completely marginalized. As will be seen later, there is good reason for village leaders to maintain the loyalty of all villager factions.

Village Political Structure. The Village Committee is a legislative and executive arm of village government, and the Cooperative an executive arm. Mostly, there are different people on the two boards. The head of the Village Committee is selected by the Village Council. Each hamlet chooses one person (over 18 years of age) to be a member of the Village Council. The village head must be a good manager and planner. Note that the head of the Village Committee is also the Vice Secretary of the Party in the village (see Figure 4.5). This means that the village head must be a Party member and that he has considerable authority in a number of the recognized associations in the village. The General Secretary is

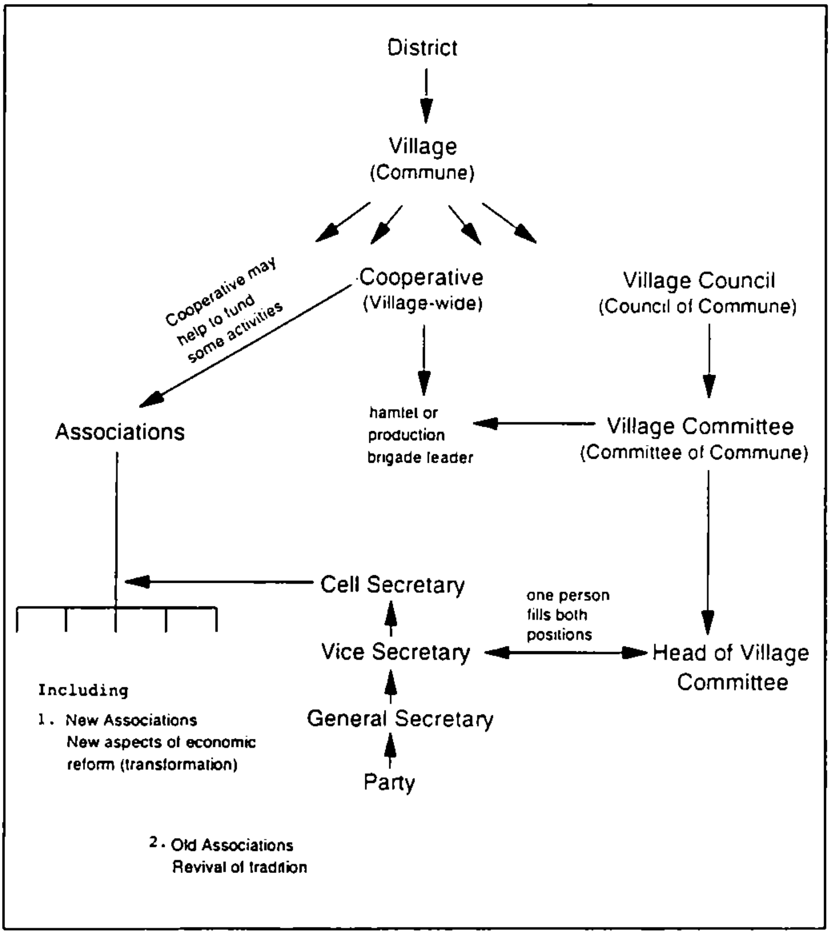


Figure 4.5 *Village and Cooperative organization.*

selected by all Party members in the village. The number of Party members varies greatly from village to village, and we do not know what percentage are members in Nguyen Xa.

The Cooperative. The chair of the Cooperative, who is chosen by farmers, must be knowledgeable about agriculture. The Plant Protection Group, Technology Association, and Irrigation Management Team are under the Cooperative. The chair of the Cooperative is also chair of the Technology Association and a member of the Village Council. He should have a degree in engineering,[10] which must effectively limit candidates for the job to those with a university education.

As the farmers present it, the key elements of the Cooperative are the Plant Protection Group and the Technology Association. Thus, the Cooperative appears nowadays to be primarily an information conduit. In addition to production-oriented activities, the Cooperative helps to fund social services such as aid to widows and poor households; pensions for retired soldiers; and activities by the Young Pioneers, Communist Youth, Women's Union, and other associations recognized and sanctioned by the official structure.

The Cooperative is the major tax collection agency. This is ideologically supported by the fact that the land formally belongs to the Cooperative. Farmers have use rights to the land. These use rights, however, last for a lifetime and can be inherited by the children. This is stated as a principle, although we were told by district officials that agricultural land is reallocated every 10 years. Disaggregated, the taxes collected are, to some extent, user fees. Farmers pay a tax for land use, for irrigation, and for numerous other services. (See Figure 4.6 and Table 4.1 for an illustration of taxes assessed on two households for spring 1991.)

The Plant Protection Group monitors pests, finds out about suitable pesticides, and broadcasts this information over the radio. The Cooperative buys the pesticides for people to buy on this group's recommendation. Farmers depend heavily on this group's information. There were no complaints about lack of pesticides and fertilizers or their costs. This is probably due to the conjunction of several factors. One is that transport in this region is excellent. Nguyen Xa is located at the center of transport in the region, with access to three urban economic centers: Nam Dinh, Hai Duong, and Hai Phong. The Binh Cach River also facilitates transport. Second, local authorities ensure that necessary inputs are available. Finally, even if the Cooperative does not have all the chemical inputs available, they are purchasable through private sources. There were no complaints about costs of these inputs, probably because the price of rice is currently very high.

The Technology Group gives out information on new varieties and methods of agriculture. When the Cooperative receives new varieties, it informs farmers about their requirements (e.g., the appropriate time to sow nurseries or to transplant, and advice on water levels). Farmers follow the Cooperative's advice because they themselves claim they have no knowledge of the new varieties' requirements. The farmers' viewpoint is that the Cooperative therefore takes responsibility for the

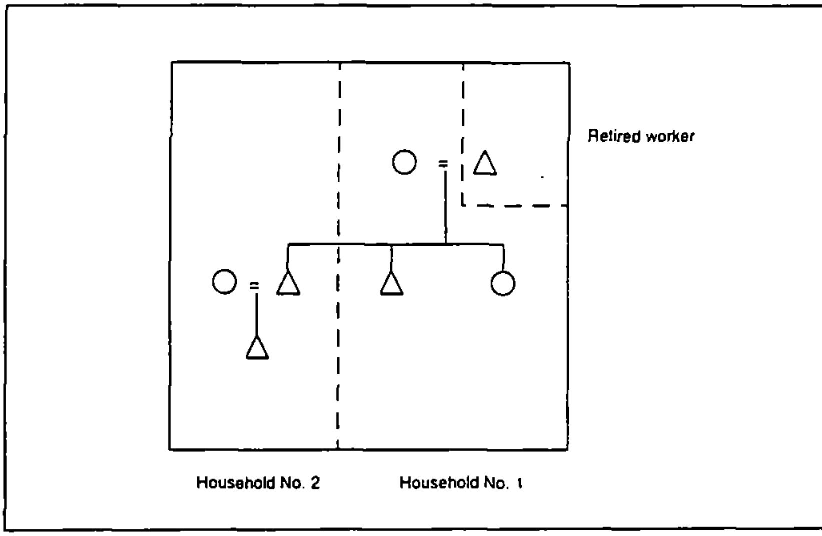


Figure 4.6 *Two households and their tax burden* (cf. Table 4.1).

success or failure of a certain variety or method. For instance, the most recent spring crop had very low yields due to a cold spell when the rice was flowering. Farmers blamed this on the district and the Cooperative, both for poor weather forecasting and poor advice on the timing of sowing and transplanting. The few farmers who sowed and transplanted at a different time got better yields. As a result of the Cooperative's "culpability," however, the tax rate was reduced for all farmers for the spring rice crop.[11]

Associations. Each adult villager appears to be a member of one or two associations. Those officially sanctioned are the Veteran's Association, Women's Union, Farmers' Association, Young Pioneers, Handicrafts Association, Retired Persons' Association, Soldiers' Mothers Association, and Communist Youth. These associations are under the auspices of the Communist Party. The relationship between the Village Committee/Cooperative and the officially sanctioned associations is illustrated in Figure 4.5.

In addition, Party Directive No. 100 revitalized a few traditional associations (i.e., the Funeral Association, Old People's Association, Grandmothers' Buddhist Association, and the Lane Associations). Since the 1988 Party Directive No. 10, there are also a number of new voluntary associations: retired people of the same age cohort, various

Table 4.1 Taxes and Fees for Two Households Under One Roof in Spring 1991 (*cf. Figure 4.6*)

	Household No. 1	Household No. 2
Amount of land	4 *sao* and 5 *thuoc* = 1,560 m^2	2 *sao* and 13 *thuoc* = 1,032 m^2
Persons in household	2	3
First Land Fund tax	2 x 113 kg x 14.1% = 31.9 kg	3 x 113 kg x 14.1% = 47.8 kg
Second Land Fund tax	272.9 kg x 29.3% = 80 kg	4.5 kg x 29.3% = 1.3 kg
Obligation labor	none	1 (wife exempted due to childbirth) = 8.5 kg
Social welfare association	7.4 kg	2 persons x 3 kg = 6 kg
Production brigade	1.2 kg	0.2 kg
Cooperative	none	2 persons x 3 kg = 6 kg
New economic fund	none	2 persons x 1.4 kg = 2.8 kg
Tax	10 kg	2 kg
Total taxes and fees	130.5	74.6
Total production	498.9 kg	343.5 kg
Percentage of rice production taken in taxes	26.16	21.72
Average percentage of rice production taken in taxes	24.35	

trader associations, and traveling trader associations. Finally, there are now several auxiliary associations: the *cheo* (traditional operetta) and *mua roi nuoc* (water puppet) groups.

The officially sanctioned associations extend up to the national level with offices in Hanoi. In one sense, they are the arm of the Party in the village, giving advice and showing the path to socialist society. For instance, much information on family planning is now given through almost all of the official associations. Similarly, the Women's Union gives its members advice on having healthy babies and teaching their children how to be good citizens. In general, associations educate people in national policy.

Associations may also serve as mediators in conflicts. The Women's Union may intervene in a conflict between two women; or, when a couple wants to divorce, the Women's Union, along with a representative of the Cooperative, will attempt to counsel the couple about how to reconcile their differences. This can be a useful way to override lineage or neighborhood loyalties that can cause a dispute to ramify, but it is not clear if the formal associations' authority to mediate conflicts is recognized by villagers.

Village Factions. Nguyen Xa is split into three different sociocultural "elements." These are reflections of the factionalism and class differences in Nguyen Xa's history. One of the manifestations of these in the past (and today, although in different forms) was the existence of three different communal houses. The three communal houses are associated with different lineages and occupations (see Figure 4.7). The first communal house was founded by the Nguyen Kenh (the founders of the village) about 480 years ago and included peasants and mandarinate. There was always a significant population of traders here, however; Nguyen Xa tends to be one-half peasants and one-half traders. The second communal house was comprised of those involved in trade or handicrafts, people of wealth. In the eighteenth century, Nguyen Ba Duong, who had received his "doctorate" but was denied recognition of his status in the first communal house, started the second. The conflict continues today; the second element claims wealth and that the first is not of the highest grade; the first claims purity and older origins. The third was the communal house of the poor and the noncitizens of the village. (There are two kinds of village residents: *chinh cu*, formal or citizens; and *ngu cu*, informal or noncitizens. The latter are

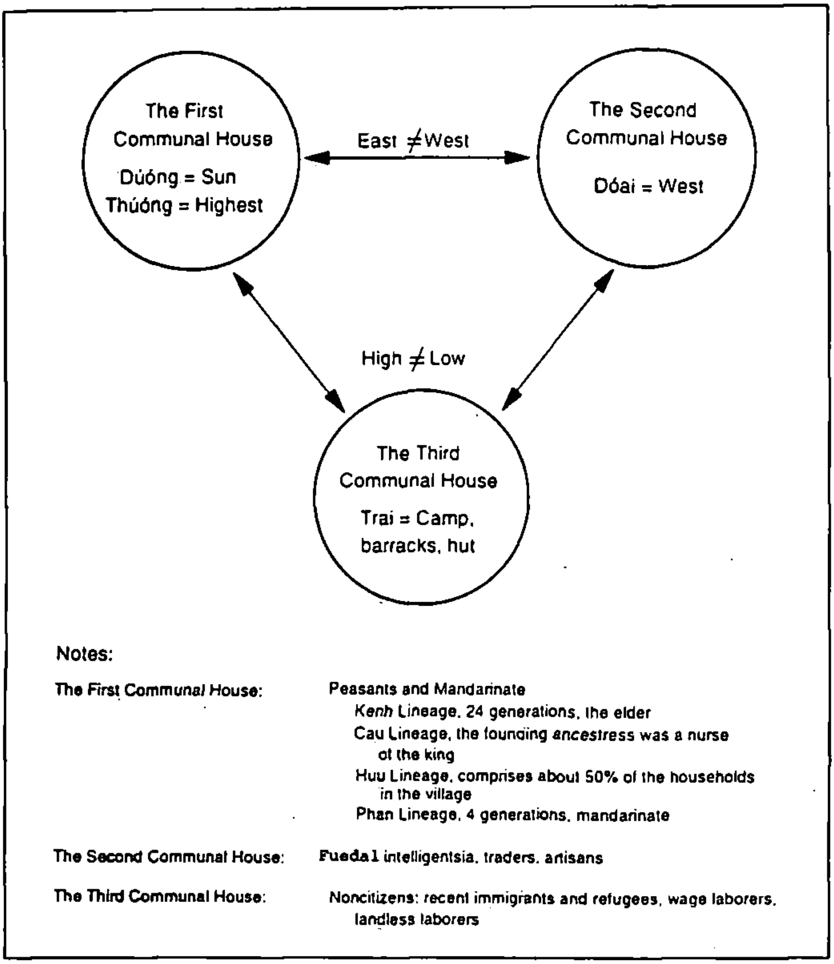


Figure 4.7 Dinh *and factionalism in Nguyen Xa.*

nonregistered, and officially have [or had] no land; after three generations, they were allowed citizenship.)

Village Solidarity. If serious conflicts arise among villagers, the Party or the Village Committee intervenes. In theory, households have a certain amount of political autonomy. They could go directly to the district, province, or national government for conflict resolution. But in practice this rarely happens. There is a hierarchy of resort. Neighbors and the hamlet are the first resort in any dispute. The associations, lineages, and communal houses can also contribute to its resolution. On the other hand, factionalism along the lines of locality, kinship, or communal house membership can exacerbate conflicts. Then the Village Committee should try to adjudicate. If there is no resolution, the disagreement can be taken to the district level. A lawyer and investigator are hired by the district for this purpose. If still dissatisfied, the parties could take the disagreement to the province's lawyer and investigator. But it is very rare for disputes to be taken much beyond the district. To do so, the parties should have a relative or lineage member's help in negotiating the higher reaches of the government structure. There are strong pressures within the village to keep problems within the village. Although no one institution has total authority to mediate conflicts, in total they form a web of obligations and duties that, ideally, keeps conflicts from being taken outside.

There seems to be little room for serious corruption and exploitation. There is certainly use of wealth and influence to gain access to benefits. But the relatively high household equitability and autonomy imply that there are no key families that control resources or families in a permanently dependent relationship to another. In part, this is due to the reforms made since 1954, from comprehensive changes in land allocation to formal and informal restrictions on display of wealth. But the high equitability of this system may also be related to the relative wealth of the agroecosystem. Nguyen Xa villagers have some of the highest productivity rates in the Red River Delta; good transportation; efficient province, district, and Cooperative administrations; and are heavily involved in trade and other alternative activities. Therefore, few are so poor as to be permanently dependent.

EMERGENT PROPERTIES: SOLIDARITY AND AUTONOMY

All of these relationships can be evaluated in terms of their roles in solidarity and autonomy. It is difficult, however, to evaluate them in simple terms, such as high, medium, and low. For instance, lines of solidarity are also potential points of cleavage—lineage ties link people together within the lineage, and pull people apart in different lineages. Similarly, ties of solidarity can be under sufficient stress to crack. For instance, the relationship between father and eldest son may be close and culturally valued; but the relationship is also subject to tension over management decisions, inheritance, and so on. The nature of solidarity is too complex for unitary evaluations. Rather, it might be more appropriate to say that the solidarity of "n" is "high" given conditions "a," "b," and "c," and "low" given conditions "x," "y," and "z." The same is true of autonomy.

Solidarity

Two basic categories of relationships promote high solidarity in Nguyen Xa Village. One type has a special moral basis. The other type can be said to be based on its utility to villagers. Among those with a special moral basis are the household and family, lineage, and neighborhood and hamlet (see Figure 4.8).

The household and family appear to rate high in solidarity. Yet, we must remember that the interests of household members are never exactly the same. There may be considerable strain between husband and wife, father and adult son, or between brothers about allocation of resources in the household. Note, also, the apparent difference in family solidarity among wealthier and poorer families. Wealth allows a family to stay together; relative poverty may force families apart as individuals seek their livelihoods. Nevertheless, a strong cultural value is placed on the solidarity of the family. Similarly, lineages appear to rank fairly high in solidarity in the village. Again, this probably varies with size and wealth. Although not suppressed as "superstition," the regalia of lineages were removed. The future role of lineages in the village, as they attempt to regain or claim halls and temples, may contribute to intravillage factionalism.

The hamlet, again, ranks fairly high in solidarity. Part of this is based on affect and part on the mutual aid neighbors afford one another. In the cooperativization process, hamlet mutual aid was built on to form Cooperatives or production brigades. In turn, vestiges of these transformed structures continue to build hamlet relations today. Forces countering high intrahamlet solidarity are the fact that marriage and post-marital residence may occur in interhamlets. Hamlet neighbors may also compete for resources.

Solidarity among (nonrelated) households is low; among hamlets, medium; among lineages, low. Village solidarity always has the potential to be cross-cut by hamlet, communal house, neighborhood, lineage, affinal, and household loyalties. In addition, there is potential conflict

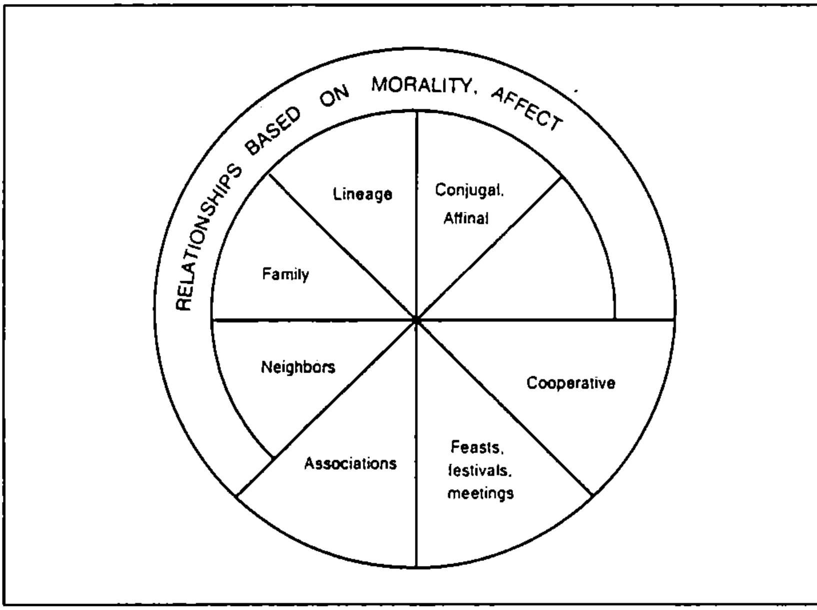


Figure 4.8 *Forms of social relationships in Nguyen Xa.*

among those of different levels of wealth; among those with leadership positions and those without; and so on. Their interests and perspectives on some issues are bound to be different. Yet some of these same institutions (e.g., lineage, communal house, affinal ties) cross-cut the village, uniting wide parts, if not all, of it. The evidence is that the village successfully overcomes potential divisions. It is possible that one of the mechanisms enabling continued solidarity is the village's flexibility in dealing with village divisions. And when faced with the outside world, Nguyen Xa unites.

The village displays high solidarity in more ways than can be mentioned here. One example is the desire of the village to remain as one village, and the petition of the hamlet of another village to rejoin Nguyen Xa 40 years after having been designated part of another village. The most powerful evidence of village solidarity, however, is village history. Despite much fluctuation in numbers of hamlets, production brigades, and Cooperatives, especially between 1954 and 1968, Nguyen Xa remained one village. Another example of this solidarity is the village's autonomy. At the beginning of the 1980s, Nguyen Xa was one of the first to delegate control of land to the households, ahead of government policy and therefore illegally. First, they converted to a contract system, where the Cooperative's teams still performed land preparation, irrigation, and pesticide applications. Then when the national government shifted to the contract system, Nguyen Xa delegated all control to the households in 1983—5 years before the national government took this step. This indicates solidarity in that the village as a whole took these potentially risky steps.

That the Cooperative remains an important village institution today is largely due to its utility in providing essential technology and information to farmers. But there are tensions here as well, as indicated by farmers blaming the Cooperative (and the district government) for the failure of the spring 1991 crop.

The solidarity of the officially sanctioned associations is rather low. These associations are essentially channels through which ideas and information are transferred from the national and provincial levels to the village and thus to the households. Their goal is national solidarity. This in itself makes these ties more diffuse. Nor are they as pervasive as intravillage ties. Village ties are myriad. Whenever one line of interaction breaks down, others take its place or repair it. Consider conflict resolution. In general, relatives of various kinds and neighbors intercede. The disputants and their allies or intermediaries will see each other every day of their lives—they must get along. There are no such pressures on association ties beyond the village, except for those people whose interests lie beyond the village. Furthermore, many of the associations do not have the moral force in people's lives that relationships supported by ideas of kinship do. However, the Old People's Association, in particular, seems to hold people's loyalty. Perhaps this is because it replicates traditional practices and institutions regarding honor of the elderly.

AUTONOMY

The high level of village solidarity must be related to the high autonomy in carrying out certain policies. Yet, this autonomy is more apparent than real. For instance, lineages exhibit high autonomy. Yet, they can be said to have low autonomy in that they exist because they are allowed to exist by more encompassing structures. Similarly, the hamlets have low-to-medium autonomy vis-à-vis the village, Cooperative, and external sociopolitical structures.

Households exhibit low social autonomy because of the necessity of maintaining (at least) affinal relations with other households. In regard to the management of rice production, households exhibit high autonomy vis-à-vis the Cooperative and each other. This autonomy can be related to the fairly high equitability of households in terms of basic land allocation, current Cooperative practice, and the irrigation system.

Again, this autonomy is illusory. Nguyen Xa's people have a long history of heavy involvement in regional trade. Today, people are market-oriented. All depend heavily on external inputs to agriculture, nonfarm income-generating activities, and now-essential household items available only through the market. Thus in terms of the larger regional system, households must be ranked quite low in terms of autonomy, and this overrides the "decision-making" autonomy of households—how autonomous can they be in their production decisions, given their dependence on external inputs? Furthermore, household autonomy generated by the irrigation system is a further sign of household dependence on an external system. This water control system is actually a subsystem, part of a well-maintained provincial dike system that protects the water control system of Nguyen Xa (see Chapter 9). In addition, all pumping stations depend on electrical power provided by the national government. Thus, household autonomy in production is based on dependency on the larger system, most immediately on the province.

Another example illustrates how difficult it is to separate autonomy and nonautonomy. Directive No. 10 delegated production decisions to the household. Household size and composition have changed in response to this policy. At the same time, national and provincial policy is enforcing family planning policy. Thus, decisions about reproduction have been taken out of the hands of the household at the same time that decisions about production have been returned to the household. In these respects, the appearance of household autonomy in Nguyen Xa is shaped by forces outside the ordinary citizen's control. As in any modern nation, people are highly integrated into the political and economic system.

Socially, the village is characterized by medium-to-high autonomy. Although the ways in which Nguyen Xa Village uses this structure is uniquely theirs, the makeup of the village is, in its outlines, based on a national model and brought into being by national forces. Thus, there is a great deal of autonomy, although within limits. Certainly these villagers have shown themselves capable of circumventing bothersome restrictions in the past, and the evidence is that they do so now.

Like households, the village ranks quite low in terms of economic autonomy. Some of the production issues have been discussed. In addition, we can look at the role of the Cooperative in autonomy of the village. The Cooperative is the main channel for transfer of information and technology, and thus one of the major links of the village to the outside world, up to the national level. The pest control team, frequently cited by villagers as one of the resources of the Cooperative on which they depend, receives information and pesticides from the provincial pest control office. Most farmers also said that they listened to the Cooperative's radio broadcasts on new technology. Most bought new seeds from the Cooperative every other season.[12] Thus, farmers have the option of using or not using the Cooperative's technology and information. But it is their only source of such information, and their main source of such technology (although some farmers buy chemicals and seed elsewhere, the Cooperative has the virtue of being closer). In their turn, the Cooperative gets this information from the province and national research centers, and their commodities from Russia, Indonesia, and the Philippines, as well as national sources. With their production decisions heavily based on this channel, farmers and the village cannot be said to be autonomous. Without these inputs, the agricultural system could not support the population it now does, and production would probably be extremely unstable.

CONCLUSION

This is a remarkably fine-tuned and pervasive system. All resources are used to their maximum. It seems that there are social institutions and policies to cover every contingency. But there are still holes in the system. For instance, public lands, such as roadsides and dikes, are open access resources. As such, their use is uncontrolled and they suffer from overexploitation. The reasons for the continued failure to control use of these resources should be examined more closely. There may be social mechanisms involved that we do not understand.

As a village, Nguyen Xa displays extraordinary solidarity vis-à-vis the world outside the village boundaries, despite internal factionalism and conflicting loyalties. Interestingly, this solidarity cannot be linked to any one particular activity, such as irrigation management. The nature of the irrigation system means that it is not the force for village solidarity that irrigation is in other agroecosystems. Rather, village solidarity must be linked with the village's endeavors to maintain relative autonomy—they either hung together or swung separately.[13]

Today, the modern nation-state has the task of extending solidarity to a national level. To this end, the national associations teach people how to be good citizens, good farmers, and good wives and mothers. The schools teach children according to a national curriculum that emphasizes loyalty to Vietnam (and the Party that currently governs it). Even though the influence of these associations and other national institutions is qualitatively significant, in general they remain diffuse. The solidarity of family, neighbors, and co-villagers still overrides most loyalties that extend outside the village.

Figure 4.9 depicts the social and economic relations in which a villager is involved. Note that the relations categorized earlier as having a moral basis (see Figure 4.8) tend to be located predominantly within the village or near to it; those categorized as having a basis in shared interests are more directly linked to extra-village forces. These latter institutions are relatively new. They do not carry the weight of cultural meaning and validation that other ties such as kinship do; or, their significance and validation have their ideological and moral support in forces outside the village. It appears that their positive value is based in part on their continued utility to people. This begs the question of the relationship between the "new" and "traditional" institutions. To what extent did the "new" institutions such as the Cooperative or associations exist in another form in previous forms of village society? This must be studied historically. The importance of national moral and ideological support for the new institutions should not be underestimated, either. It is simply that villagers spoke of these institutions in utilitarian terms.

The system properties discussed cannot be considered good or bad in and of themselves. Dependence is, in some respects, a negative aspect of life in Nguyen Xa. Villagers do not have complete control over their decisions, production, or social organization. Yet along with this low autonomy, villagers have gained protection against the devastation of storms, the instability of agricultural production, insufficient production, and the health consequences of high birth and mortality rates. It must

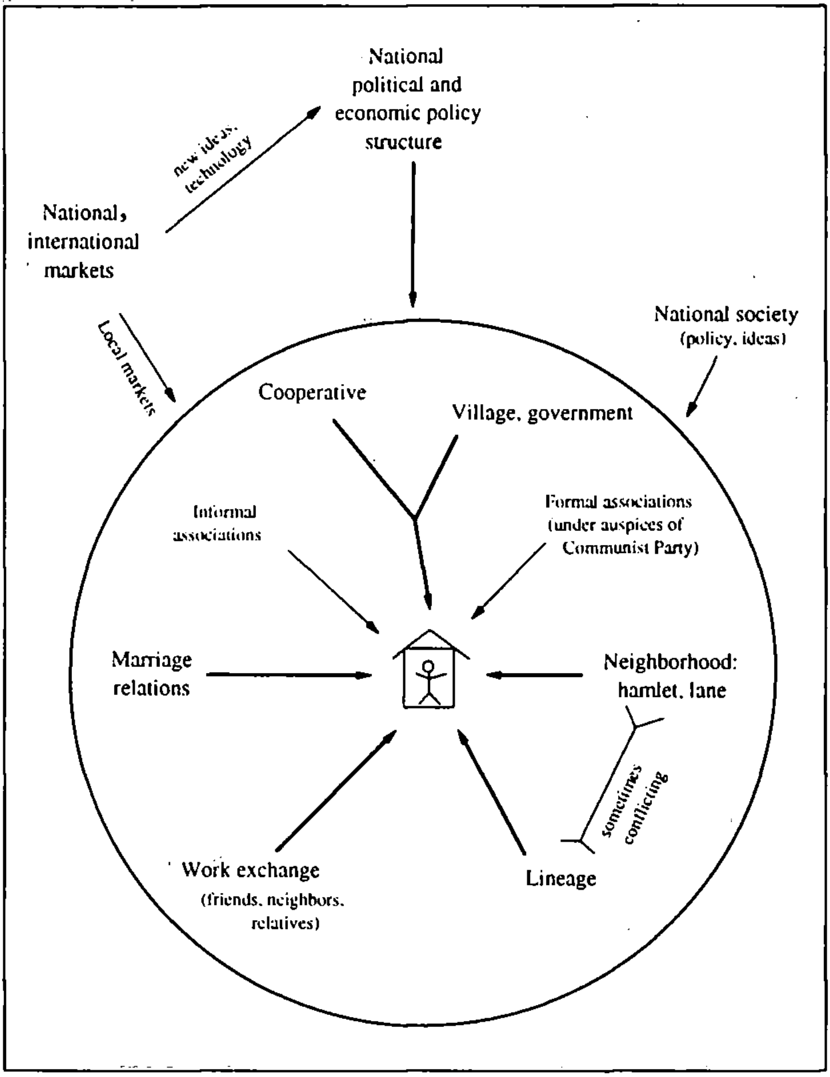


Figure 4.9 *Villagers' social and economic relationships.*

be clear from all of this that solidarity and autonomy must be measured along several poles: the economic and social are two aspects. Solidarity and autonomy must also be ranked differently for each of the hierarchical levels: household, neighborhood, hamlet, village, and Cooperative. All of these relationships affect each other in various ways, depending on economic conditions and national policy.

Endnotes

1. Even though all couples have a right to residential land, in practice they pay to get it. A desirable parcel can cost 1.2 million *dong*, and a poor spot one-half of that. A really bad spot can be purchased for about 50 kg of rice.

2. Diep Dinh Hoa has been conducting research on the social structure of Nguyen Xa Village for many years. We have drawn on some of his earlier findings in writing this chapter.

3. Out of a total of 29 couples, 5 of the marriages occurred between people from the same hamlet; 14 of the marriages occurred between people from Nguyen Xa but not from the same hamlet; and 10 occurred with spouses from outside Nguyen Xa. Of the exogamous marriages, three—all from the same natal family—were living in other provinces. Three of the spouses had probably originated from another province, but most of the other seven spouses definitely came from neighboring villages. Often, intervillage marriages are associated with having left the village for further education and meeting a future spouse in school; or the husband found work that took him out of Nguyen Xa, such as transport, or left to join the army.

4. We did not ask about marriage with the mother's lineage, but two marriages recorded by Diep Dinh Hoa illustrate marriage rules. The S of a D of the Nguyen Huu lineage, thus not a member of the Nguyen Huu lineage, married a Nguyen Huu girl of his mother's generation. She was the boy's MFFFBSSD (see Figure 4.3[A]). This was an unusual marriage. In turn, their son married a girl related to the Nguyen Huu lineage by her mother. She was the groom's MFFFBSSDD (see Figure 4.3[B]). This type of marriage (cross-cousin marriage) is highly valued; also common but not as highly valued is parallel cousin marriage (among children of sisters). All of these indicate high lineage solidarity.

5. Diep Dinh Hoa 1990:218. There are 46 Nguyen lineages, plus one other, the Nguyen Van. Before 1945, this was the family name of the village heralds, belonging to the lowest status sociocultural layer in the village in former times.

6. These are the husband's F, M, FF, FM, MF, MM, FFF, FFM, FMF, and FMM (see Figure 4.4[A]).

7. The woman observes the death days of her F, M, FF, FM, FFF, and FMM. Her husband observes the death anniversaries only of his wife's F and M (see Figure 4.4[B]).

8. The only truly obligatory death days may be for one's parents and one's spouse's parents (pers. com., Shaun Malarney). The implications of these fees are interesting, however. First, if not strictly obligatory, then the high fees are a strong disincentive to attendance of the wife's patrilineage's death days. But this could possibly offer strategies for demonstrating status. If a household chooses to observe each of these death days, especially the wife's, then they are displaying great wealth. If this is true, then close involvement with the wife's patrilineage may be an indicator of socioeconomic status.

9. The lineage of one farmer we interviewed, the Nguyen Cau, met four times a year, had a large, newly renovated ancestor hall and temple, and maintained a fishpond. This may indicate exceptionally high solidarity. They claim "200 households" and to be the largest lineage in the village. Their founding ancestress was nurse to the king, but they also have numerous lineage mates in other provinces because one ancestor was a general and married in several different places. They claim a family register going back 500 years, but Diep Dinh Hoa has found that the founding ancestress was

born in 1740. The hall was dated 1935–38. Thus, in Nguyen Xa, there are only three generations of this lineage. There has been a split between branches of this lineage, into the Nguyen Ba and the Nguyen Trong. (See Diep Dinh Hoa [1990:226–227].)

10. This is a university degree approximately equivalent to a bachelor's in the U.S. system. The university begins in the thirteenth year of schooling, and "undergraduate" education continues for 5 years.

11. The spring rice tax is 28 percent for First Land Fund and 63 percent for Second Land Fund. In 1991, the tax on First Land Fund was reduced to 14.1 percent of the crop, and the tax on Second Land Fund was reduced to 29.3 percent of the crop. Because these rates are set by the district or province, we are not sure how the Cooperative was able to reduce the tax, but this is what farmers we interviewed told us. (See also Table 4.1.)

12. This is per crop. For instance, if seeds are bought for the spring crop of 1989, they will use seeds from that harvest for the spring crop of 1990, but they will have to buy new seeds for the spring crop of 1991. Farmers said that the seeds get weak. These seeds may or may not be new varieties.

13. The nature of solidarity in the villages in the Red River Delta, both traditionally and in the modern period, has been the subject of much controversy. See, for example, the special issues of *Vietnamese Studies* (Nos. 61 and 65), Diep Dinh Hoa 1990, and Fforde 1989.

5. EQUITABILITY

GLADYS A. CRUZ
NGHIEM PHUONG TUYEN
CHARMAINE RAMBO
NGUYEN QUOC HAI
NGUYEN THI TUYET MAI
TRUONG QUANG BICH

The farmers of Nguyen Xa Village practice a refined and intensive form of rice cultivation, and the community exhibits a remarkably high quality of life despite the strong population pressure on land resources. Casual observation, however, suggests the existence of economic differentiation among the villagers. Some households appear much better off in material terms than others. Table 5.1 summarizes data gathered from interviews with households that have differing economic status in four hamlets in the village.

To assess the extent of economic differentiation, our team first identified several indicators that can be used to compare the relative wealth of households in the community. These included land area under cultivation (total land per capita); size of residential plot and homegardens; quality of housing; ownership of consumer durables, productive equipment, livestock;[1] and income levels and sources.

LIVELIHOOD PATTERNS

Rice production provides employment to a majority of the village population throughout the year. Whether rich or poor, farming is the main activity of livelihood of the villages. It does not generate the cash incomes they need on a daily basis, however. Villagers consume a large proportion of the rice they produce and often have very little surplus left after agricultural taxes (in the form of rice) have been collected. The fact that their land allocation is small indicates that relatively low total yields can be expected each year. A majority of the farmers we talked to said that their rice yield is just sufficient for their household's food requirements. Some households also reported experiencing rice shortages ranging from 1 to 4 months, depending on harvests.

To cover production short-falls, households require a ready source of cash to purchase food. The farmers usually sell their livestock whenever

Table 5.1 Indicators of Differences in Socioeconomic Status of Four Households

	Place of household on socioeconomic continuum Poorer <---> Richer			
Main Source of Income	Rice Production	Rice Production	Rice Production	Rice Production
Subsidiary work	None	Buying and selling of scrap metals and bottles	Small-scale family-based businesses, such as tofu production Buying and selling of paper, candy, children's clothes	Rice mill Truck for rent Sale of traditional medicines
Nature of subsidiary work		Only during off-season farming		Regular Stable source of income
Consumer durables owned by the household	Bicycle	Bicycle Radio Electric fans		TV Cassette player Motorcycle and bicycles Small truck Sewing machine Refrigerator
Water sources	Fishpond	Deep well	Deep well Water tank	Water pump Deep well Water tank
Electricity	None	Available		
Livestock	Pigs and chickens			

their cash requirements dictate they do so. Hence, even if most of them just break even in pig raising, it is a good source of cash during emergencies. It is in this respect that animal husbandry is a perfect complement to rice production. It is also common for farmers to purchase their other nonrice food needs using rice as a form of payment.

This means that, in general, rice production is a subsistence activity. Sale of surplus rice is not sufficient to account for the evident wealth in the village. Rather, the opportunity to engage in cash-generating subsidiary work seems to explain why some households are wealthier than others. Poor households tend not to have any other employment and income source aside from rice production. Richer households, on the other hand, have a more varied mix of livelihood activities from which to derive their cash needs. Of course, some subsidiary work generates more cash returns than others. For instance, rice milling is a profitable activity in one household. Although their agricultural land allocation is small and hence rice yields do not differentiate them from other households, the fact that they have enough capital to invest in this nonagricultural work provides them the opportunity to generate higher cash incomes for themselves. Compared to incomes from buying and selling scrap metal and bottles, or from selling tofu and candies in the market, the rice mill generates a larger and more stable income.

Wealthy households also tend to have regular and stable subsidiary work that sustains their needs even when rice production is low. Poorer households, on the other hand, tend to engage more in small-scale, family-based informal activities that they undertake only during the off-season of rice production. Subsidiary income is not only low, but it is also unstable. Evidently, however, these types of activities are pervasive and actually encouraged by the authorities. As village officials point out, a large internal market exists within Nguyen Xa where the residents buy and sell much of their produce to one another. This suggests that there is a stream of cash flowing from household to household. Such activities are largely untaxed by the government.

Pensions of retired household members also provide a low but stable flow of cash to the household. One of our respondents was a major in the army before he retired. He currently receives 120,000 *dong* a month as pension, augmenting his family's agricultural income. Another respondent was a member of the trade committee and receives a pension. Households with family members who died in the army also receive a small but regular amount from the government. Other than these sources of livelihood, mat production in the village handicraft cooperative was also identified as a major activity.[2] These incomes from subsidiary work allow some households to acquire better housing, cleaner and safer water sources, more appliances, motorbikes, and other forms of transport.

QUALITY OF HOUSING AND OWNERSHIP OF CONSUMER DURABLES

Relatively well-off residents have large, two-story concrete houses, complete with electric fans, television sets, and radio-cassette players. The poorer families have one or two small electric fans and sometimes a radio. One of our respondents did not even have an electric fan because her house did not have electricity.

The ownership of motorbikes seems to be another indicator of wealth, with the poor and middle-level households capable of buying only bicycles. All of the nine households, for which we have data on consumer durables, have at least one bicycle each whereas only two have motorbikes. One wealthy household that did not have a motorbike used the wife's dowry from her mother to invest in a small truck, which they rent. In 1990, the proceeds from the truck rental generated an additional income of 1.8 million *dong*, which they used to buy a rice mill. They earned an annual income of 2.4 million *dong* from the rice mill.

Fuel

There are two main sources of fuel: rice straw and a mixture of coal dust and earth dried into a round cake. The cost of the coal is about 10,000 *dong* per 100 kilos. Alternate forms of fuel are rice husks and branches collected from trees. A wealthy family can afford to purchase the coal dust for fuel, but poorer households need to find cheaper alternative sources such as twigs from the homegardens and the tops cut from rice seedlings.

Water Sources

An important difference among the rich and the poor of Nguyen Xa Village is their source of water for domestic uses such as drinking, washing, cooking, and bathing. Eighty percent of the households in the community do their washing in the fishponds located near their homes. The fact that these fishponds are shared implies that water quality is poor and disease prone. The relatively well-off get their water from wells or, if they can afford it, from a water pump installed in their yard. One respondent told us that UNICEF came to the village to help build pumps, and he was able to get one installed for his family's use at a cost of 300,000 *dong*. Concrete water tanks were also installed by some households to collect and store rainwater for drinking. Obviously, one needs money to get better quality water.

Livestock

Livestock raising is an important component of the livelihood structure of the residents of Nguyen Xa Village. Animal husbandry is not extensive or on a large scale. However, the majority of the households interviewed raised pigs for the sale of pig meat and for manure to put on the rice fields. Because of disease, only a few chickens were raised—mainly for household consumption. Most families cannot afford to raise buffalo or cattle by themselves. Only one household out of the nine that we interviewed owned a buffalo.

Income from husbandry depends largely on the family's capital to raise a larger number of animals and the efficiency of the household in integrating husbandry, rice production, and subsidiary work. If a family has much available capital, it might be able to buy livestock feed. Given the low prices for livestock extension, capital is not a major constraint in improving varieties. There is a potential for generation of higher incomes in livestock production, as experienced by one of our respondents from Nguyen Trai Hamlet who earned 1.5 million *dong* in 1990 from selling 300 kg of live-weight pigs. Proceeds from this sale were untaxed.

At present, however, pig raising is not considered a profitable venture by most households because they are only breaking even. The value of pigs to agricultural production, however, is high since they provide manure for the rice fields, which not only increases the productivity of crops but also reduces costs in terms of purchased fertilizers. Poor households with fewer pigs also derive less manure for fertilizers, which, in turn, may lead to lower rice productivity.

Livestock performs another important function in the village of Nguyen Xa. Pigs are a source of immediate cash for a family. During a rice shortage, a pig can be sold in the market for cash to purchase food for the family. Pork is sold for 5,000 *dong* per kg or for the equivalent cost of 9 kg of paddy per kg of pork.

Homegardens and Fish Ponds

The residential land that is allocated to each household varies greatly in size, thus affecting the size of the homegarden. Almost all the households that we interviewed had homegardens, most of which were small and not extensively planted.

Most families with homegardens sell fruits and vegetables at the central market in Nguyen Xa. The income from homegardens is roughly equivalent to that from animal husbandry. Equity of the homegardens depends on the family's efficiency in planting and the variety of plants that are planted. Another factor is the amount of land the family can spare to plant gardens, because this use competes for space with fishponds, residential land, and paddy land.

On the average, each household has about 144 m^2 (six *thuoc*) of communal fishpond shared with several other families. These families might collectively buy nursery fish to raise in the pond. When these mature and are harvested, they provide a small income from sales at the market, although on the average the income from the fishpond is low.

LAND DISTRIBUTION IN NGUYEN XA VILLAGE

Four kinds of lands are allocated among the residents of Nguyen Xa. These are residential land, the 5 Percent Land, the First Land Fund, and the Second Land Fund. Table 5.2 shows data on land allocation of seven households.

Residential Land

Every household in Nguyen Xa has a right to 240 m^2 of residential land to be assigned to it by the Village Cooperative. There are marked differences in the size of residential lands of the seven households; five households have more than the average. This may be explained by the fact that although the village "owns" all lands, residential property can actually be bought, sold, and inherited in Nguyen Xa. Two households purchased their house lots, whereas one inherited a lot from his parents. In these cases, land size is larger than the village average of 240 m^2. The area of residential land per capita ranges from 32 m^2/person to as high as 87 m^2/person. Thus, the distribution of residential land in Nguyen Xa exhibits a low level of equitability.

The 5 Percent Land

This land fund was first allocated in 1960 and later again in 1985. Since then, no redistribution has occurred. Therefore, only residents born before 1985 possess 5 Percent Land. Due to the small quantity of land designated as 5 Percent Land, some households were made to choose between paddy field and fishpond land. One *thuoc* (24 m²) of paddy field is equivalent to two *thuoc* (48 m²) of fishpond land.

As shown in Table 5.2, 5 Percent Land distribution exhibits medium equitability. The source of inequitability comes from the fact that younger members of the population cannot avail themselves of this type of land. Because the 5 Percent Land is generally of the fourth classification of land, families commonly use it for growing winter vegetables, particularly for use as pig feed (e.g., potatoes and sweet potatoes). Not having a share in the 5 Percent Land will significantly affect livestock production and further increase the costs of pig raising. Thus, although the area of 5 Percent Land is small, it is significant in farmers' strategies.

The First Land Fund

This type of land was allocated in 1988 based on household size: one *sao* (360 m²) per member regardless of sex and age. Only adults who were not farming at that time did not get a share in the First Land Fund.

Although for agricultural purposes, 360 m² per person is small, the distribution of the First Land Fund is highly equitable. Farmers will certainly not get rich from these lands, but at least they are guaranteed a source of livelihood that more or less adequately provides for their family's sustenance. The only problem with the First Land Fund is that it cannot adequately deal with marriages where women come from another village. In these cases, women receive land allocation from the Second Land Fund, until the periodic redistribution of the First Land Fund.

The Second Land Fund

A Second Land Fund is also available but granted only to those households who can show need for more land. Involvement in subsidiary work is not a factor in decisions about whether to allocate

Table 5.2 Land Distribution of Seven Households (m^2)

Household No.	Residential Land		5% Land		1st Land Fund		2nd Land Fund		Total Land Allocated	
	Total	Land per Capita	Total	Land per Capita	Total	Land per Capita	Total	Land per Capita	Total	Land per Capita
1. 9 members, 1 laborer	288	32	240	27	2,532	281	0	0	3,060	340
2. 9 members, 6 laborers	310	34	384	43	3,240	360	2,490	277	6,424	714
3. 8 members, no laborers	400	50	384	48	2,952	369	0	0	3,736	467
4. 9 members, 3 laborers	420	47	360	40	3,240	360	1,080	120	5,100	567
5. 5 members, 2 laborers	240	44	192	38	1,800	360	168	34	2,400	476
6. 3 members, 3 laborers	262	87	542	180[1]	1,080	360	540	180	2,424	807
7. 3 members, 2 laborers	240	80	144	48	1,080	360	1,080	360	2,544	848
Equitability	Low		Medium		High		Medium		Medium	

[1]The farmer was able to borrow 400 m^2 of 5% Land from another farmer.

Second Land Fund or not. It is also allocated to village-determined "privileged" households that either earned the right by productive records in the past or had sons who served and died in the army.

The Second Land Fund allocation is medium in terms of equitability. Because of land constraints, not all households can be given this extra land. It is therefore granted more as a privilege than as a right. A much higher agricultural tax, however, is collected on the Second Land Fund.

Overall, land allocation in Nguyen Xa is highly equitable. Village officials have been successful in allocating available agricultural and residential land in ways that all households have access to at least the minimum area needed to ensure their survival.

INFLUENCE OF NONFARM INCOMES ON EQUITABILITY

Unlike in many other Southeast Asian nations, landownership in Nguyen Xa does not seem to be a major factor in accounting for income differences among households. So what accounts for the differences in their economic status? Subsidiary sources of income, access to capital for investment, and different tax burdens appear to influence wealth differences.

Subsidiary Work

Subsidiary or secondary sources of livelihood are critical to the functioning of the household economy of Nguyen Xa. Households that have a regular and stable source of cash, aside from farming, are better able to provide for their consumption and production needs. They can afford to purchase motorbikes, TV sets, and other appliances and can also build larger two-story houses. This is something an ordinary rice farmer cannot do.

Access to Capital for Investment

The major constraint among poor farmers is their lack of capital to engage in subsidiary work to supplement rice production amid a heavy agricultural tax burden. There are no formal credit institutions to mobilize available financial resources to allow all farmers better opportunities to increase their incomes.

Taxes

Since taxes represent a major drain in household incomes, the method of distributing the tax burden strongly influences the wealth of these households. Higher taxes will result in lower disposable income and, hence, lower demand for consumer goods and services that may account for differences in the ownership of appliances, motorbikes, work animals, and productive equipment.

The relatively high equitability of land distribution in Nguyen Xa Village is coupled with a tax system that imposes a high burden on agricultural incomes. Income from nonagricultural activities is less heavily taxed.

The features of the agricultural tax in the village are as follows:

1. Taxes are based on the estimated yields of the land allocated to farmers. If the farmers produce more than the estimated yield of their land, they are free to dispose of the surplus.
2. The agricultural tax is structured in such a way that better quality soils are taxed more than soils of marginal quality. This is to compensate for the differences in the yields brought about by differences in natural soil quality. One of the results of this is that farmers with land classified as poor are able to make considerable inputs to their fields to raise their yields; but they still pay lower taxes.
3. The tax on the Second Land Fund is significantly higher than the tax on the First Land Fund. For instance, on Class 4 soils, a tax rate of 28 percent is imposed on the First Land Fund, whereas a tax rate of 63 percent is imposed on the Second Land Fund, for spring rice. The heavier tax burden on the Second Land Fund appears to be imposed to discourage farmers from applying for it or getting rich from it.
4. Other kinds of fees and taxes are collected by the village and contributed to the public fund of the village and to the Cooperative. Contributions to a resettlement fund are also collected to finance the establishment of families in New Economic Zones outside the Red River Delta.

Despite these tax burdens, farm productivity has risen under the new socioeconomic policy of Vietnam. The distribution of land back to the farmers means that they have free control in managing their farms. The freedom to decide what varieties to plant, what inputs to use, as well as when to plant, is a minor benefit. The major incentive comes in the freedom to dispose of surplus (i.e., beyond that of estimated yields) after taxes have been collected. Increasing productivity beyond the target yield levels set by the Cooperative means that part of their output is untaxed by the government.

Notwithstanding this, however, the tax burden on agricultural incomes is still heavier than on nonagricultural incomes. The fact that most forms of subsidiary work are not taxed (e.g., sale of traditional medicines, alcohol, pigs) causes an even larger difference in the disposable incomes of those with subsidiary work and those without it.

CONCLUSION

Overall, Nguyen Xa Village displays high equitability. With the recent changes in socioeconomic policies giving the individual more economic freedom as a producer, there have been significant improvements in farm productivity. The major challenge, however, is how to ensure that such a desirable trend will continue into the future. Nguyen Xa is a village in transition. The sustainability of its economy depends on its capacity to cope with all the changes that are taking place.

Endnotes

1. We did not include buffalo in our evaluation of economic status because only one of the households we interviewed owned a buffalo. All the others shared a buffalo. This was not a sufficiently large sample to allow correlation of buffalo ownership with wealth.

2. Since 1990, the activities of the Handicrafts Association have ceased. The mats had been made for export to Russia, but there is currently no market for them there. Former mat makers expect to receive an allocation of 360 m^2 (one *sao*) of Second Land Fund in recompense for loss of this income.

6. BIOLOGICAL DIVERSITY

KARYONO
DINH XUAN HUNG
DAO ANH THU
NGUYEN DUC MINH

The goal of this group was to identify the diversity of plants and animals in Nguyen Xa Village. But because of the limits on time and expertise of our group, we mainly focused on crop and livestock diversity. Data were collected using survey methods for different types of land use systems. Additional information was also gathered from households by interviewing farmers. Eight households were observed, and five of them were interviewed in detail.

PLANT DIVERSITY

Each land use system—roadsides, canals and ponds, rice fields, and homegardens— supports a distinct set of domesticated and wild plants.

Roadsides

Nguyen Xa Village is divided by the provincial asphalt road. This trunk is connected to the hamlets by a network of earthen roads and narrow paths. The most common tree species grown along the roadsides are *xa cu* (*Khaya seneganensis*), *bang* (*Terminalia cattapa*), *gao* (*Bombax malabari cum*), *xoan* (*Melia azedaracta*), *phi lao* (*Casuarina*), *da* (banyan or *ficus*), and *bach dan* (Eucalyptus). They are commonly grown for shade and fuelwood. The populations of these species, however, are small. In addition, coconut (*Cocos nucifera*) is often found beside the smaller roads in the hamlets. Some species of grasses such as *co may* (*Chrysopogon aciculatus*) and *co ga* (*Cynodon dactylon*) are found at the edges of roads and paths.

Irrigation Canals and Ponds

A number of aquatic species are cultivated by the villagers or allowed to grow naturally in canals. Some, such as kangkong (*Ipomoea aquatica*), are eaten as vegetables. Other aquatic plants—water hyacinth or *Beo nhat* *ban* (*Eichhornia crossipes*), *Beo ong* (*Salvinia cucullata*), *Beo cai* (*Pistia stratiotes*), and *Beo tam* (*Lemna minor*)—are used for animal fodder. Lotus (*Nelumbo nucifera*) is also grown on the edges of ponds and canals. Villagers grow *Sesbania*, bamboo, *doc mung* (*Colocasia indica*), and *mon* (*C. esculenta*) on the banks of canals as well.

There are two types of ponds: communal ponds and private ponds (see Chapter 8 for a fuller description of ownership and management of these ponds). Communal ponds are generally larger than the private ones. Ponds are not necessarily located near home lots; some are as far as 1–5 km away. Thus, the ponds are not necessarily closely integrated with the homegarden. They are, however, an important source of animal fodder. Communal ponds are mainly used to cultivate kangkong and other aquatic plants, unless the pond has been contracted out by the Cooperative for raising fish. Private ponds, however, are well exploited by each household in terms of both fish and plant culture. Families interviewed said that they raise species of fish such as crusian carp, red eye carp, major carp, grass tench, black tench, and tilapia. We also observed many varieties of aquatic plants, but the number of individuals is small in such ponds. Most common are kangkong, aquatic yam, weeds (*Pistia*, *Salvinia*), water hyacinth, and lotus—all cultivated for human food and animal fodder. Kangkong, *Pistia*, *Salvinia*, water hyacinth, and lotus are common aquatic plants found in the pond. Farmers periodically clean aquatic weeds from their ponds and use them for green manure or pig fodder.

Rice Fields

According to the farmers interviewed, rice monoculture practices have been employed for many years. In the past, there were more varieties of rice, such as *nep cai* (sticky rice), *di huong*, *tam bai*, and *tam xuan*. Although they had low yields, they were much more resistant to pests than the currently predominating varieties. Only a few high-yielding varieties of rice are now being used (see Chapter 7 for a description of rice varieties). In addition, some glutinous rice is still cultivated in both the spring and fall seasons.

Between the fall and spring rice crops (November–January), farmers grow nonrice crops such as soybean, potato, sweet potato, and corn. These crops are also cultivated on subsidiary lands. We do not know which varieties are planted nor their sources.

The main pests of rice are brown hopper *Ray nau* (*Nillaparvata lugens*), stem bore *Sau duc than buom hai cham* (*Scirpophaga incertulas*), leaf folder *Sau cuon la* (*Cnaphalocrocis medinalis*), and stinkbug *Bo xit dai* (*Leptocorisa acuta*). The diseases most commonly affecting the rice crops of Thai Binh are *Benh kho van* (*Rhizoctonia solani Kuhn* or *Thanatephorus cucumeris* FR. Dowk), *Benh dao on* (*Pyricularia oryzae* or blast), *Benh tiem lua* (*Helminthosporium oryzae* or brown spot), and *Benh bac la* (*Xanthomonas campestris pv oryzae* or bacterial leaf blight). The farmers interviewed have a good awareness of pest problems. They know that by employing monoculture practices, especially monovarieties, they face a greater risk of pest damage. And therefore, to minimize pests, they cultivate glutinous rice in combination with nonglutinous rice. In addition, glutinous rice commands a higher price than does nonglutinous rice in the market, so that it contributes substantially to their income. Besides, Nguyen Xa farmers use it themselves for preparing certain ritual foods and confections.

Homegardens

The homegarden is the only land use system with relatively diverse species composition. An inventory of plant species yielded 91 species (see Tables 6.1 and 6.2). The plant composition of each homegarden varies in both the variety of species and the number of individual plants, however, and the diversity of individual gardens is quite low compared to homegardens in other parts of the world. The size of the homegardens, which range from 100 to 300 m^2, is relatively small. Still, some are planted to a dense variety of plants, from small herbs to tall trees.

Homegarden plants provide various daily necessities for the household, such as fruits, vegetables, spices, medicines, staple foods, building

Table 6.1 Plant Species in Homegardens

Plant Category	Number of Species
Fruits	24
Vegetables	15
Staple crops	5
Ornamentals	17
Spices and medicines	19
Miscellaneous	11
Total	91

Table 6.2 Species Diversity of a Homegarden in Nguyen Xa

No.	Scientific Name	English Name	Vietnamese Name
I.	**Fruit**		
1.	*Annanas aquatica*	Pineapple	*Dua*
2.	*Annona muricata*	Sour sop	*Na*
3.	*Artocarpus integra*	Jack fruit	*Mit*
4.	*Arerrhoa carambola*	Star fruit	*Khe*
5.	*Carica papaya*	Papaya	*Du du*
6.	*Citrus maxima*	Pomelo	*Buoi*
7.	*C. nobilis*	Orange	*Cam*
8.	*C. lemon*	Lemon	*Chanh*
9.	*Musa paradisiaca*	Banana	*Chuoi* [1]
10.	*Psiduim guajava*	Guava	*Oi*
11.	*Cocos nucifera*	Coconut	*Dua*
12.	*Diospiros kaki*	Persimmon	*Hong xiem*
13.	*Syzygium javania*	Water apple	*Roi*
14.	*Persea americana*	Avocado	*Le*
15.	*Pachyrhizus erosus*	Jam bean	*Cu dau*
16.	*Ziziphus mauritiana*	Jujube	*Tao*
17.	*Artocarpus parva*		*Chay*
18.	*Elaegnus latifolius*	Oleaster	*Nhot*
19.	*Litchi chinensis*	Litchi	*Vai*
20.	*Fortunella japonica*	Kumquat	*Quat*
21.	*Spondias laxonensis*		*Dau da xoan*
22.	*Dimocarpus longan*	Longan	*Nhan*
23.	*Punica granatum*		*Luu*
24.	*Citrus sinenns*	Lime	*Cam chanh*
II.	**Food Crops**		
25.	*Colocasia antiquorum*	Giant taro	*Khoai so*
26.	*Manihot esculenta*	Cassava	*San*
27.	*Ipomoea batatas*	Sweet potato	*Khoai lang*
28.	*Dioscorea esculenta*	Yam	*Khoai tu*
29.	*Solanum tuberosum*	Potato	*Khoai tay*
III.	**Vegetables**		
30.	*Lagenaria siceraria*	Bottle gourd	*Bau*
31.	*Brassica oleracea* var. *capitata*	Chinese cabbage	*Bap cai*
32.	*B. alboglabra*	Chinese kale	*Lai*
33.	*Sauropus androgynous*		*Ngot*
34.	*Cucurbita maxima* v.	Squash	*Bi ro*
35.	*Ipomoea aquatica*	Kangkong	*Rau muong*
36.	*Dioscorea alata*	Water yam	*Cu mo*
37.		Soybean	*Dau tuong*
38.	*Anethum graveolens*	Dill	*Thi la*
39.	*Cochorus capsularis*		*Rau day*
40.	*Basella rubra*		*Mong toi*
41.	*Amarantus tricolor*	Amaranth	*Rau ren*
42.	*Luffa cylindrica*	Smooth loofah	*Muop*
43.	*Momardica charantia*	Angled loofah	*Muop dang*
44.	*Lycopecsicon esculentum*	Tomato	*Ca chua*
IV.	**Ornamental Plants**		
45.	*Bambusa* sp.	Fenced bamboo	*Truc, tre*
46.	*Bougainvillea spectabilis*	Bougainvillea	*Hoa giay*

Table 6.2 Species Diversity of a Homegarden in Nguyen Xa (*cont.*)

No.	Scientific Name	English Name	Vietnamese Name
47.	*Helianthus annuus*	Sunflower	*Huong duong*
48.	*Hibiscus rosashinensis*	Hibiscus	*Dam but*
49.	*H. tiliacaus*	Beach hibiscus	*Tra laui chicu*
50.	*Jasminum sambac*	Jasmine	*Hoa nhai*
51.	*Codiaeum* var.	Croton	*Cay ngu sac*
52.	*Ixora* sp.	Ixora	*Hoa trang*
53.	*Rosa chinensis*	Rose	*Hoa hong*
54.	*Acalypha wilkesiana*		*Cay tai tuong*
55.	*Caladium* sp.		*Mon dom*
56.	*Canna hybrida*	Canna	*Cay chuoi hoa*
57.	*Chrysanthemum indicum*	Chrysanthemum	*Hoa cuc*
58.	*Ixora*	Peony	*Hoa mau don*
59.		Nenuphat	*Hoa tung*
60.	*Ipomoea pulchella*	Convolvulus	*Bim bim*
61.	*Cosmos bipinnatuls*	Cosmos	*Cuc chum chuọn*
V.	**Spices and Medicines**		
62.	*Allium cepa*	Onion	*Hanh*
63.	*Areca catechu*	Betel palm	*Cau*
64.	*Capsicum annuum*	Chili pepper	*Ot*
65.	*Curcuma domestica*		*Cay nghe*
66.	*Zinziber officinale*	Ginger	*Gung*
67.	*Piper betel*	Betel pepper	*Trau khong*
68.	*Thea sinensis*	Tea	*Che*
69.	*Alpinia galanga*	Galangal	*Rieng*
70.	*Pueraria thomsonii*	Chinese manioc	*San day*
71.	*Kalanchoe pinnata*		*La bong*
72.	*Sophora japonica*	Sophora japonica	*Hoa hoe*
73.	*Artemisia vulgaris*	Mugwort	*Ngại cuu*
74.	*Ocimum basilicum*	Basil	*Rau hung*
75.	*Blumea myriophala*		*Xuong song*
76.	*Cymbopogon citrotus*	Citronella	*La sa*
77.			*Sac chi*
78.	*Boerhaavia repanda*	Vietnamese ginseng	*Sam nam*
79.	*Perila crispa*	Melissa	*Tia to*
80.	*Cordyline terminalis*	Bloodleaf	*Huyet du*
VI.	**Miscellaneous**		
81.	*Eucalyptus camalduleusis*	Eucalyptus	*Bach dan hang*
82.	*Casuarina equisitifolia*	Casuarina tree	*Phi lao*
83.	*Saccharum officinarum*	Sugarcane	*Mia*
84.	*Calamus* sp.	Rattan	*Cay may*
85.	*Melia azedaracta*	China tree	*Xoan*
86.	*Bambusa* sp.	Bamboo	*Tre*
87.	*Ceiba pentandra*	Kapok/bombax	*Cay gao*
88.	*Ficus racemosa*	Sycamore	*Cay sung*
89.	*Gleditchia australis*	Australian locust	*Bo ket*
90.	*Morus alba*	Mulberry	*Cay dau*
91.	*Maranta arundinacea*	West Indian arrowroot	*Cay dong*

[1]Five varieties of banana were identified: (1) *Chuoi tieu*, (2) *Chuoi tay*, (3) *Chuoi ngu*, (4) *Chuoi mit*, and (5) *Chuoi hat*.

materials, and firewood. These supplement household nutrition and sometimes provide additional income for the household. All farmers interviewed said that the main function of the homegarden is to provide food and materials for household use. Most farmers do not consider homegardens as an important additional source of income. This is understandable because homegarden production is relatively small. Products are harvested year-around, making a steady contribution to the household economy, but one that is infinitesimal at any time. Therefore in contrast to the farmers' detailed knowledge of the statistics of their rice production system, they do not retain complete production figures for their homegardens. Farmers only consider produce as income if they obtain cash from selling it; they do not figure in production that goes toward household consumption. This perception makes the income from the homegarden appear even lower than it actually is, since we were unable to estimate total production (see Table 6.3).

The homegarden, like other land use systems in Nguyen Xa Village, is largely subordinate to rice production on which most household resources, effort, and technology are focused. Where homegardens, livestock, or fishponds are also important (since no activity really shifts focus off rice cultivation), other factors may be involved. Note that the two households with the highest reported income from homegardens are among the three households with the lowest reported income from rice cultivation and have the smallest amount of rice land. They also have relatively larger areas of homegarden and pond. In contrast, the two households with lower homegarden income lacked either a pond or homegarden land.

Other teams reported interviewing farmers who had devoted their homegardens to particular income-generating activities. These seem to have the same status as other income-generating activities, such as making candy or fish sauce; every household has some kind of supplementary activity. For instance, one household raised traditional medicinal plants, another avocados. The avocado farmer got his seeds from a friend who drove trucks along Route No. 9 to Laos. This farmer devised a method of pruning his trees so that they bear fruit out of season, thus enabling him to command a higher selling price. He estimated that he earned one million *dong*/yr income from the avocados. Another household member was an herbal physician who grew medicinal plants in his garden and earned a considerable income from this activity.

Table 6.3 Household Income

	Household				
Item	1	2	3	4	5
Size of land (m²)					
Rice field	2,424	4,220	1,650	1,080	1,440
Subsidiary land	360	720	360	360	540
Homegarden	0	100	80	180	720
Pond	60	0	40	72	360
Income (in *dong*/yr) x 1,000					
Rice field	3,510	6,240	2,600	1,560	2,080
Homegarden					
Crops	—	100	200	320	500
Pond	450	—	150	150	900
Livestock	1,000	1,800	400	600	1,000
Subtotal	1,450	1,900	750	1,070	2,400
Subtotal, excluding livestock	450	100	350	470	1,400
Other	4,500	4,800	1,900	—	1,350
Total income	9,460	12,940	5,250	2,630	5,830
Percentage of homegarden income to total income[1]	15%	15%	14%	41%	41%
	(5%)	(0.7%)	(7%)	(18%)	(24%)
	[0%]	[0.7%]	[4%]	[12%]	[9%]
Percentage of homegarden income to rice field income[2]	41%	30%	29%	69%	115%
	(13%)	(2%)	(13%)	(30%)	(67%)
	[0%]	[2%]	[7%]	[21%]	[24%]

[1]Percent figure in parentheses represents the percentage of homegarden income excluding livestock to total income. Percent figure in square brackets represents the percentage of homegarden income excluding livestock and fishponds (crops only) to total income.

[2]The percent figure in parentheses represents the percentage of homegarden income excluding livestock to rice field income. The percent figure in square brackets represents the percentage of homegarden income excluding livestock and fishponds (crops only) to rice field income.

The commercial production of homegardens in this area has a potential for improvement, and there are good reasons for trying. Rice cultivation and other husbandry or agricultural activities in Nguyen Xa are unlikely to produce sufficient food and income for villagers in the near future. To make up for this shortage, they will probably turn to traditional market activities, such as family-scale production of confections, sausages, rice paste, and rice noodles. One such activity that would support biological diversity is cultivation of herbal medicines in the homegarden.

The development of homegardens is greatly constrained, however, by the scarcity of residential land in Nguyen Xa. It appears on first sight that people are wasting a valuable resource when they plant cassava on a plot of land next to their house. But a house is likely to be built on this land in the near future; to plant perennials or other crops that take some time to bear fruit could be a waste of resources. Some of the land surrounding houses may also be unsuitable for homegardens because they are recently filled low-lying land or swamps (in some cases, earth excavated while digging fishponds has been used to build raised beds for houses). Therefore, it would be useful to know if there is any correlation between the housing density of hamlets and the size and diversity of homegardens.[1] It may also be that there simply is no historical tradition of planting homegardens in this area, possibly because of periodic flooding. Furthermore, there are no enormous trees, perhaps because of floods and the occasional high winds that accompany typhoons.

Valuable guidance could be obtained by a more detailed analysis of plant associations in the homegardens. The possible improvement effort could aim at a well-designed planting pattern based on the selection of species in terms of nutrient content and market demand. Since farmers in this area spend so much time and energy on rice cultivation, selecting high-yielding species of perennial fruit trees with high economic value is preferable (e.g., orange, pomelo, and longan). Perennial crops are suggested because they require less labor for their maintenance. The garden could be diversified further by planting vegetables and other plants under the trees.

If high-yielding varieties of certain fruit trees could be introduced to the area, farmers would have to wait at least 5 years for the trees to bear fruit and are ready to be harvested. Thus the waiting time is a risk; land scarcity may preclude setting land aside to a nonproductive activity, even if only temporarily. And although the example of other countries in homegarden improvement programs may be useful here, even the high population density areas of Java are nowhere near as densely populated as Nguyen Xa.

DIVERSITY OF ANIMALS

The diversity of wild animal species is very low, most probably because of the homogeneous nature of the agroecosystem in this area and a human population so dense that it is nearly urban. Still, even heavily urbanized or industrial regions provide habitat for animals that are adapted to, or can learn to adapt to, new conditions. For instance, cockroaches and rats are successful in urban environments everywhere, and foxes in the United Kingdom have adapted to suburbia. Thus, the low diversity of wild animals in Nguyen Xa reflects the domination of humans: the dominance of rice cultivation; the sheer number of people taking over land for their homes and fields, thus destroying natural habitats; and the heavy exploitation of all resources in the environment.

We observed very few birds, lizards, and reptiles. Even in homegardens with diverse plant composition, few butterflies, ants, or other insects were seen. This may be the result of intensive pesticide use for many years in the rice fields. Species may also have been eliminated from this village by direct destruction, because they competed with humans for food or as a side effect of methods to kill pests. The death of birds and some insects is also probably a result of human exploitation for food.

Table 6.4 shows the diversity of livestock and wild animals of this village, based on information gathered from the farmers interviewed and field observations. The list elicited from farmers did not include butterflies, rice pests, and other insects, or rats. A further study of biodiversity should also examine villagers' categories of animals. We

Table 6.4 Diversity of Animals and Livestock

Nondomestic Animals	Domestic Animals
Birds	Pigs
Frogs	Chickens
Turtles	Ducks
Crabs	Buffalo
Shrimp	Fish
Eel	Crusian carp
Lizards	Red eye carp
King Cobra	Major carp
Butterflies	Grass tench
Rats (house and field)	Black tench
Rice pests	Tilapia
Ray nau (Nillaparvata lugens)	Loach
Sau duc than buom hai cham	Eel
(Scirpophaga incertulas)	Snakehead
Sau cuon la	Shrimp
(Cnaphalocrocis medinalis)	Dogs
Bo xit dai (Leptocorisa acuta)	Cats
Other insects	

suspect that some are so common as to barely deserve mention; others may be recalled because of their significance as food or sources of danger (e.g., the King Cobra).

We unfortunately have little information on the numbers, types, and uses of these various animals. We do know that until 1989 there were a far greater number of frogs; then the population was depleted by intensive hunting when the price of frogs increased dramatically in 1990. Other teams observed children collecting baskets of crabs from paddy dikes to sell. It is probable that people eat field rats. We do not know about varieties of chickens and ducks, but observations by other teams make it clear that the pigs tend toward one variety—the indigenous species is continually cross-bred (through artificial insemination) with an improved breed (see Chapter 8). Thus, aside from the low number of species, there is low genetic diversity within each species as well.

CONCLUSION

It can be seen that the environment of Nguyen Xa is extremely human dominated. Diversity has been simplified; the number of species appears to be relatively small. The existing plant and animal species are those specifically maintained by humans for their own purposes, and humans have chosen to maintain a small percentage of plants and animals. Everything is oriented toward a few high-yielding varieties. Even diversity of weeds and other pests has doubtless been altered by the use of pesticides. Plants and animals that are not specifically linked to rice production fit into the interstices of the rice production system: they are kept in part because they make use of resources not otherwise used, because they serve some pressing need, or out of simple inertia—they do not interfere with the main activities—and are able to adapt to these radically transformed conditions. Yet, a certain degree of diversity remains. It is notable that this tends to involve small organisms—insects, crabs, shrimp, frogs—and probably various weeds, grasses, and algae. We suspect that the sheer biomass of nonhuman-controlled plants and animals has decreased radically. In short, Nguyen Xa is a prime example of the effects on biological diversity of near-total domination of an environment by humans for their own food production.

Endnote

1. The population and land area of hamlets vary, so that some are much more densely populated than others.

7. PRODUCTIVITY AND STABILITY OF CROPS

MANU SEETISARN
NGUYEN THU PHUONG
PHAM VAN PHE
LE DONG TAN
PHAN HUY BINH

Rice, the staple food of the Vietnamese, is the most important crop in the Red River Delta. The majority of the cultivated area is devoted to rice. Wherever it is possible to grow rice, it is given priority over other crops. Historically, because of physical, social, and economic conditions, Thai Binh Province, in general, and Nguyen Xa Village, in particular, have been intensive rice cultivation areas. Given people's overwhelming dependence on this staple, the productivity and stability of rice is of great consequence. Currently, this is a highly productive system, but many problems are looming on the horizon. The central concerns are: How can enough food be produced for the local people? Can crop productivity increase with population growth? Are current production levels stable?

SOME CHARACTERISTICS OF THE HOUSEHOLDS AND THE CROP PRODUCTION SYSTEM

We interviewed six households. The households interviewed ranged in size from four to six persons, with an average of 5.3 persons. They have an average of 3.5 people available for labor. Land areas for crop cultivation among these households range from a low 1,248 m^2 (3 *sao* and 6 *thuoc*, or 0.13 ha) to 2,784 m^2 (7 *sao* and 11 *thuoc*, or 0.29 ha).[1] The average landholding for the province as a whole is 0.348 ha/household. Thus, the farmers we interviewed in Nguyen Xa have smaller landholdings. Given this amount of cultivated land, farmers considered the amount of labor available more than sufficient for farm activities. All households have other nonfarm economic activities (e.g., producing orange juice, tofu, cassava cake, and trade). Income from these sources is quite substantial and correlated with family wealth (see Chapter 5).

The rice yields of these households in 1990 were high. Their spring rice crop yields ranged from 4.6 t/ha (162 kg/*sao*) to 6.1 t/ha (220 kg/*sao*); fall rice crop yields ranged from 4.0 t/ha (144 kg/*sao*) to 4.7 t/ha

(165 kg/*sao*). On the average, each household produced 3.4 t of paddy, or 647 kg paddy/individual that year. In addition, the households produced other crops equal to 70 kg of paddy. If tax payment is deducted, the amount of rice available to the household for consumption is lower. All the farmers interviewed said that their households had sufficient food.

In 1991, however, the average spring rice yield was only 2.7 t/ha (97 kg/*sao*). This low yield was due to cold weather encountered during the spring crop, which has caused much concern among the farmers interviewed.

All households also grow glutinous rice, combined with ordinary rice, in the fall rice crop. Besides rice, the farm families of Nguyen Xa grow other crops on the rice land, such as corn, potato, sweet potato, and soybean, for food and fodder. These are grown on higher land following the fall rice crop. All but one household interviewed also have small areas for a homegarden and a fishpond. The products from these sources complement rice as the main source of food for the family and fodder for their livestock. The lack of significance attributed to these activities is indicated, however, by the fact that the farmers interviewed could not give an estimate of the food and fodder derived from these sources (see Chapter 6). In general, very little land is devoted to nonrice food crops. Among households interviewed, for instance, land for winter catch crops occupied only 30 percent of the agricultural land. Land for homegardens and fishponds averaged 0.0006 ha/household. In addition, most families keep some livestock, pigs, buffalo, cattle, and poultry. These, especially pigs, provide additional sources of income and, most important, provide the manure needed for the rice crop.

CROPPING SYSTEMS: CALENDAR AND PATTERNS

Although the cropping systems in the Red River Delta area can be classified into several categories (Tran Duc Vien 1991), the main cropping system in the village is, strictly speaking, a rice-rice system (i.e., rice followed by rice for the entire year). In the past, the fall crop ran from mid-June to November, and the spring crop from late November or early December to June. Now, with improved irrigation control and rice varieties, and the relatively low temperatures in the dry season, these cropping seasons are somewhat shorter. The fall crop runs from late May or early June to early October, and the spring crop from early January to June (see Table 7.1). This allows farmers to grow alternative catch crops in the intervening winter months: from October, at the harvesting of the fall rice crop, to December or January. Aside from providing additional food and fodder at a time that was historically one of relative shortage, this cropping pattern provides work for the available labor force and increases the farmers' income.

PRODUCTIVITY

The people of the Red River Delta have thousands of years' experience in increasing crop productivity. They value "first, water; second, manure; third, labor; and fourth, varieties."

A well-constructed irrigation system from the provincial to the individual household level provides enough water for paddy fields and allows for quick drainage in case of flood. There is inadequate manure due to constraints on buffalo husbandry, but the expanding market enables buying of fertilizers. The high population density means that there is more than sufficient available labor. In recent years, however, rice varieties have become the dominant factor in cropping practices and increasing productivity.

Production Levels

For the past 10 years, the average rice yields in Nguyen Xa have been increasing, and yields are higher than the average yields for the district and the province as a whole (Figure 7.1, Table 7.2). In 1990, productivity was 6.45 t paddy/ha for the spring crop and 4.68 for the fall crop. The average yearly production was 9.76 t paddy/ha. Nguyen Xa has one of the highest yields of rice in the Red River Delta. Several interacting factors account for this high productivity.

Water. The availability of year-round water and the ability to control water levels are major factors in the high productivity of this system. (The water management system is described in detail in Chapter 9.)

Fertilizer. Second, the high production is due to the widespread use of high-yielding varieties, combined with heavy fertilizer (chemical and manure) and pesticide use. The farm households interviewed stated they

Table 7.1 Crop Calendars, Historical and Modern

	Historical		Modern	
Timing	Fall	Spring	Fall	Spring
Nursery[1]	10–20 June	25 Nov–5 Dec	Late May–early June	Early Jan
Transplanting	10–17 July	Feb	June–July	Late Feb
Harvesting	Nov	June	Early Oct	June

[1]At harvest time, the farmers prepare the land and scatter seed for germination on the fields they have harvested. In addition, rice seed may be broadcast in the homegardens. Thus, activity during this period is not spatially restricted to the nurseries.

Table 7.2 Rice Yield (Paddy) by Hierarchical Level (t/ha)

	Spring			Fall		
Year	Village	District	Province	Village	District	Province
1981	5.46	3.88	NA	4.43	3.39	NA
1982	5.98	4.25	NA	4.58	3.56	NA
1983	6.01	4.51	NA	3.62	3.07	NA
1984	6.08	4.60	NA	3.93	2.95	NA
1985	5.87	3.02	NA	4.22	3.37	NA
1986	4.05	3.06	2.76	3.57	2.88	2.88
1987	3.71	4.55	2.58	5.65	4.05	4.05
1988	6.36	4.26	4.91	5.28	3.31	3.31
1989	6.45	4.43	5.02	4.90	3.84	3.85
1990	6.45	4.68	4.96	4.68	3.91	3.91
1991	3.03	2.03	NA	NA	NA	NA

Source: Data were collected from the province (note that slightly different data were received from the district office).

NA = not available.

used 139–166 kg nitrogen/ha (5–6 kg/*sao*),[2] 139–277 kg phosphorus/ha (5–10 kg/*sao*), and 55–139 kg potassium/ha (2–5 kg/*sao*) on their rice crops. In addition, farmers used 8–19 t of a manure/rice straw-composted mix per ha (300–700 kg/*sao*). These average to about 149 kg nitrogen/ha, 203 kg phosphate/ha, 54 kg potassium/ha, and 11 t manure/ha. These levels of fertilizer use are high among the rice-producing countries. For pesticides, they used about 693 grams/ha (25 grams/*sao*). Until 1986, all farmers also cultivated Azolla as a green manure. Especially since the issuance of Directive No. 10, farmers have

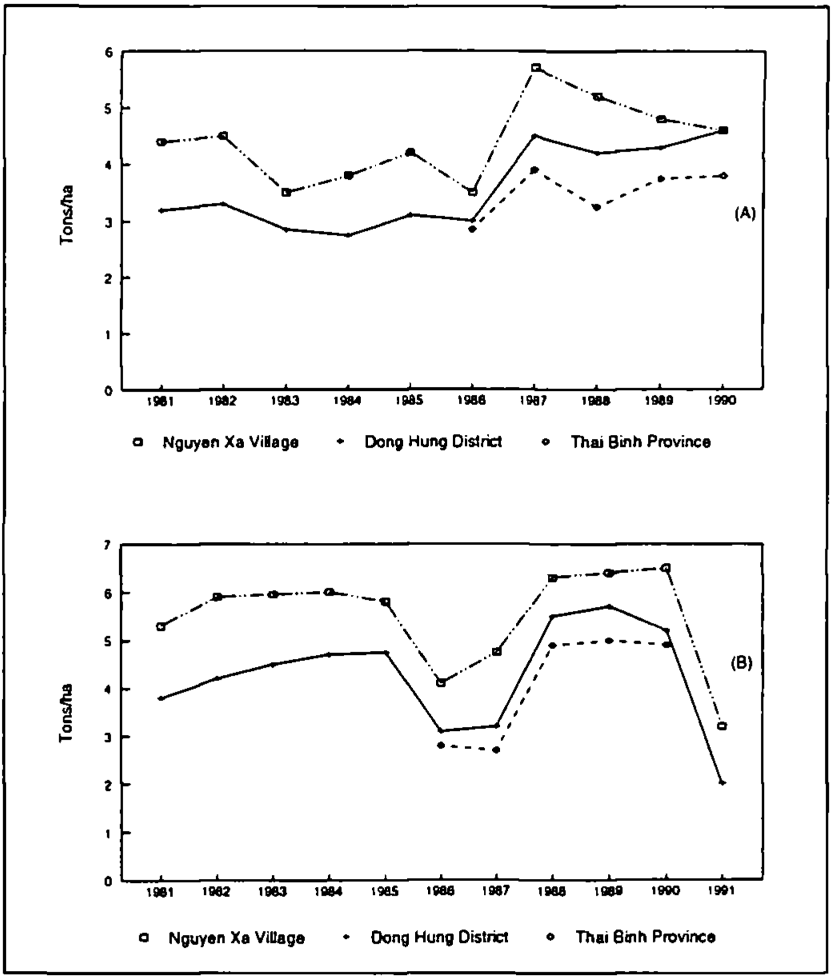


Figure 7.1 *Rice yields in Nguyen Xa: (A) fall; (B) spring.*

been using other fertilizers, particularly chemical fertilizers. Some households still buy baskets of Azolla from the market to multiply for use in other fields, but they are not able to estimate how much they use (Azolla is discussed further below, and in Chapter 10).

Labor. Third, the farmers are well informed about agricultural practices. They know what they are doing and why. We observed that land preparation is elaborate and refined. Transplanting is done on a relatively fixed schedule. This is by no means to imply that there is no flexibility in production. If the conditions warrant it, the farm households interviewed said that the schedule could be adjusted. But farmers have a narrow window of opportunity, given the intensity of cropping; and most farmers plant the same varieties, so they would tend to sow, transplant, and harvest at the same time. In the week the researchers spent in Thai Binh, the fields along the road from the capital to Nguyen Xa Village were full of people uprooting seedlings and transplanting. Nearly the entire area of rice fields was transplanted in that period. Another factor in scheduling is that most people said they rely heavily on the advice of the Cooperative Agricultural Advisor.

On the average, the farm households interviewed spent 233 labor days/ha/crop (8.4 labor days/*sao*/crop) for rice cultivation. The range was 162 to 324 labor days/ha/crop. Compared with other Southeast Asian countries, this labor input is very high. Although high, these rates are understandable. Since the amount of land is fixed, the only way to expand production is to increase the yields per unit of land. Given high population densities, increased labor input is the preferred way to increase production. Labor is almost totally manual. The amount of labor used in farm activities, however, also depends on other nonfarm opportunities available. The more nonfarm activities the farm households have, the less labor is used on the farm. There is sufficient excess labor that farmers can afford to put high amounts of labor into the fields; if other activities are available, labor can be transferred with little loss to rice cultivation.

Varieties. Figure 7.2 illustrates the amount of land devoted to various rice varieties in Dong Hung District. These show that before 1987, much land was devoted to growing NN8, which has high yields; but this variety has degraded, resulting in low productivity and poor adaptability over the next 2 years. In 1986, rice production was low because a large land area was dedicated to growing the Moc Tuyen variety. In 1987, the variety CR203 was dominant, resulting in high productivity. Figure 7.3 illustrates the significance of research on and investment in new rice varieties. Before 1987, for instance, NN8 was the dominant variety, providing high productivity (5 t/ha). But the vigor of this variety degraded, and its resistance against pest and diseases diminished over time. As a result, its productivity declined to 2.8–2.9 t/ha. Therefore, other rice varieties, including CR203 and VN10, have replaced NN8. CR203, which is non-photoperiod sensitivity, has medium growing period, and high resistance against hoppers, is suitable for both the fall and spring crops. VN10 is suitable for the spring crop

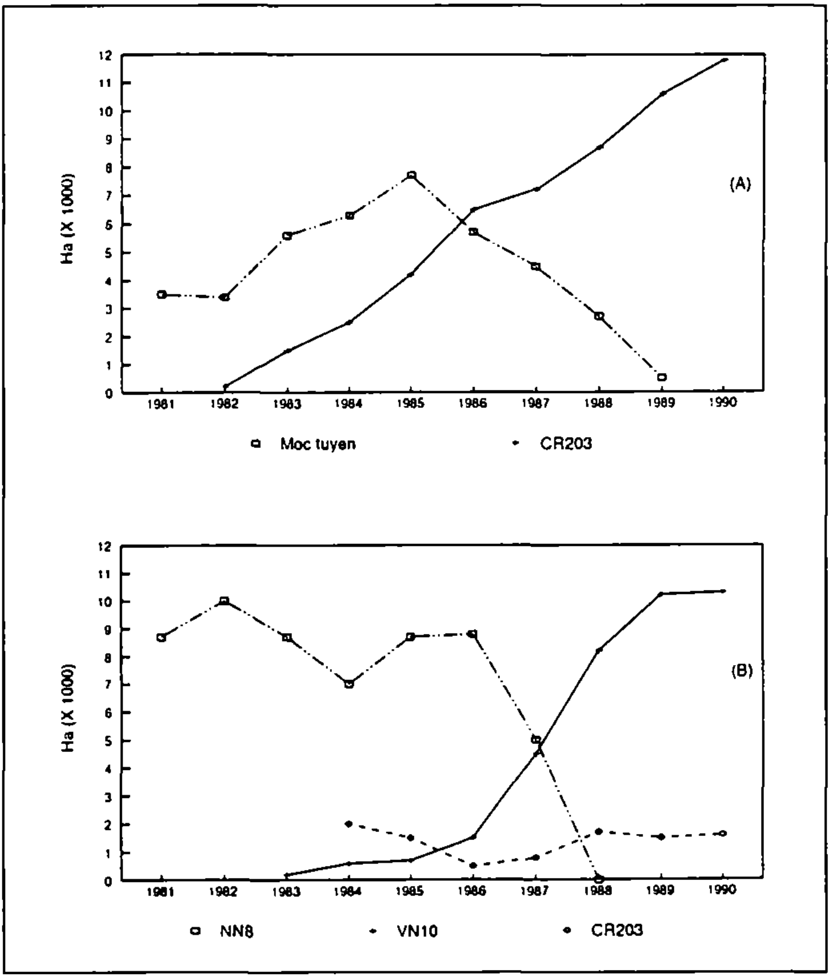


Figure 7.2 *Amount of land devoted to rice varieties in Dong Hung District: (A) fall; (B) spring.*

because it has a long growth period, can make use of a large amount of fertilizers, and has high resistance against pests and diseases.

Government Policies. Finally, high production can be attributed to government policies. First, the government pursued a policy of increasing technological inputs into rice production to ensure high and relatively stable productivity. It built an efficient water control system, promoted use of new improved rice varieties, and made chemical fertilizers and pesticides easily available to farmers. In addition, the

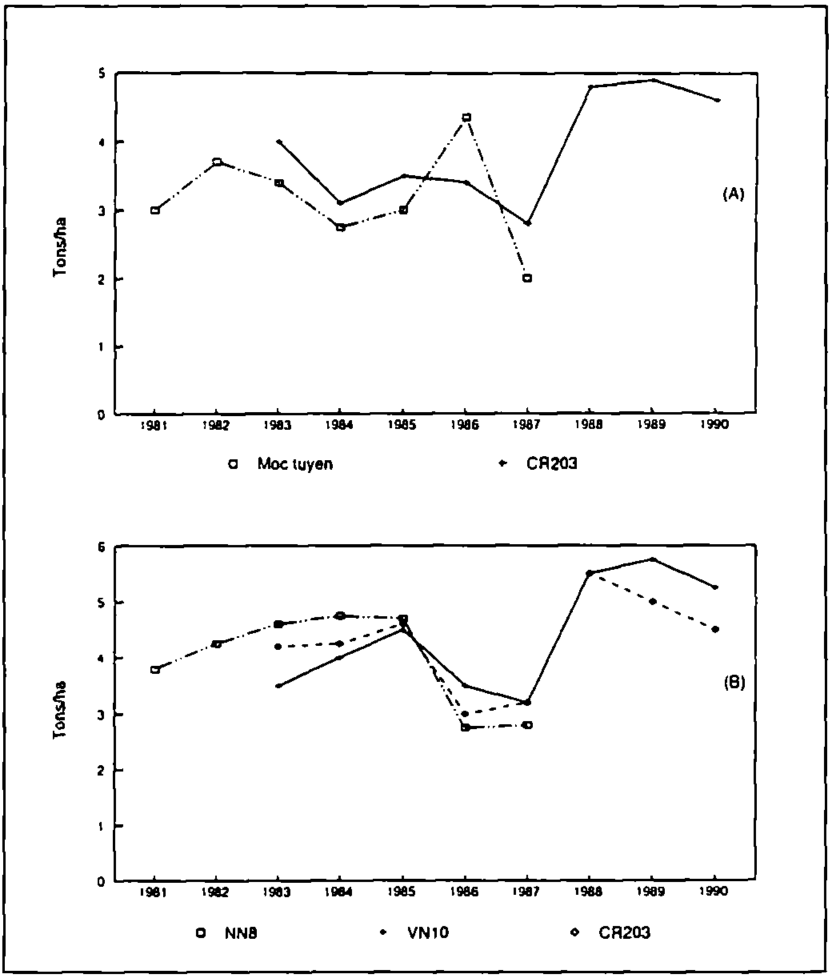


Figure 7.3 *Significance of research on and investment in new rice varieties: (A) fall; (B) spring.*

contribution of the high degree of equitability in land distribution to improving productivity must not be overlooked.

More recent policies have significantly increased production levels as well. Before 1988, the village allocated land to farm households on a yearly basis. There was no guarantee that they would get the same plot to work again in the next year. Thus, the farm households were not interested in investing their labor and capital in field improvement. In addition, the farmers complained about high fees the village charged for seeds, fertilizers, pesticides, and water. Since Directive No. 10, farmers are more willing to make inputs of labor, capital, fertilizer, and knowledge; rice production between 1988 and 1990 was high.

STABILITY

This high production is not stable, however. As Figures 7.1 and 7.3 show, rice yields seem to have reached their plateau and have started to decline, although the time period considered is rather short. The decline of winter crop production in 1986 and 1987 in Nguyen Xa Village and the province as a whole is an example of this. The productivity of the 1986 fall crop was low, but increased in 1987. The spring crop of 1991 was exceptionally low, due to weather. Similarly, the production levels of other food crops have been increasing but not stable. They fluctuate greatly in some years (see Figure 7.4). This phenomenon is true for the village, the district, and the province. This is a cause for concern: Is it possible to maintain a consistently high level of productivity in such a complex system? Can farmers maintain as high a level of yields in the future as they have in the past 10 years? The question of sustainability is considered in Chapter 10. We will address factors in the instability of rice production.

Pest outbreaks, climatic changes, and the outside world are contributing factors. Thai Binh Province's climate is tropical monsoon with relatively high humidity, which is advantageous for both crop and pest development. Thus, varieties must be changed as they lose resistance to pests. The pest outbreak in spring 1986 and 1987 (brown plant hoppers, leaf folders, and leaf blight) forced the farmers to stop using the NN8 variety completely, even though it had higher yields than the others (see Figures 7.1[B] and 7.2[B]). The 1986 fall rice varieties also show the same fluctuations (Figures 7.1[A] and 7.2[A]).

One farmer interviewed maintained that the varieties now in use will probably suffer the same fate and have to be changed in the future; he has noticed increasing incidence of pests. Besides, few rice varieties are available, a situation that leaves much to be desired. He said that he had confidence that scientists would come up with new and better varieties to replace the old ones—we are not so confident. Pests are also the cause of yield decreases in potatoes. The fluctuations in potato yields at the village, district, and province follow the same pattern and are quite severe (Figure 7.4[B]).

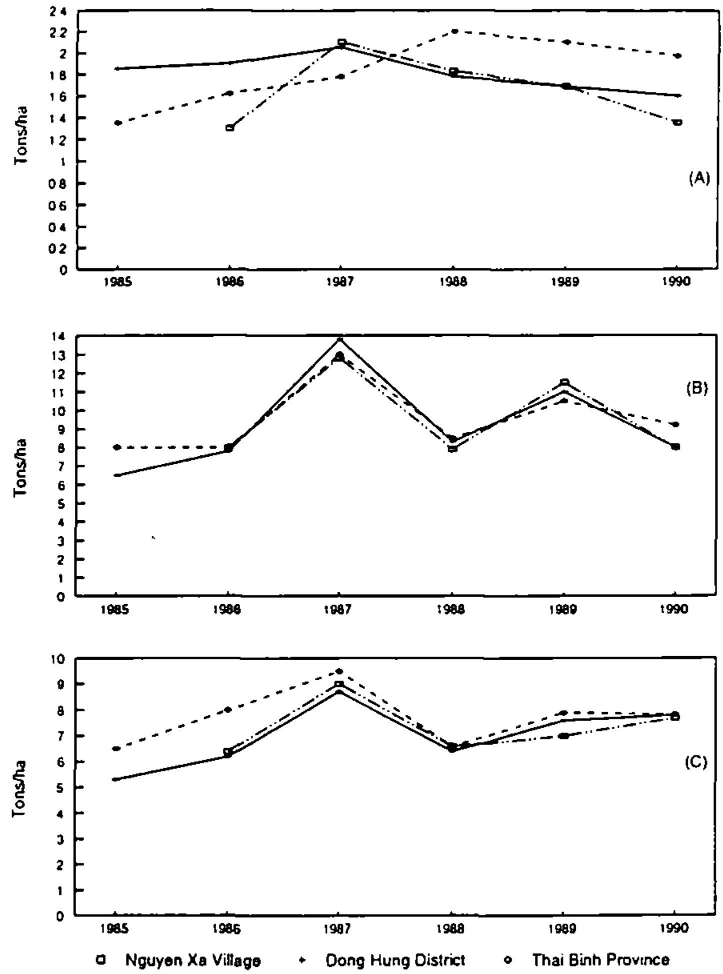


Figure 7.4 *Yields of other food crops: (A) maize; (B) potato; (C) sweet potato.*

Climatic change, especially the temperature decrease in winter, can also cause a decrease in rice yields if it occurs during the flowering period. As mentioned earlier, the major reduction of yields of the 1991 spring crop was the result of severe cold weather the farmers encountered. One farmer even accused the authorities of issuing the wrong forecast. The original forecast was that the winter would come earlier than usual; farmers sowed and transplanted early. But in fact the cold weather came later, coinciding with the flowering stage. This resulted in a one-third reduction in yields. This farmer contended that if he had an accurate forecast, he could have planned the rice production in such a way that it would have reduced the effect of the cold weather somewhat, if not entirely. Since his plan was based on incorrect information, he could not cope with the problem when the cold weather came. Thus, instability can, in modern times, be attributed to problems in information systems as well as weather. But weather will always be a constraint. A look at the historical data (Tran Duc Vien 1991) shows that drops in temperature have frequently occurred in the past. Cold weather will remain a problem for the farmers of the Red River Delta.

Flooding is not a factor in the decrease of yields in Nguyen Xa, due to the efficiency of irrigation and water control systems. However, the water control system can create externality problems. One farmer interviewed complained that he regularly lost Azolla to his neighbor's fields because of the water control system. Thus, he did not use it any more, even though he knew that it was beneficial. This externality problem requires careful investigation and analysis, as it may apply to other factors as well.

Although water is not a problem for Nguyen Xa, it can be a problem for other areas in the province and in the Red River Delta. Again, the historical rainfall data (Tran Duc Vien 1991) suggest that the amount of rainfall is increasing over time. Thus, flooding might be a problem for some other areas even if Nguyen Xa can neutralize its influence. Here again, externality problems will be involved.

Vietnam is not an isolated and closed country, and Nguyen Xa Village is also an open system. Whatever happens in the outside world will one way or another have repercussions for Vietnamese agriculture. Markets influence productivity. For instance, in 1987 Thai Binh Province exported potatoes to the former Soviet Union, resulting in an increase in productivity. The recent reduction in potato production is not only due to the pest problem, but also due to the decrease in demand from the export market.

Vietnam is not self-sufficient in fertilizer and pesticide production and has to depend almost entirely on foreign sources.[3] Increasing prices currently are not a problem because rice prices are high. Furthermore, even if quantities of fertilizer are low, this region would probably still have priority in distribution due to the high population density and proximity to the seat of government. But the increasing cost of fertilizer will eventually affect stability of production.

Availability of wage labor and alternative income-generating activities also affect crop productivity, particularly of catch crops. Wage labor plays an important role in household income in Nguyen Xa. Households that have employment for wages input less labor and capital for catch crops or simply do not plant them even if they have land available. This is one of the factors in the instability of potato and sweet potato productivity.

MAINTAINING PRODUCTIVITY IN THE FUTURE

In recent years, rice productivity has been high but unstable. Can rice production be kept high and stable, especially given the continuing increase in population and human impacts on the environment? Can we even think of increasing rice production?

We believe that it is necessary to introduce new crop varieties, especially rice varieties. Crops in this area are rather poor in species and varieties. Thus, productivity is vulnerable in disadvantageous conditions. For example, if cold weather occurs during the flowering stage, rice cannot fertilize (*thu phan*), resulting in withering (*hat lep*). If various varieties with different properties (e.g., different growing stages) were planted, rice production as a whole could adapt to variable conditions, limiting reduction of productivity.

Statistical data indicate that the amount of fertilizer used in this system is higher than that used in other countries. Overuse of fertilizer is, according to province authorities, polluting water sources, especially drinking water sources. As irrigation systems are not far from ponds and wells, the natural process of water filtration is too short to sufficiently purify water. Consequently, gastrointestinal disease is a problem. Soil and water are poor in fauna species. Given the high rate of fertilizer use, alternative water sources should be sought.

Another issue not discussed so far is the question of system changes over time or due to changes, goals, or context. There are signs that such changes impact on long-term stability of the systems. Here again, we return to the issue of fertilizer use. Nutrient recycling by using manure requires a great deal of labor. The high amount of labor used in rice production is largely due to the use of large quantities of manure. Although the farmers know the benefits of manure, they complain that they have less labor for other activities because they use it. It remains to be seen whether or not the farmers will continue to use more manure if the returns to labor in other activities are more attractive. If the amount of manure used decreases, the yields of rice will certainly decline. It will not only be unstable but unsustainable as well in the long term.

In our opinion, it is necessary to resume planting Sesbania and Azolla, which were cultivated from 1981 to 1986. After 1 month of growth, Azolla can produce 25–30 tons of biomass/ha, with 50–60 kg of accumulated nitrogen, equivalent to 250–300 kg of ammonium sulphate fertilizer. Such alternative manure/fertilizer sources would improve productivity and make it more stable.

Related to the preceding issue is the problem of the rice-rice system, which is a monocultural cropping system. If nutrients are not recycled, as earlier speculated, the system will break down. The farmers interviewed understand this and are concerned about it. It might also be necessary to introduce a crop rotation system. The rice-rice system can lead to land degradation, whereas a rotation of soybean or mungbean could improve soil fertility.

The agroecosystem of Nguyen Xa, and that of the Red River Delta as a whole, is in a transitional stage. The problem of maintaining or even increasing productivity, as well as making it more stable, is complex, requires in-depth analysis, careful question identification, and cautious research and experimental approaches.

Endnotes

1. One *sao* equals 360 m^2. One *thuoc* equals 24 m^2. There are 15 *thuoc* to one *sao*. One hectare equals 27.7 *sao*. A third measurement commonly used is the *mau*, which is 3,600 m^2, or 10 *sao*.

2. The source of nitrogen is urea. Potassium chloride (KCl) comes from kalium. Superphosphate or phosphate is a source of elemental phosphorus. Potassium chloride is the source of potassium.

3. Fertilizer imports rose more or less steadily from 987,000 tons in 1976 to 2,085,200 tons in 1990 before falling to one million tons in 1991 (General Statistical Office 1992:238, Table 116).

8. THE ROLE OF LIVESTOCK IN THE AGROECOSYSTEM

BOUNTHONG BOUAHOM
BUI HUU PHAT
CU VIET HA
LE VAN THU
LE VAN LANH
PHAM XUAN THAO

The Nguyen Xa agricultural system is focused on rice production. Not surprisingly, domestic animals (buffalo, cattle, pigs, and poultry) have a minor place in the agroecosystem. Animal husbandry serves as a complementary and supplementary activity to rice cultivation. Animals are important as (1) draft power to plow paddy fields, (2) a source of organic manure, and (3) supplementary sources of income and food. Species diversity is low and populations relatively small. Table 8.1 lists the type and number of animals kept in Nguyen Xa Village.

Farmers keep buffalo and cattle primarily as draft animals to plow paddy fields, rather than for meat consumption or for reproductive purposes. The other important output of ruminants is manure, which farmers need for intensive rice cultivation. Pigs are the dominant livestock in terms of numbers and as a source of much-needed manure for the rice fields.

Farmers keep few chickens, which we were told is typical of villages in northern Vietnam. This is surprising, because such small and relatively low labor animals might be a useful addition to the diet. Disease seems to be a major constraint on keeping chickens—potentially severe epidemics would be possible in such densely populated villages. Only some households raise ducks, predominantly for eggs. Ducks were being herded out to feed in unplanted paddy fields while we were in Nguyen Xa. There are a few pigeons. No other types of poultry (e.g., turkey, goose, quail) were observed in the village.

Farmers said that in the past there were many natural fish, shrimp, crabs, snails, and frogs in the rivers and paddy fields but because of overexploitation and pesticide use, their numbers have progressively decreased. Farmers said that in 1990 there still were many frogs in the fields. They captured and sold these to a trader for export at the

Table 8.1 Number of Animals in Nguyen Xa Village

Type of Animal	1987	1988	1989	1990	1991
Pigs	2315	2420	2500	2650	2600
Buffalo, including females	120	120	97	97	97
Cattle	5	8	9	8	10
Poultry	1000	1000	1000	1000	600

Source: Village records.

exorbitant price of 35,000 *dong*/kg, or more than five times the usual price. Farmers stated this is why there are now no frogs at all.

Fish production is traditionally a significant source of protein for the farmer. It is a traditional Vietnamese saying that "the most important thing is aquaculture, the second is homegardens, and the third is rice cultivation." In this village, however, fish production is a relatively minor part of the agricultural system. Although the village tends to use its resources intensively and to their limit, fish production seems underexploited. Aquaculture will be further discussed below.

PIG HUSBANDRY

Pigs are the principal livestock kept in Nguyen Xa Village. Pig keeping is basically an industry to produce manure for the paddy fields. Each family keeps from two to five pigs to produce organic fertilizer. Some farmers complain that they get no profit or only a low profit from raising pigs. When one farmer was asked why he raises pigs, he answered that he does so in order to get manure for the paddy fields, to save money for future use, and to consume substandard potatoes, sweet potatoes, and sometimes corn that are harvested from the winter vegetable crop. Pig raising also allows him to use agricultural residues to the maximum possible extent. In return, he gets manure for his paddy fields.

Nguyen Xa farmers are knowledgeable about the statistics of their production activities. For instance, they are able to estimate that for each kilogram of live-weight gain of a pig, they will get about 10–13 kg of manure (including the 70 percent rice straw with which it is mixed). The farmers also build sophisticated pig pens designed with a special foundation to collect and compost manure (see Figure 8.1).

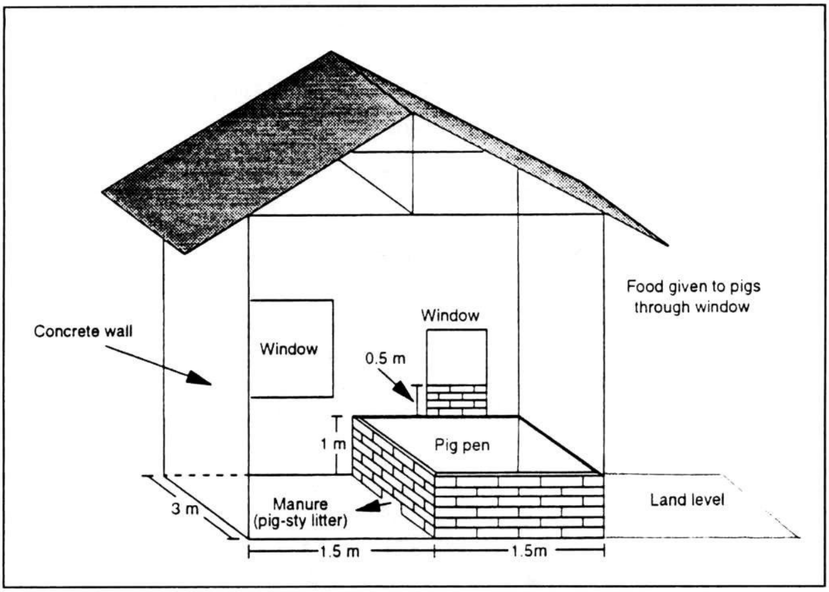


Figure 8.1 *Pig pen.*

Although pork production is not the major focus of pig husbandry, meat is produced. About 200 tons of pork was produced in Nguyen Xa in 1990, of which about one-half was consumed locally.[1] Almost one-half of the back legs is used to make a special local sausage (*gio*) to sell in the district or Thai Binh markets. About 20 families engage in this sideline activity, from which they get good additional income—an incentive for pig raising.

The farmers mostly keep high reproductive quality sows that have 10 or 12, sometimes even 16, piglets per litter. Sows in this village generally have two litters per year. (A good extension service is available at the village level to offer advice.) We did not see farmers keep boars as breeders. One hundred percent of the sows are artificially inseminated (AI) with crossbreed semen of Landrace and Large White, disseminated from the AI Center of the district. The cost of an AI is 5,000 *dong*/dose. The AI center is increasing the percentage of exotic breeds each year to improve the productivity of local pigs.

Our team had the opportunity to meet a successful pig-raising farmer. In contrast to other farmers, he said his pig-raising operation is profitable. His success is probably due to superior fodder and thus knowledge of nutrition. He uses a different kind of fodder from other

Nguyen Xa farmers, including high protein content feed such as cheap fish and soybean, in addition to traditional feed (rice bran, residue mash from alcohol distilling, sweet-potato vines, vegetables from the fishpond). The result is that compared to other farmers whose pigs gain 10–12 kg of weight per month, his pigs gain 16 kg. This is a good yield for farmers under these husbandry conditions. In 1990 this farmer sold about 600 kg of live pigs and earned 2.4 million *dong*. His experience could be useful for other farmers in the village and district.

There is good market potential for pigs in Dong Hung District; however, the farm gate price depends heavily on rice production. For instance, if rice production is low, rice bran will be more expensive or insufficient due to high demand. Thus, farmers have to sell pigs even when prices are low.

THE SYSTEM OF BUFFALO HUSBANDRY AND OWNERSHIP

The focus of buffalo husbandry is on draft power, and more than 90 percent of the herd can plow. Farmers keep both buffalo bulls and female buffalo. Only rarely do they keep cattle because buffalo are more adaptable to wet paddies. There are eight small-iron buffalo—hand tractors—in the village remaining from the Cooperative period. These are mainly used to pull carts on the roads. At present fewer than 5 percent of the paddy fields are plowed by hand tractors; thus, buffalo or cattle must be the major source of draft energy.

Despite the need for buffalo in the rice cultivation system, the village has a shortage of draft animals. The number of buffalo in the village has decreased from 120 head in 1987 to 97 in 1991 (see Table 8.1). The same situation obtains in the whole of Dong Hung District for buffalo, although the number of cattle at the district level is increasing.[2] There is one buffalo or cattle per 15 households, and one head per 2.85 ha of paddy fields. The plowing capacity of one buffalo is only about six to seven *mau*, or 2.24 ha/crop. As a result, some farmers must prepare their fields by pulling the plow and harrow themselves, instead of with buffalo. Local people know that cattle are not capable of providing as much draft power as buffalo; nor are cattle always suitable for plowing paddy fields.

The system of buffalo ownership is now quite complicated. Prior to

1986, all buffalo belonged to the Cooperative. Nguyen Xa Village was administratively divided into 15 hamlets, which were designated as production brigades. A number of buffalo were kept in each hamlet for each brigade's use according to paddy field size and the plowing capacity of the buffalo. In each production brigade, an animal group took care of these buffalo.

Cooperative policy changed, first locally and then nationally, through the 1980s. In Nguyen Xa, when Cooperative policy was changed in 1986, the Cooperative formed a committee to appraise the condition of existing buffalo in order to sell them at a cheap price to groups of farmers. They classified the buffalo into three grades (A, B, and C) according to the size of the animals and their plowing capacity with a price ranging from 240 to 400 kg of rice.

To buy one buffalo, a minimum of six households together needed to have a total of at least 2.16 ha (six *mau*). The committee's decision to take six *mau* as a unit probably comes from the plowing capacity of one buffalo, which ranges from about six to seven *mau*. At present, this system still exists. Most of the households interviewed share buffalo with five or six related households. The buffalo is usually kept in what was formerly a Cooperative pen or in a privately owned pen. The main problem is that of feeding the animal. Each household gives rice straw to a designated keeper according to their area of paddy field (25 kg of rice straw or *sao* per crop). The keeper is supposed to give the buffalo 5–6 kg of this straw everyday and take care of the other needs of the buffalo. The keeper is responsible for letting the buffalo graze on the dike, cemeteries, and roadside. For this job the keeper receives 200 kg of rice per crop. The job of keeper might rotate among families. Sometimes each household feeds the buffalo in rotation for 2 days. The buffalo should be fed about 6 kg of rice straw per day when it is in their care. The problem with this system is in ensuring that each household actually contributes its full amount of straw when the animal is in its care, and that it ensures the animal receives fresh food through grazing. All households share the manure. Death and illness of the buffalo is recognized as a problem. Some share-groups buy insurance on their buffalo.

The share-households first use the buffalo to plow their own fields and then hire it out to plow paddy fields for other farmers. When plowing for other farmers, they charge 10 kg of rice per 360 m^2 (one *sao*) for the summer crop and 12 kg of rice per *sao* for the autumn crop. This income includes 3 kg of rice for the labor of the person who plows, and 7–9 kg of rice for the labor of the buffalo itself, which will be divided equally among each of the six share-families. Sometimes the share-households keep this rice as a depreciation fund to buy a new buffalo for replacement. This is the first system of ownership that is currently practiced in most of the village.

The second system of ownership is new for Nguyen Xa Village. In this, an individual family has sole ownership of a buffalo. The buffalo is kept behind the house, usually in a private pen. After using the buffalo for its own fields, the family will contract out the animal. Our team interviewed one farmer who has a contract for plowing with ten families. The buffalo is fed rice straw and about 30 kg of grasses collected by his 17-year-old daughter almost everyday. He receives more than 1 ton of manure (before adding rice straw) per crop. Last year he earned more than 1 ton of rice from contracting out his buffalo. Thus, private ownership can be profitable both in monetary terms and for rice cultivation.

Ownership in this intensive land use area predominantly depends on the number of laborers in the household and the area of paddy field that produces rice straw. There is limited grazing land (dikes, roadsides, and cemeteries) because every suitable bit of land is given to paddy production or to housing. Thus, rice straw is an important component of ruminant feed. Farmers usually use rice straw in its natural condition. Sometimes they add salt to water and mix it with the rice straw to feed the buffalo. Rice straw could be more effectively used in the context of improving digestion if urea was mixed with the straw before giving it to the animals. Because this could be done by individual households, it would possibly be more successful than pasture improvement. But straw is used in many alternate ways: thatch, compost, fodder, and (most important) fuel for cooking. Thus, paddy production for rice straw is the major constraint on buffalo husbandry (see Table 8.2). Wealthier households have more rice straw available for their buffalo, because they can afford to buy alternative sources of fuel.

A family with 1,800 m^2 (five *sao*) of paddy field and less than three laborers will find it difficult to share or keep either buffalo or cattle. A family with 2,160–3,240 m^2 (six to nine *sao*) of paddy field and three to five laborers could have enough rice straw (see Table 8.3) to share a

Table 8.2 Dependence of Buffalo Ownership on Paddy Production and Field Size

Description	Unit
Amount of rice straw needed for buffalo (kg):	
Per day	6
Per month	180
Amount of rice straw obtained per crop (6 months)	1080
Production of rice straw/ha (kg)	693
Land required for rice straw production for one month's feed (*mau*)	6–7

Source: Farmer interviews and estimates by team.

Table 8.3 Household Livestock Production

Household	# 1	# 2	# 3	# 4	# 5	# 6
Total persons in household	3	6	5	5	2	9
Laborers in household	3	4	3	5	2	4
Area of paddy field (m^2)	1,800	3,240	2,160	3,240	1,080	3,600
Number of animals:						
Pigs	2	3	5	3	2	3
Buffalo	0	1/6	1/6	1	0	1
Poultry	> 10	> 10	> 20	< 30	> 10	> 20
Fishpond (m^2)	200	0	0	0	300	200

Source: Farmer interviews.

buffalo with five to six other households. A family who keeps one buffalo should have a minimum of five laborers and at least 3,240 m^2 (nine *sao*) of paddy fields.[3] Table 8.2 further illustrates the minimum field size and rice straw production necessary to keep a buffalo.

When we asked farmers without a buffalo why they do not buy one, the three main reasons they gave were shortages of labor, rice straw, and grass; lack of money was never mentioned.

The *Vietnam News* of 16 July 1991 stated that the size of buffalo and cattle herds was decreasing that year. They blamed the negligence of the veterinary network and the export of live cattle to China and Laos by frontier people. We confirmed by our research in Nguyen Xa Village and with provincial and district officials that the number of ruminants is not increasing in the Thai Binh area. But we must consider some of the pressures constraining the husbandry of large ruminants in such intensive cultivation conditions. Buffalo husbandry is extremely expensive in terms of both labor and material resources. There is little available to feed buffalo, largely because the landscape is dominated by rice cultivation. There is no pasture as we usually know it. The only grazing land available is the small area of grasses along dikes, on roadsides, and in cemeteries. Although these areas could be technically improved through a pasture improvement program, such a program would be constrained by social factors. One is whether people would allow improvement of cemetery land. The other is that grazing land is an open access resource. Anyone can and does use it, which contributes to extremely poor conditions. A pasture improvement program would require some restrictions in the use of these resources. It is unlikely that this is possible, especially since the demise of extensive Cooperative control—if it was ever effective in controlling use of these resources.

FISH CULTURE IN NGUYEN XA VILLAGE

The full potential of fish culture in Nguyen Xa is currently unrealized. In part, this is because ponds serve many purposes such as sources of water for bathing and washing; as a site for cultivation of aquatic weeds used to feed pigs; and for fish culture (see Figure 8.2). These multiple uses constrain fish culture, as do concerns about security (i.e., theft of fish), and the problem of having a fishpond that is too far from the house. When fish are kept, people usually add pig, cattle, and buffalo manure, which is detrimental to the use of the pond's water for domestic purposes, and agricultural residues such as rice straw.

In the past, fish culture was neglected even more than it is now. An aquaculture group was established by the Cooperative in 1966. Its duty was to raise fingerlings and to manage the fishpond system of the entire Cooperative. In the entire village, 11 ha of ponds was managed by the Cooperative, and only 1.1 ha of these fishponds had fish. The rest was used to grow *Pistia stratistes*, weeds, hyacinth, and bindweed, and to harvest naturally occurring fish. The fish yield reached an average of only 1.36 t/ha/yr. The fish was distributed to laborers or sold to households at a price set by the Cooperative.

After Directive No. 10 was issued by the Council of Ministers, the aquaculture group ceased to exist because fishponds were allocated to households. A small fishpond is managed by a single household, whereas large fishponds are shared by a number of households. Thus, there are

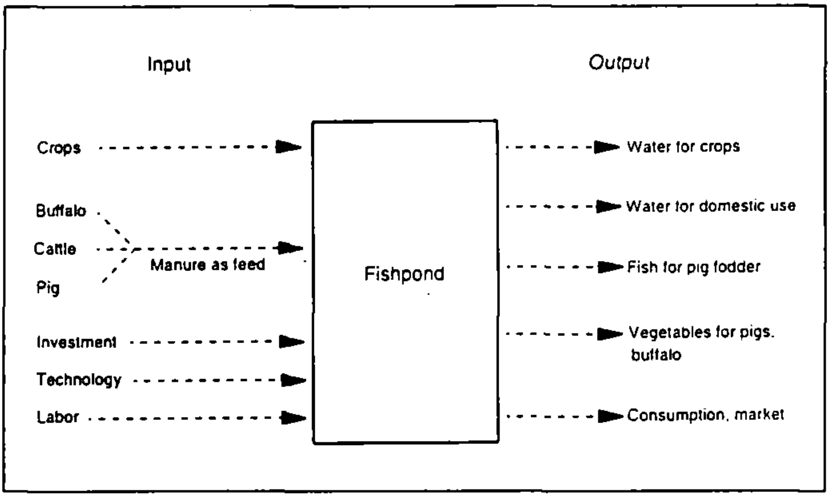


Figure 8.2 *Flow of materials in and out of the pond.*

two main types of fishpond management: management system by the household and management system by a number of households. Those who share fishponds distribute products based on the percentage of their labor and investment inputs.

Those who are allocated fishponds are not given 5 Percent Land. Two *thuoc* of fishpond is considered equivalent to one *thuoc* of paddy field. The rest is rented out by the Cooperative or managed by a household, which requests it as an allocation under the Second Land Fund. For these ponds, households pay a tax of 5 kg rice/360 m^2/crop (i.e., 10 kg rice/yr). This is a reduction from the tax of 15 kg rice/360 m^2/crop charged for paddy land out of the Second Land Fund. Many people do not want fishponds far from their houses, however, as it is difficult to manage them, partly because of theft problems.

The fish yield harvested by each household varies greatly because of differences in technical knowledge and level of labor and capital investment. A number of households in the village harvest only naturally occurring fish. They do not stock the ponds or make inputs other than the most basic in the traditional system (some manure and agricultural residue). The fish yield is low, particularly when a group of households share one fishpond. Where there is application of new technology and high investment, some households achieve a high yield.

The effect of changes in the ownership system and application of new technology is illustrated by the following case. Thirteen households shared one fishpond with an area of 1,800 m² (five *sao*). In 1987, due to low investment, the fish yield was only 300 kg. In 1988, the Cooperative auctioned off rights to the fishpond. The winning farmer now pays 650 kg of rice each year to the Cooperative on behalf of all the households. In return, he manages the fishpond himself and keeps all of the fish production. He increased the fish yield to 900 kg in 1989 and to 1 ton in 1990. According to him, in order to get 1 kg of grass carp (*tram co*), he needs to put in 80 kg of grass. We were unable to independently confirm this. Table 8.4 lists the fish he raised in this pond, along with the expected productivity by the end of 1991. Table 8.5 illustrates the species of fish he had stocked in this pond, and the expected productivity for 1991.

In 1988, the same farmer received 1.1 ha of fishpond from the village (the pond mentioned earlier was rented from or allocated by the Cooperative). This pond, known as Bac Ho Fishpond, was allocated on a contract to this farmer by the Village Committee. He had a 5-year contract and agreed to pay the equivalent of 575 kg of fish/yr to the village in return for using the pond, which is currently equivalent to one million *dong*. In 1988, he claimed a 1.7 million *dong* profit, equivalent to 2.1 tons of rice. He had been so successful that the village wanted to renegotiate the contract to assess a higher rate.

In 1991, the same farmer also raised fish in a canal in an area 1-km long, 15 m wide, and 1.3 m deep. He spent eight million *dong* to buy fingerlings and construct two weirs. He started the fingerlings in Bac

Table 8.4 Estimate of Investment, Fish Productivity, and Return (in 1,800-m² pond for 9 months in 1991)

Investment	Amount	Cost (*dong*)
Rice bran	1,584 kg	2,217,600
Grass	14,400 kg	288,000
Fingerlings		341,500
Harvesting costs (pumping water)		150,000
Renting fee (to Cooperative)	650 kg rice	1,300,000
Total costs[1]		4,297,100
Gross return	1,584 kg of fish	5,666,400
Net return		1,369,300

[1]Total costs do not include labor costs for pumping water, collection of food, etc.

Table 8.5 Expected Productivity (*dong*) of Fish Species Raised for 9 Months of 1991 (in 1,800-m² pond)

Fish Species	*Tram Co* (Grass Carp)	*Troi An Do* (Indian Carp)	*Me* (Marsh Carp) (*Hypophthalmichthys*)	*Troi Ta* (Common Carp)	Carp	Total
Amount of fingerlings (head)	300	3,000	1,300	200	200	5,000
Price of fingerlings (*dong*)	15,000	195,000	71,500	40,000	20,000	341,500
Number of harvested fish (head)[1]	180	1,800	780	120	120	3,000
Total weight of harvested fish (kg)[2]	324	900	312	12	36	1,584
Estimated value of harvested fish (*dong*/kg)	4,000	4,000	1,800	4,200	4,400	NA
Estimated return (*dong*)	1,296,000	3,600,000	561,600	50,400	158,400	5,666,400

[1]This is the farmer's estimate of total head at the end of 9 months of raising (February to October), given 40 percent loss of fingerlings. Thus, these numbers represent 60 percent of the stock originally put in the pond. He only keeps the fish for 9 months because he finds this to be more economical; if he keeps them longer, he has to feed them too much. We do not know how he evaluates this; perhaps labor, perhaps cost of feed, or other factors.

[2]This is the farmer's estimate based on the number of head times the weight of the fish. The harvest weight of each species is as follows: *tram co*, 1.8 kg/fish; *troi an do*, 0.5 kg/fish; *me*, 0.4 kg/fish; *troi ta*, 0.2 kg/fish; carp, 0.3 kg/fish.

NA = not applicable.

Ho Fishpond and transported them to the canal; the distance between his site on the canal and the pond is about 1 km. He had hoped to get 4 tons of fish, equivalent to fifteen million *dong* (thus, seven million *dong* in profit).

Unfortunately, it is difficult to develop fish culture in the village as a whole, due to the following constraints: (1) lack of knowledge of fish-culture techniques, (2) lack of investment, (3) lack of rice bran, because of its use as pig feed and the high price of rice, and (4) low price of fish. If new technology and investment were available, the local people's income could increase because excess labor would be used and the amount of protein in the villagers' diet would also improve. Improving fishpond production would also benefit pig production, as fish could be added to pig fodder to increase the protein content and result in live-weight gain. There is potential here for improvement of the agroecosystem.

CONCLUSIONS

One of the central problems in rice cultivation in this system is draft power. Buffalo are extremely expensive to keep because of domination of the landscape by rice cultivation. There is little land for grazing; whatever there is, is overexploited. Rice straw, the dominant fodder for buffalo, is also used as fuel; there is too little land available to grow fodder or trees to provide fuel. In short, the very conditions that necessitate keeping buffalo also constrain buffalo husbandry. Pasture improvement is desirable but might not be feasible. Research into the role of open access resources such as roadsides, dikes, and cemeteries might help us to find a feasible way to improve pasture. Simple improvements in fodder, such as addition of salt or urea to rice straw, might be more likely to be adopted by Nguyen Xa farmers.

Pig husbandry is a good complement to rice cultivation: it makes use of rice bran; pigs can be readily sold to supplement household subsistence; and the manure is essential to the productivity and sustainability of intensive rice cultivation. There is excellent market potential for pigs in Nguyen Xà. There is already a fair amount of marketing going on. The major constraint on pig production seems to be the low price of pork. Few farmers said they made a profit, per se; manure itself appeared to be the major benefit. In fact, pig manure is so essential to the agroecosystem that it would be advisable to encourage pig production as much as possible. To this end, the model of the successful pig farmer should be considered. Some simple improvements in feed could make a great difference in live-weight gain, resulting in increased income and manure.

Fish production has great potential, but one constraint is that the farmers use fishpond water for bathing, washing clothes and dishes, and cleaning. This practice limits the use of manure in the ponds. An important social constraint on fish cultivation is that farmers do not want fishponds far from their houses for security reasons. If this constraint can be solved, the potential for fish cultivation as a source of income, for pig feed, and to improve human nutrition is very good. That these are not permanent or pervasive constraints is shown by the example of the successful fish farmer discussed earlier.

Endnotes

1. This represents approximately 15 kg of pork/capita/yr.

2. A similar trend is evident in the delta as a whole. The number of buffalo declined from 3,927,000 head in 1976 to 3,559,000 head in 1991 (General Statistical Office 1992:215, Table 108). The number of cattle decreased from 715,000 in 1976 to 283,000 in 1991 (ibid.:219, Table 109).

3. In contrast, the number of pigs kept does not seem to be correlated to either number of *sao* or labor.

9. RESILIENCE TO HAZARDS AND NATURAL DISASTERS

HAROLD J. MCARTHUR
VU QUYET THANG
TRAN KIEU HANH
PHAN MINH CHAU

One important aspect of the sustainability of an agroecosystem is its ability to recover from disturbances caused by major hazards and natural disasters. This ability to bounce back from such disturbances in the normal flow of resources and energy can be referred to as "resiliency." In order for a system to be sustainable, it must be able to recover periodically from, or adjust to, major changes in the environment.

This chapter will focus on the environmental, structural, and social factors that contribute to the resilience of the agroecosystem of Nguyen Xa Village to natural hazards and disasters such as floods, typhoons, droughts, severe pest infestations, and unexpected and pronounced changes in climatic conditions. There would be serious consequences for human life if the productive capability of the system was not able to mitigate and/or recover from these and other natural disasters.

NATURAL HAZARDS

Thai Binh Province is located in a tropical monsoon belt. The rainy season, between the months of May and October, frequently generates six to eight typhoons. These storms can pose a major threat to Thai Binh and its surrounding areas (Figure 9.1). Parts of the province regularly suffer crop damage and loss of property from flooding.

During the storm season from August to October, precipitation can range from 200 to 300 mm/day and wind velocities can reach 40–50 m/sec. Historically one of the worst natural disasters in the area occurred in 1945, when a particularly violent typhoon damaged more than 3 km of river dikes. According to villagers old enough to remember, much of Nguyen Xa was submerged under 2–3 m of water for 3 months. In addition to crop loss that brought about a major famine, many people died from waterborne diseases.

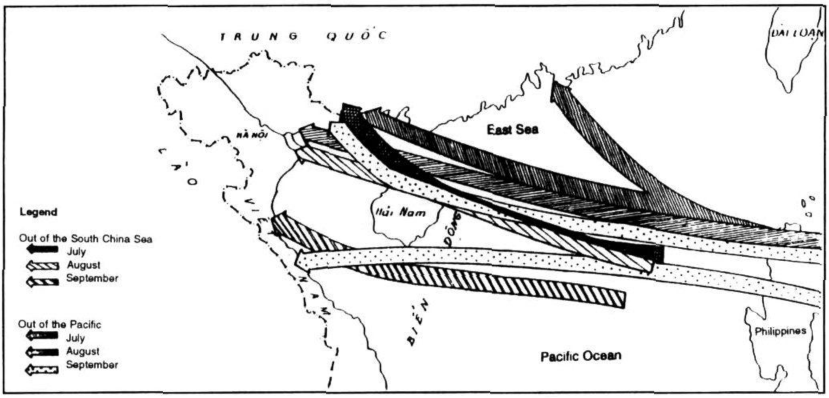


Figure 9.1 *Typhoon direction.*

Before 1964, when the first main canal was constructed across Nguyen Xa, the community or individual farmers could do little to protect themselves against and lessen the impact of monsoon storms. By 1972, a model irrigation and drainage system was completed. This system now provides year-round irrigation and good water control to 90 percent of the field areas, covering 800 *mau* (288 ha) (see Figure 9.2). As a result, over the past 30 years no major flooding has occurred in Nguyen Xa Village. What was once a force of potential destruction for the people of Nguyen Xa has been controlled by well-designed changes that have been made in the physical and social environment.

THE WATER MANAGEMENT SYSTEM

Physical and Structural Characteristics

The irrigation and drainage system, originally designed by Chinese hydrologists, currently consists of two canals, two control gates, five fixed pumping stations, six pump boats, and an elaborate network of field channels and trenches. The largest of the pumping stations (*Cau Den*) became operational in 1989.

The system was initially envisioned with separate sets of canals for irrigation and drainage. One higher level primary canal would provide the main source of irrigation water. The fields served by this source of water would be laid out in such a way that they would all drain into a lower level drainage and flood control canal (see Figure 9.3).

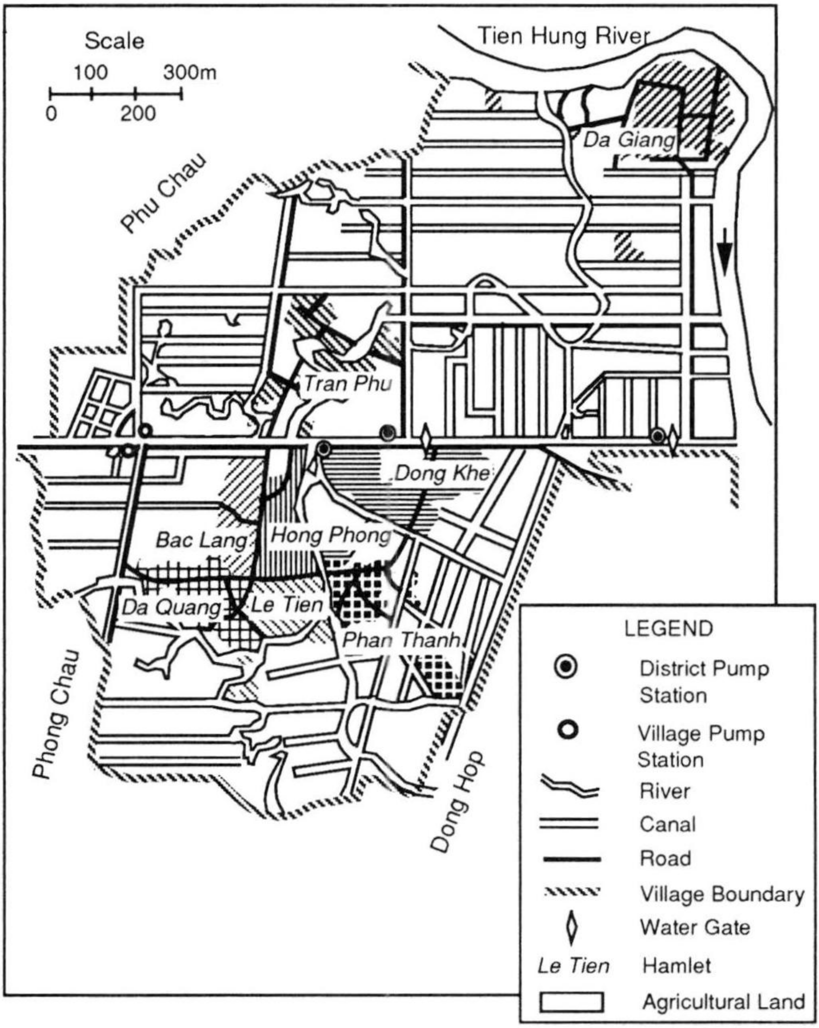


Figure 9.2 *Canal and dike system of Nguyen Xa.*

It proved difficult to maintain the proper field levels and canal heights necessary for the system to work as originally designed. As a result, various modifications have been made so that each canal and ditch is a multipurpose artery that can be used for both irrigation and drainage, if necessary (see Figure 9.4).

The five pumping stations are situated along the primary Thong Nhat Canal (see Figure 9.5). The two gates on the canal can be opened or

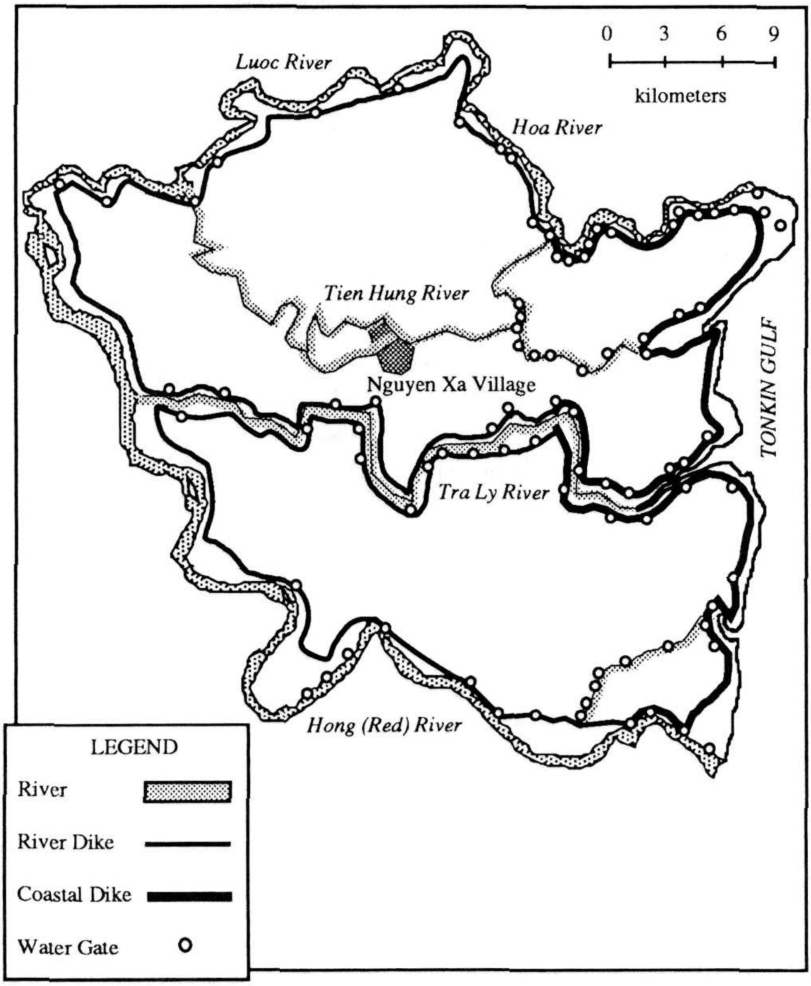


Figure 9.3 *Hydrological and dike system of Thai Binh Province.*

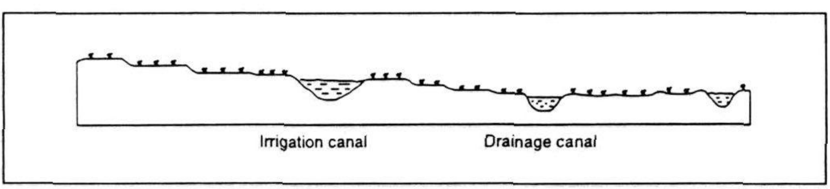


Figure 9.4 *Canal and field transect.*

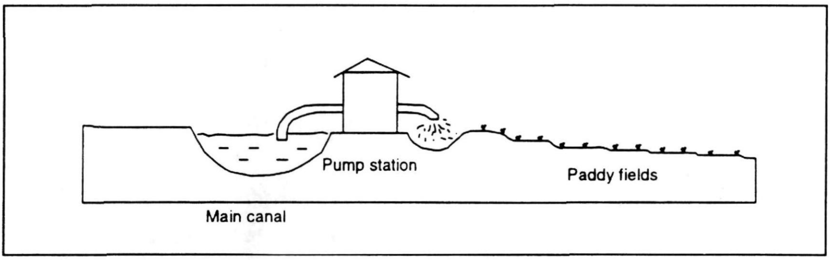


Figure 9.5 *Pumping diagram.*

closed to raise and lower the water level in a particular portion of the canal. The 8-km long canal, of which only about 2.5 km runs through Nguyen Xa Village, connects two sections of the Tien Hung River. When the gates are open, water flows naturally from the upper portion of the river, through Nguyen Xa, and re-enters the Tien Hung River at the Nguyen Bridge on the far east side of the village, where one of the gates and the largest of the five pumping stations is located. Care must be taken when one or the other of the two gates is closed to ensure that the resulting rise in water level in the canal does not cause any flooding in fields east of Nguyen Xa. Normally, the gates are closed only for brief periods at the beginning of the crop season to ensure an adequate supply of water for the initial irrigation. Water from the canal is pumped into a raised ditch that runs perpendicular to the Thong Nhat Canal. The lateral trenches that run into the field areas are fed by this irrigation ditch. Following planting, water is normally pumped to each field area one to three times per week, depending on the temperature and amount of rainfall.

The pump boats operate, as necessary, from the Tien Hung River and a smaller tributary that meanders across one field area (see Figure 9.6). If there is a major electrical power outage, the boats, which can pump a maximum of 3,000 m^3 of water per hour, can provide an emergency backup to the five pumping stations. Apparently Nguyen Xa is the only village that has pump boats, as they were part of the original system designed by the Chinese hydrologists. The pump boats are assigned to persons who live near the river. These men are paid by the Cooperative to maintain the boats and operate the pumps as requested by the irrigation team. For this work each boatman receives 150 kg of rice per cropping season.

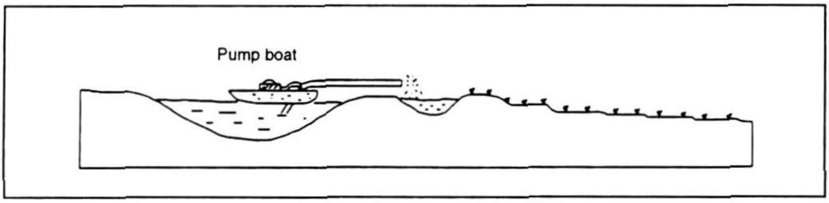


Figure 9.6 *Pump boat operation.*

Since completion of the system, it has not been necessary to use the pumps for other than irrigation. This is because of good drainage and the fact that compared to other villages in Dong Hung District, Nguyen Xa has relatively high land that is generally not prone to flooding (see Table 9.1).

The winter-spring crop is irrigated weekly for 12 consecutive weeks. Three to five cm of water is applied with each irrigation for a total of 360–600 mm of water for the winter rice crop. Rainfall during the winter cropping season (January–June) is approximately 500 mm, and the potential evapotranspiration is about 400 mm.

The summer-autumn rice crop is transplanted in late June or early July and harvested in October. The crop is irrigated eight times with 3–5 cm of water per irrigation for a total of 240–400 mm of water. Since the autumn crop falls entirely within the rainy season, less irrigation water is applied.

About 40 percent of the farm land is planted to a non-rice crop such as potato, sweet potato, corn, or vegetable immediately following the autumn rice harvest. This crop is irrigated with about 10 cm of water between mid-October and the end of December.

Easy access to water throughout the year has enabled the villagers to profitably invest in other production factors such as fertilizers, soil amendments, and pesticides, and to adopt new high-yielding rice varieties that respond to high input. Thus, water control—the capacity to apply and/or remove water at will—is one of the underlying reasons for the agroecosystem's high productivity and stability.

The water of the Red River, which is rich in sediment, may also contribute to sustainability of the agroecosystem. The sediment load is 1–3.1 kg/m^3 on the average, fluctuating between 3–3.5 kg/m^3 when the flow peaks, to 0.5 kg/m^3 in the dry season.

Table 9.1 Land Area by Elevation in Dong Hung District (ha)
(including percentage of subdistrict's land in each type)

Subdistrict	Very High	High	Middle	Low	Very Low	Total
An Chau	—	152.5 (57%)	95.6 (36%)	20.7 (08%)	—	268.8
Do Luong	—	25.6 (09%)	255.7 (90%)	2.8 (01%)	—	284.1
Me Linh	9.5 (02%)	160.2 (39%)	182.6 (44%)	59.3 (14%)	—	411.6
Lo Giang	9.3 (04%)	79.7 (31%)	106.8 (42%)	60.0 (23%)	—	255.8
Phu Luong	187.9 (60%)	122.5 (39%)	—	1.9 (01%)	—	312.3
Lien Giang	40.6 (10%)	83.1 (20%)	220.6 (54%)	64.2 (16%)	—	408.5
Bach Dang	7.3 (03%)	29.0 (11%)	107.2 (40%)	67.7 (25%)	55.0 (21%)	266.2
Hong Chau	22.9 (07%)	44.3 (14%)	183.8 (59%)	34.4 (11%)	25.4 (08%)	310.8
Hong Viet	51.1 (12%)	105.5 (24%)	243.0 (54%)	42.3 (09%)	6.4 (01%)	448.3
Hong Giang	5.6 (02%)	84.3 (35%)	88.3 (37%)	35.9 (15%)	26.3 (11%)	240.4
Hoa Lu	14.4 (05%)	33.0 (12%)	188.7 (71%)	30.0 (11%)	—	266.1
Hoa Nam	—	31.5 (15%)	66.7 (32%)	89.6 (43%)	21.4 (10%)	209.2
Thang Long	44.0 (20%)	44.6 (20%)	94.9 (43%)	25.4 (12%)	10.2 (05%)	219.1
Minh Tan	26.8 (11%)	78.9 (33%)	54.0 (23%)	76.2 (32%)	2.4 (01%)	238.3
Nguyen Xa	85.3 (26%)	229.6 (69%)	15.5 (05%)	—	—	330.4
Phong Chau	4.7 (01%)	31.5 (08%)	278.1 (75%)	57.1 (15%)	—	371.4
Phu Chau	40.0 (11%)	154.9 (42%)	167.4 (46%)	4.7 (1%)	—	367.0
Minh Chau	—	48.5 (19%)	201.2 (81%)	—	—	249.7
Hop Tien	17.0 (08%)	27.9 (12%)	159.6 (70%)	22.0 (10%)	—	226.5
Chuong Duong	23.9 (08%)	86.1 (30%)	140.6 (49%)	35.3 (12%)	—	285.9
Dong Phu	6.1 (02%)	79.4 (30%)	106.0 (40%)	68.7 (26%)	5.4 (02%)	265.6
Trang Quang	7.9 (02%)	181.1 (34%)	257.1 (49%)	79.7 (15%)	—	525.8

Source: Thai Binh Department of Statistics (1991).
Percentages may not add up to 100% due to rounding.

However, the irrigation water for Nguyen Xa Village is diverted into the Thong Nhat Canal from the Tra-Ly River, a minor river that splits off from the Red River. Since the sediment concentration is highest in midstream, where the water velocity is highest, the water that is diverted into the Tra-Ly River should be expected to have a lower sediment concentration than the Red River. By the same token, further reduction in sediment concentration can be expected when water is diverted from the Tra-Ly River into the Thong Nhat Canal.

It is possible to estimate the amount of sediment deposited each year in the irrigated fields if we know (1) the volume of river water applied to the fields, (2) the sediment concentration of the irrigation water, (3) the volume of excess water draining off the fields, and (4) the sediment concentration in the drainage water.

In June 1992, the sediment concentration in the irrigation and drainage waters was measured at several locations.[1] Average values of 0.08 kg/m^3 and 0.04 kg/m^3 were obtained for the irrigation and drainage waters, respectively. These values are expected to vary, but estimations of sediment gains and sediment losses based on them can give insights into the amount of sediment deposited each year, and the impact long-term deposition may have on soil fertility and sustainability of the agroecosystem.

We begin the estimation procedure with the amount of irrigation water applied each year. It turns out that about 1 m of irrigation water is applied. This is the sum of 20 applications of 4–5 cm of water to the two rice crops and another 10 cm applied to the non-rice crop. Since the amount of sediment brought to the fields in the irrigation water is the product of the irrigation water depth (1.0 m) and the sediment concentration, we have

$$1.0 \text{ m} \times 0.08 \text{ kg/m}^3 = 0.08 \text{ kg/m}^2.$$

But not all of the sediment that flows into the fields remains there. Some sediment is removed from the fields in the drainage water and returned to the main canal.

The total depth of water leaving the rice fields each year is the difference between the amount added and the amount lost through evapotranspiration. The amount added is the sum of rainfall (~ 1,800 mm) and irrigation (~ 1,000 mm), and the amount lost through evapotranspiration (about 1,000 mm). This leaves about 1,800 mm or

1.8 m of water that must be removed annually from the fields. The product of 1.8 m and 0.04 kg/m^3 is 0.072 kg/m^2, which represents the amount of sediment removed each year.

If we take the difference between what is added (0.08 kg/m^2) and what is removed (0.072 kg/m^2), we obtain a net sediment gain of 0.008 $kg/m^2/yr$ or 80 kg/ha/yr. This amount is negligible; but if we assume a soil bulk density of 1.0 mg/m^3, a soil layer 1.0-cm thick will be produced after 120 years of irrigation with water from the Thong Nhat Canal.

Before the dikes and water control devices were put in place, the annual flooding resulted in much higher sediment deposition on the surface of the delta. Now most of the sediment is transported to the sea. During the rainy season, silt accumulation in the rivers and canals is a major problem. The Red River alone deposits about one million tons of sediment in the ocean each year.

Another feature of the irrigation water is its neutrality to alkaline pH (7.0–7.4). This is in strong contrast to the high acidity of the soils of Nguyen Xa Village. Like most soils developed from recent, sulfur-rich marine sediments, the soils, and particularly the subsoils of Nguyen Xa Village, are acid. This acid soil has been capped by even more recent, less acid sediment from the flood waters of the Red River. The relatively greater thickness of the sediment capping the acid subsoil in and near Nguyen Xa Village probably gives the soils their high productivity. But even the top soil is now becoming acid from heavy application of acid-forming nitrogen fertilizers. It is nearly certain that the high pH of the irrigation water has helped to lessen the negative effect of heavy fertilizer application.

MANAGEMENT AND MAINTENANCE RESPONSIBILITY

Administrative and Social Organization

The water management system of Nguyen Xa is part of a complex and highly integrated system that requires input and coordination at the national (*quoc gia*), provincial (*tinh*), district (*huyen*), village (*xa*), and hamlet *(thon)* levels. The major tidal and flood dikes along the Red River, the Luoc River, and the Tra-Ly River were designed and constructed by the national government. They are maintained by provincial and district water management and irrigation offices with funds allocated by the central government. More than 600 km of tidal and flood control dikes in Thai Binh Province protect agricultural and residential land from flooding and saltwater intrusion. The central government manages a total of 337 km of the system (133 km of tidal dike near the sea and 204 km of flood control dikes running inland along the rivers).

The canal system in Nguyen Xa was built by the district irrigation and hydrological office with labor provided by the local villagers. The Thong Nhat Canal and three of the pumping stations are maintained by the district. The two remaining pumping stations, the six pump boats, and all the lateral field channels are maintained at the village level by the Cooperative irrigation team. All the pumping stations depend on electrical power provided by the national government.

Each of the eight hamlets in Nguyen Xa has an irrigation group of three to five persons. These groups are combined into one team under the direction of a Cooperative manager. Each member receives 70–80 kg of rice per year from the district and is expected to handle all the regular maintenance work. In an emergency, villagers may be called upon to contribute their labor. In 1972 when a storm caused extensive damages, the irrigation team enlisted assistance from the villagers to make necessary repairs to the system.

Individual households are responsible for the care and maintenance of the feeder channels that supply water and drainage to their paddy fields. If gravity feed does not provide sufficient water to a particular paddy field, the individual farmer is responsible for lifting and transferring the necessary water by use of a one- or two-person scoop (see Figure 9.7). This additional work is considered in establishing the tax on the rice produced.

The residential areas of Nguyen Xa are drained and protected from flooding by a series of interconnected multipurpose ponds. The ponds have been developed in the depressions where soil has been excavated for house construction. As a protection against flooding, houses in the village are built on compacted mounds of soil that has been taken from the ponds.

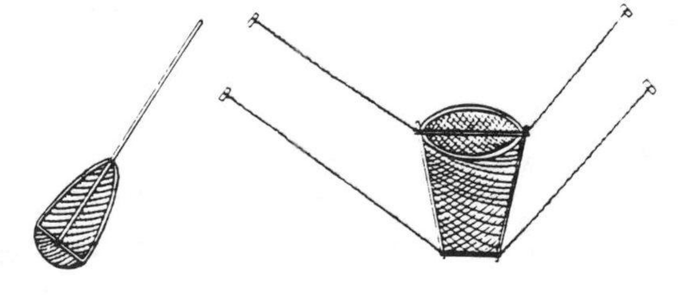


Figure 9.7 *Water scoops.*

CURRENT VULNERABILITY

With the present water management system, there is minimal risk to Nguyen Xa from flooding or drought. It has year-round irrigation, enabling the production of three crops, and its fields are all located in well-drained areas. Farmers, however, are still very much at risk to crop loss from strong winds and unseasonally warm or cold temperatures. In 1991, 50–60 percent of the winter-spring rice crop was lost due to cold air that descended from the north during April. These cold winds are especially devastating when their appearance coincides with flowering.

Considering the level topography and the near absence of trees, there is little natural protection from strong winds that can result in significant crop loss from lodging, which occurs when rice plants are blown over and fall against the water or mud in the paddy. Several informants in Nguyen Xa said that their main concern from typhoons is not heavy rain or flooding, but the strong winds over which they have no control. One farmer estimated that some loss in yield is experienced in three out of every ten harvests.

In addition to wind and temperature, rice is vulnerable to damage from pest infestation or disease. The village Cooperative's pest management team is responsible for monitoring levels of pest damage and taking appropriate action. The team has easy access to information and pesticides from the province pest control office. Although control technology is available and used regularly, this does not necessarily protect against massive infestations that may be related to certain climatic conditions. The main pests are *Ray nau* (*Nillaparvata lugens*), *Sau duc than buom hai cham* (*Scirpophaga incertulas*), *Sau cuon la* (*Cnaphalocrocis medinalis*), and *Bo xit dai* (*Leptocorisa acuta*). The diseases most commonly affecting the rice crops of Thai Binh are *Benh kho van* (*rhizoctonia solani Kuhn* or *Thanatephorus cucumeris* FR. Dowk), *Benh dao on* (*Pyricularia oryzae* or blast), *Benh tiem lua* (*Helminthosporium oryzae* or brown spot), and *Benh bac la* (*Xanthomonas campestris pv oryzae* or bacterial leaf blight).

Farmers in Nguyen Xa employ a number of strategies to control loss from pests and disease. During any given planting season, about 20 percent of the land is used to test new varieties of rice that the farmers want to evaluate as potential replacements of their current varieties. The farmers may change the dominant variety grown in their fields as often as every 3–5 years for maintaining some level of biological control against pests and preventing yield decline. Farmers are experimenting with three varieties: CH3, A20, and Mien Tay 58. Most of the fields are planted to CR203 in the summer and VN10 in the winter. Variety CR203 has a slightly shorter stalk (55 cm) than VN10 (50–70 cm) and may be somewhat more resistant to wind.

In addition to changing varieties, farmers claim that seasonal alternation in their application of fertilizer helps to reduce crop loss from pests and to increase the amount of straw produced in the winter crop. For the winter crop they use 5 kg of nitrogen and 10 kg of phosphorus per *sao* (360 m^2). For the summer crop the treatment composition is reversed with 10 kg of nitrogen and only 5-7 kg of phosphorus. They also incorporate a mixture of pig manure and straw (called *phan chuong*) into the soil. Table 9.2 shows the frequency of major environmental disturbances and their consequences for agricultural production as reported by the farmers.

Figures 9.8 and 9.9 provide some idea of the relationship between climatic disturbances and rice yields. The graphs plot a 5-month seasonal average temperature (January–May for the spring crop and June–October for the summer crop) across a 10-year period. We can see that there were indeed higher than normal temperatures during the period that the district suffered considerable losses in the spring crops of 1986 and 1987. In 1991 the temperatures from January to March were above normal, followed by a sharp cold spell just as the rice was beginning to flower in April, which resulted in a severe reduction in yield.

Table 9.2 Dates and Conditions of Unexpected Crop Loss

Date	Nature of Disturbance	Extent of Loss
1991	Warm temperature followed by cold during period when rice flowers	40–60% of winter-spring crop
1987	Warm temperature and pests	40% of winter-spring crop
1986	Warm temperature, pests, and disease	30% of winter-spring crop
1976	Wind	30% of winter-spring crop
1972	Rain and high water	Damage to dike
1945	Flooding	Crop loss, famine
1926	Flooding	Crop loss, loss of life

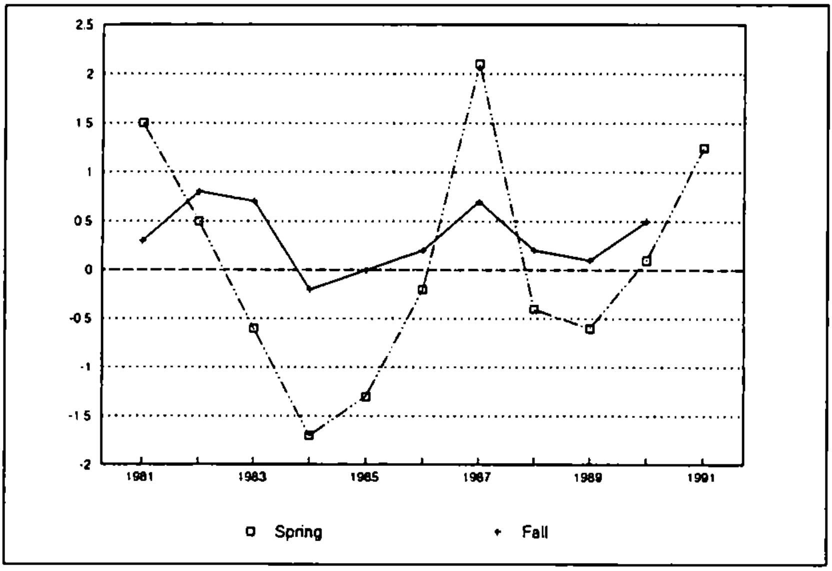


Figure 9.8 *Seasonal variation in average temperature.*

SUPPORT MECHANISMS

Despite their water management system, farmers in Nguyen Xa still face the possibility of unexpected crop losses. When this happens, certain communal forces and institutional structures are activated to provide emergency assistance to the most needy villagers.

One village leader noted that every family is expected to maintain its own emergency rice reserve. He said that each family should have a 6-to-12-month supply of rice on hand at all times. This reserve can be

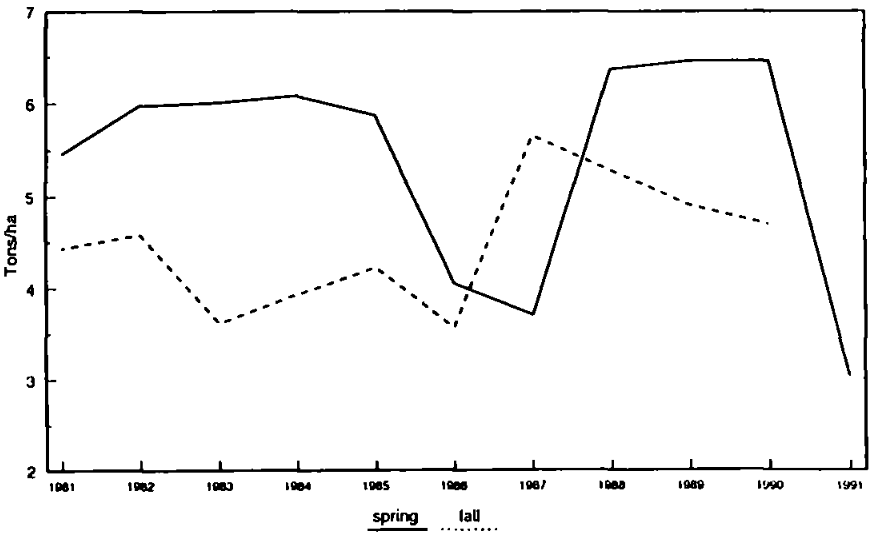


Figure 9.9 *Rice yields, 1981–91 (tons of paddy per ha).*

created from saving the surplus from a year in which the yields were exceptionally high and from purchasing additional rice, usually with money earned from the sale of pigs and numerous sources of outside income.

Although working-age couples are responsible for the welfare of their family, the village does manage a special fund from which assistance can be given to the very needy. In addition to the yield tax, each household is required to contribute paddy to a special social/cultural fund. The district office keeps the records on this fund, but each village is responsible for collecting and keeping the contribution in the village storage house. A village committee consisting of one representative for each ten farmers decides on how the fund will be used. In 1991, the committee gave special assistance of 10–15 kg of rice to four families following the spring crop loss. This fund has also been used to provide a subsidy for individuals and families who elected to move from Nguyen Xa to one of the country's New Economic Zones. One individual who decided to leave received an allotment of two million *dong* (about US$250).

In addition to emergency relief, the fund is used to support special events and village celebrations. On such occasions the village may choose to use the fund to sponsor a water puppet performance. Nguyen Xa is famous throughout the country for its water puppetry. The village currently has a puppet team of about 20 individuals.

During a year in which many farmers suffer a major crop loss, the committee can elect to reduce the level of the required contribution to the fund. For example, in 1991, people who would normally be required to contribute 10 kg of rice to the fund were only asked to provide 8 kg.

WEATHER FORECASTING

Although the weather is beyond anyone's control, farmers worldwide have developed ways of predicting weather changes to prepare themselves for the inevitable or to decide when to plant or harvest. Farmers in Nguyen Xa are no exception. They have a number of traditional indicators of weather change. For example, some farmers feel they can predict stormy weather by looking at newly sprouted bamboo shoots. If the shoots grow straight, parallel to the older standing stalks, this is a sign of good weather. If, on the other hand, the shoots appear to bend toward the older stands, then bad weather and storms can be expected.

Another similar method involves predictions based on an examination of the leaves of a particular grass called *co gung* (*Panicum repens*). If the leaves of this plant are uniformly long and slender, there is a likelihood of good weather. If the leaves show areas that are repeatedly thick and thin, then it is believed that many storms will occur. If there is only one indentation in the leaf edge and it is at the base of the leaf, there will be an early storm (which is good). If the indentation is located toward the tip of the leaf, this indicates a storm late in the growing season, which can be bad for yields.

In Hanoi, one animal scientist at the National Agricultural College noted that farmers use frogs to predict weather. They say that when the skin of the frogs in the rice fields gets darker, it is about to rain. Also, if the bone in a frog's leg is a lighter color on both ends than in the middle, this means there will be wind in the beginning and end of the month.

SUGGESTIONS FOR FURTHER RESEARCH

Although the water control problem has been solved, farmers are unfortunately still vulnerable to other climatic hazards such as strong winds and unseasonally cold temperatures. Wind is an unpredictable force that can cause severe crop loss if it comes late in the growing season. Winds cannot be prevented, but some measures can be taken to mitigate damages they cause. Farmers use a short-stemmed rice variety that they feel is somewhat resistant to wind. Also, during the winter, they put only three to five plants in each hill, compared to six to eight plants per hill in the spring. With fewer plants per hill, each stalk will have more room to grow stronger and hence be more resistant to lodging if hit by a strong wind.

Windbreaks have been used in other areas of the world to reduce crop loss from wind, but they probably would not be appropriate to the environmental and socioeconomic conditions of Nguyen Xa. Although windbreaks might help to save a crop during a particular storm, this approach would probably not be accepted by farmers in Nguyen Xa for many reasons, including the following:

1. Planting trees along the edges of the paddy field would remove a few precious meters of land from production.
2. Putting trees on top of the paddy bunds would block the walkways used to transport seedlings and manure to the fields.
3. Although some crops could be saved from severe damage every few years, the price may be too high in terms of reduced yields during good weather.
   - Although providing protection from wind, trees also produce shade that could decrease yields in certain parts of the field.
   - For windbreaks to be effective, they must be managed and protected from overcutting for firewood, fodder, and green manure.
   - Managing windbreaks would require some form of social organization, such as a windbreak team within the Cooperative.
4. Wind damage occurs once or twice in 6 or 7 years and not all wind causes damage. It is hard to measure the benefits of windbreaks in terms of costs and benefits, even over an extended period.

The discussion of the potential feasibility of windbreaks is not intended to dismiss this option but rather to illustrate the difficulty one faces in trying to assess the multiple impacts of even minor adjustments in a system that is already taxing its use of existing resources to the very limit. Actually, windbreaks have been observed in several other villages in Ha Nam Ninh Province, just north of Thai Binh.

In order to further ascertain the potential for introducing windbreak technology to Nguyen Xa, one should conduct an initial rapid rural appraisal in the Ha Nam Ninh communities to determine exactly what factors have contributed to the adoption of the technology in this location. It would be interesting to learn how the two areas compare in terms of population density, size of the Cooperative, land use strategies, agronomic and hydrological conditions, and the frequency of strong winds.

Endnote

1. These data were collected during an intensive study of soil sustainability conducted by a team of scientists from CRES, Agricultural University No. 1, the East-West Center, and the University of Hawaii. See Patanothai (1992) for a preliminary report on this research.

10. SUSTAINABILITY: NUTRIENT FLOWS AND SOILS

ARAN PATANOTHAI
TRAN DUC VIEN
LE THANH TAM
PHAN MINH NGUYET

This chapter examines the role that nutrient flows, particularly human-managed recycling of nutrients into the soil, play in maintaining sustainability of the agroecosystem of Nguyen Xa Village. *Sustainability* is defined as the ability of a system to maintain its productivity when subjected to stress and shock. It can also be viewed as the ability of a system to maintain a given level of productivity over an extended period (Conway 1987). For agricultural systems, sustainability concerns the ability of the agroecosystem to maintain the level of production over time in adjustment to changing environments, particularly increased population (Manu Seetisarn 1991, pers. com.). As there are several products in a system and their production is influenced by policy, technology, economic conditions, social and institutional factors, and environments, as well as the quantity and quality of the resource base, sustainability is complex and difficult to measure.

In Chapter 9, the Nguyen Xa Village system was examined in terms of its recovery mechanism in response to hazards. This is a factor in sustainability. In this section, we examine its ability to maintain a given level of productivity over time. For practical reasons, we have reduced the scope of the analysis to the quantity and quality of the land resource base for agricultural production. Data were collected by interviewing five farmers in three hamlets; village officials provided additional information. In this analysis, we examine how land is used and managed, determine the flows of nutrients among the subsystems within the village system and with outside systems, and qualitatively assess the trend of soil nutrients under current production practices.

FRAMEWORK AND PROCEDURE OF THE ANALYSIS

The model used as a framework of the analysis is essentially an input-output model. The model is developed by first defining the boundary of the system, then determining the variables that will carry the nutrients into (input variables) and out of (output variables) the system. The amount or magnitude of the nutrients carried by these variables is assessed qualitatively (or quantitatively, where possible). We have done this for the land resource, which is an important aspect of the resource base for agricultural production. The balance of nutrients is then assessed from the total input and total output. A high negative balance would indicate a low sustainability of the system with regard to the quality of land resources. This would provide a warning for which appropriate intervention should be made if long-term productivity is to be maintained.

The steps in carrying out this research include:

1. Generating an input-output model of the village system;
2. Determining the different subsystems, particularly field types, within the village system;
3. Examining the soil and fertility management practices, including crop residue management, in detail for each field type;
4. Laying out an input-output model for each field type;
5. Examining each input and output variable (e.g., manure, night soil, rice straw) in more detail, particularly on where it comes from and how it is used;
6. Laying out the combined nutrient flow diagram among subsystems within the village system and with outside systems.

We began the research by generating a hypothetical model defining the possible input and output variables based on experience and available secondary information prior to visiting the village. This model was used to focus the interviews and observation in the village visits. Based on information obtained, some variables were eliminated and some were added, and the relative contributions of those remaining variables were assessed. Figure 10.1 shows a model of the agroecosystem at the village level hypothesized prior to visiting the village. Some of the variables included in this model were later eliminated. At the site, we focused our analysis at the village level and the field level.

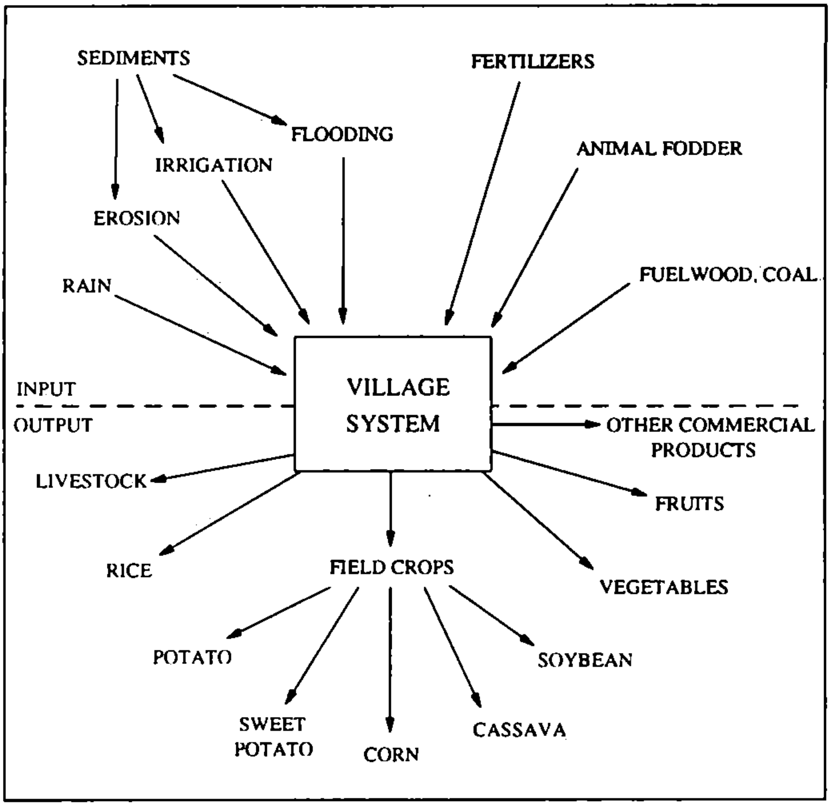


Figure 10.1 *Hypothetical input-output model of Nguyen Xa Village.*

LAND CLASSIFICATION

Cultivated lands in Nguyen Xa Village are classified by the Cooperative into different classes based on pH, nutrient content, and previous production records. Previously, the lands were classified into five types (Ia, Ib, IIa, IIb, and III), where Ia is the most productive and III is the least productive soil. Figure 10.2 shows the distribution of these land types in the village. Fields within each land type, however, are not homogeneous in terms of chemical properties. Table 10.1 shows examples of chemical properties of two fields in each land type. Apparently, Class I land, which is supposed to be the most productive, may have a problem of soil acidity or may be low in a certain nutrient, but soils in the lower classes are generally poor in all the characteristics. These heterogeneities complicate the assessment of nutrient inputs at the field level.

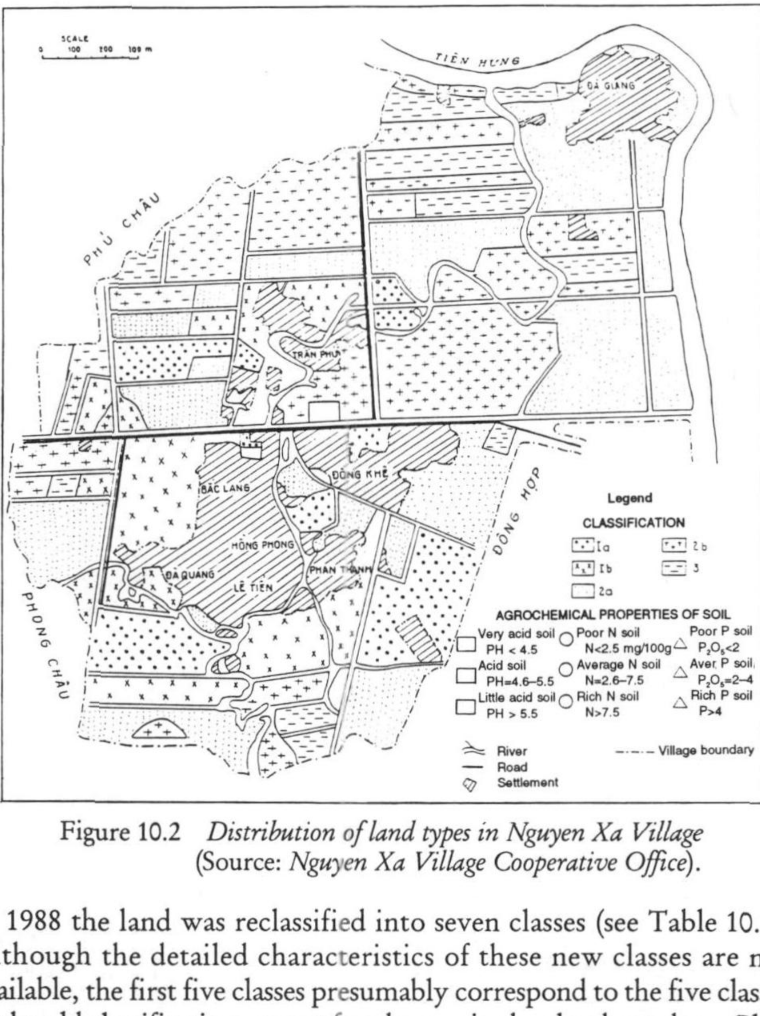


Figure 10.2 *Distribution of land types in Nguyen Xa Village* (Source: *Nguyen Xa Village Cooperative Office*).

In 1988 the land was reclassified into seven classes (see Table 10.2). Although the detailed characteristics of these new classes are not available, the first five classes presumably correspond to the five classes in the old classification, except for changes in the class boundary. Class VI includes lands newly developed from old Cooperative stables, yard ground, and grave mounds. Class VII is a small area near the river on the northern border that is designated only to subsidiary crops.

Table 10.3 shows the target productivity of the different land classes in terms of rice yield for the spring and fall seasons, as described to us by a Village Cooperative officer. But in interviews with the farmers, we found that there was relatively little correlation between the land classes and rice yields obtained, as farmers put more manure and fertilizers on poor land. Therefore, farmers with poor land are putting more labor and capital into their fields.

Table 10.1 Examples of Chemical Properties of Soils in the Different Classes (old classification system)

Soil Class	Field No.	pH (1–3)[1]	N (1–3)[2]	P (1–3)[3]	Organic Matter (1–3)[4]	Total Area (ha)
Ia	1st	2	1	3	1	35.19
	2nd	1	2	1	2	
Ib	1st	3	2	2	1	45.00
	2nd	2	1	2	1	
IIa	1st	2	3	3	1	78.00
	2nd	2	1	3	1	
IIb	1st	2	2	2	2	117.80
	2nd	3	2	3	2	
III	1st	2	3	2	3	26.60
	2nd	3	3	2	3	

Source: Nguyen Xa Village Cooperative Office.

[1] pH: 1 = >5.5; 2 = 4.6–5.5; 3 = <2.5

[2] N (mg/100 g soil): 1 = >7.5; 2 = 2.6–7.5; 3 = <2.5

[3] P (mg P_2O_5/100 g soil): 1 = >4; 2 = 2–4; 3 = <2

[4] Organic matter: 1 = high; 2 = medium; 3 = low

Table 10.2 Areas of Land in the New Classification[1]

Class	I	II	III	IV	V	VI	VII	Total
Area (ha)	50.0	100.0	70.0	60.0	20.0	3.0	2.4	305.4
Percentage	16.4	32.7	22.9	19.6	6.5	1.0	0.8	100.0

Source: Nguyen Xa Village Cooperative Office.

[1]Actual descriptions of soils in the different classes are not available.

Table 10.3 Productivity of Different Land Classes in Terms of Rice Yield

	Farmers' Yield (ton/ha) [kg/*sao* in brackets]		Yield Used as a Basis for Taxation (ton/ha) [kg/*sao* in brackets]	
Land Class	Spring	Fall	Spring	Fall
I	6.93 [250]	6.09 [220]	4.02 [145]	3.46 [125]
II	5.54 [200]	5.26 [190]	3.74 [135]	3.19 [115]
III	4.99 [180]	4.70 [170]	3.46 [125]	2.91 [105]
IV	4.16 [150]	3.87 [140]	3.19 [115]	2.63 [95]
V	3.60 [130]	3.32 [120]	2.91 [105]	2.35 [85]
VI and VII	2.77 [100]	2.49 [90]	1.39 [50]	0.83 [30]

Source: Nguyen Xa Village Cooperative Office.

According to the Village Cooperative Officer, soils in Nguyen Xa Village have loamy texture with variation ranging from heavy loam to light loam. Heavy loam soils are located in the depressions and are classified as "poor" soils because of high acidity. Farmers also informed us that low-lying fields have more acidity problems than higher elevation fields. The medium loam and light loam soils are located on higher ground and are classified as "good" soils but may be considered "poor" soils if the top soil is shallow. For these two texture types, there is a higher proportion of poor soils in De Giang, Tran Phu, and Dong Khe hamlets, and a higher proportion of good soils in other hamlets.

NUTRIENT INPUT AND OUPUT AT THE VILLAGE LEVEL

Although Nguyen Xa Village is not a completely closed system in terms of nutrient flows, it has a high degree of internal recycling (Figure 10.3). The principal nutrient inflows are atmospheric nitrogen carried by rain or fixed by nitrogen-fixing plants, sediments carried in flood water or irrigation water, and chemical fertilizers. Azolla is the only nitrogen-fixing plant worth considering here, although its use has greatly declined in recent years; other nitrogen-fixing plants are negligible. Floods no longer occur in Nguyen Xa Village. Sediments carried in irrigation water represent a small inflow of nutrients to the fields, estimated to be 80 kg/ha/yr (see Chapter 9). The silt contains 0.65 mg N, 1.17 mg P_2O_5, and 1.06 mg K_2O/100 g (Tran Duc Vien 1991). The amount of atmospheric nitrogen deposited by rain is unknown but is unlikely to exceed 10–15 kg/ha/yr.[1] Chemical fertilizers are the major source of nutrient inflow into the village system. In 1990, the Village Cooperative brought in 70 t urea, 150 t superphosphate, 10 t potassium chloride, 50 t NPK compound fertilizer, and 20 tons lime. Farmers also purchased fertilizers and lime directly from the market, the amount of which is unknown but may be considerable.

The major outflow of nutrients is through rice grain. Rice production statistics for 1981–89 show annual paddy production ranging from 2,721 to 3,227 t/yr, except in 1986 in which production was only 2,171 t. We took 3,000 t paddy/yr as a rough figure of average annual production. One major outflow of rice is through tax payments to the central government, which in 1990 amounted to 198 t of paddy. Export of processed food products is also a major outflow. According to the

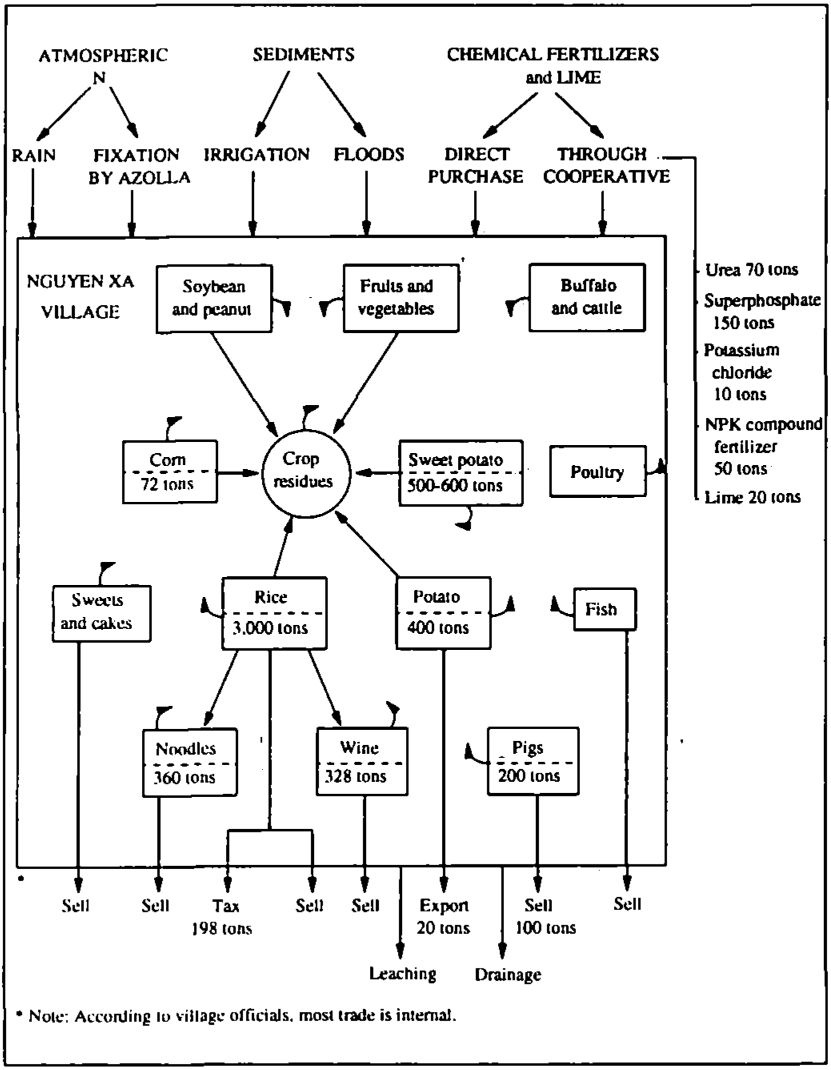


Figure 10.3 *Nutrient flows in and out of the Nguyen Xa Village system.*

Village Cooperative Office, 100 households in the village produced noodles for sale. Each household uses about 10 kg of paddy/day, or 3,600 kg/yr. This amounts to 360 t of paddy/yr for the 100 households. Wine making is also another important enterprise, taking a total of 328 t of paddy/yr (130 households, 7 kg/household/day, or 2,520 kg/household/yr). The population of Nguyen Xa Village is a little over 6,500. If each person consumes 300 kg of paddy/yr, this would amount to 1,950 t/yr. Considering other uses such as rice kept as seed, used for sweets and cakes, and for animal feed, the amount remaining for direct sale was estimated to be small.

Another major outflow of nutrients is through pigs sold out of the village, which amounts to about 100 t/yr. Other outflows are considered minor. Essentially, all crop residues and manure are recycled within the village.

Comparing the inflows and outflows of nutrients from the village system qualitatively, we believe that the balance, whether positive or negative, would be relatively small. Thus, under present conditions, the village system appears able to maintain its nutritional base of production. Such a balance is maintained through the introduction of a substantial amount of chemical fertilizers, which is quite vulnerable in terms of long-term sustainability. How long such a balance can be maintained is certainly a key question.

NUTRIENT INPUT AND OUTPUT AT THE PADDY FIELD LEVEL

For purposes of this analysis, we divided the paddy land into four types, based on cropping pattern and rates of manure and fertilizer application: (1) two rice cropland with "good" soils, (2) two rice cropland on "poor" soils, (3) three cropland (two rice crops and a subsidiary crop), and (4) land for rice nurseries.

We have omitted the rice nursery land in the analysis, as the total area is small and these fields normally receive additional manure and fertilizers apart from those applied to the crops that follow. Unfortunately, the land classification map was made available to us only after we interviewed the farmers. It did not make much difference to our analysis, however, as the classification was based on the composited index of several parameters and did not appear to correspond closely with fertilizer use.

Farmers heavily apply manure to their fields and also add more chemical fertilizers. Pig manure compost and night soil are the two main types of manure used by every household. Some farmers who own or share buffalo or cattle also have access to buffalo or cattle manure. Pig manure compost is made by putting rice straw into the pig pen as bedding everyday, then collecting the bedding and manure for use in the fields. Sometimes farmers also put grasses, rice husks, and tree leaves in the pig pen. The manure is accumulated daily and is taken to the fields twice a year for application to the spring and winter crops.

To compost night soil, farmers put ash in the latrine to mix with human excrement. Some farmers put ash in everyday, but some put it in only every two to three days. Only ash from rice straw or plant materials is used; ash from coal is used for construction or put on the road. Because a much lesser quantity of night soils is produced than pig manure, farmers prefer to use night soils for winter subsidiary crops (particularly potatoes) and rice nurseries. Night soil is applied to rice only when there is excess, or on spots with poor plant growth.

Buffalo or cattle manure is collected only from stables where animals are kept at night. We observed buffalo manure on the roads, and no one appeared interested in collecting it. The manure is collected every morning and is put into a pit near the stable. Straw left over from animal feeding is also put in the pit. When about 1 t of manure and straw is accumulated, soil is then put on the top to cover the compost. Some farmers who share a buffalo or cattle take turns in collecting manure, which they keep in separate pits, whereas others let the family who takes care of the animal keep all the manure. A few farmers also add 20 kg superphosphate and 40 kg rice husk to 1 t of manure in the pits. Buffalo and cattle manure is used the same way as pig manure.

A few farmers make compost from pig or buffalo/cattle manure by mixing 1 t manure with 20 kg lime, 20 kg superphosphate, 3–4 kg potassium chloride, 50 kg rice husks, and 200 kg dry mud and keep the manure for 3–4 months before taking it to the fields.

Essentially, Sesbania is not planted for green manure because farmers have limited land and do not want to lose any part of it to "nonproductive" activities such as tree growing. Many farmers, however, use green manure by taking weedy grasses, wild Azolla, cultivated Azolla, and sometimes sweet potato vines and peanut plants, piling them in the fields, and covering them with soil. This type of green manuring is done only for the fall rice crop, not for the spring crop, because the weather before planting the spring crop is cool and unfavorable for decomposition of the grasses. The practice was quite evident during the village visit.

Chemical fertilizers and lime are obtained from the Cooperative or purchased from the market. The fertilizers used are urea for nitrogen, superphosphate (20% P_2O_5) for phosphorus, and potassium chloride for potassium. We also observed a farmer carrying limestone to make lime. Apparently some farmers made lime by burning the stones and spraying water on them.

The following rates of manure and fertilizer applications are recommended: for spring rice, 8.3–13.85 t manure, 166–222 kg urea, 416 kg superphosphate, and 83 kg KCl/ha;[2] and for fall rice, 8.3–13.85 t manure, 11–139 kg urea, 277 kg superphosphate (or 277 kg of NPK compound fertilizer), and 83 kg KCl/ha.[3] Farmers, however, apply manure and fertilizers differently, varying from farmer to farmer and from field to field. Generally, farmers apply a higher rate of manure and also put lime in the fields with poorer soils or with soil acidity problems. Some farmers add night soil in spots with poor plant growth; others may use night soil to replace part of the manure for the fall rice crop, if they do not grow a subsidiary crop or the three crop areas are small and there is extra night soil.

Farmers normally apply night soil to their potato crop, and animal manure to their sweet potato crop. If there is insufficient night soil, however, they will add manure to the potato crop. If there is extra night soil, they may apply it to the sweet potato crop. Generally, nitrogen fertilizer is applied to both potato and sweet potato, but only some farmers apply phosphorus fertilizer to the two crops. Among the farmers interviewed, no one applies potassium fertilizer to these crops.

All the crop residues are removed from the fields. Rice straw is cut at the base close to the soil surface. Essentially all of these crop residues, however, are recycled into the field one way or another. Rice straw is used for making compost, for fuel, for buffalo and cattle fodder, and a small amount is used for making house roofs. The ash from rice straw is used for composting night soil. Rice husks are used for compost, and rice bran is fed to the pigs (being recycled as manure). Fresh potato and sweet potato vines are used for pig fodder, and dry vines are used for making compost. The majority of the products from these three crops are recycled into the fields through animal manure or night soil. Even though it may appear that all the plant biomass, except roots, are removed from the fields, they are later recycled in a different form. As previously discussed, only some parts are taken out of the system at the village level.

Figure 10.4 shows the nutrient flows between the two rice crop fields and the household, and other subsystems in the spring and fall cropping seasons. Although a similar diagram could also be drawn for the three crop fields, it would be a bit more complicated.

We estimated the amount of the variables carrying nutrients in and out of the two rice crop fields with good and poor soils (Figure 10.5) and the three crop fields with potato and sweet potato as the third crop

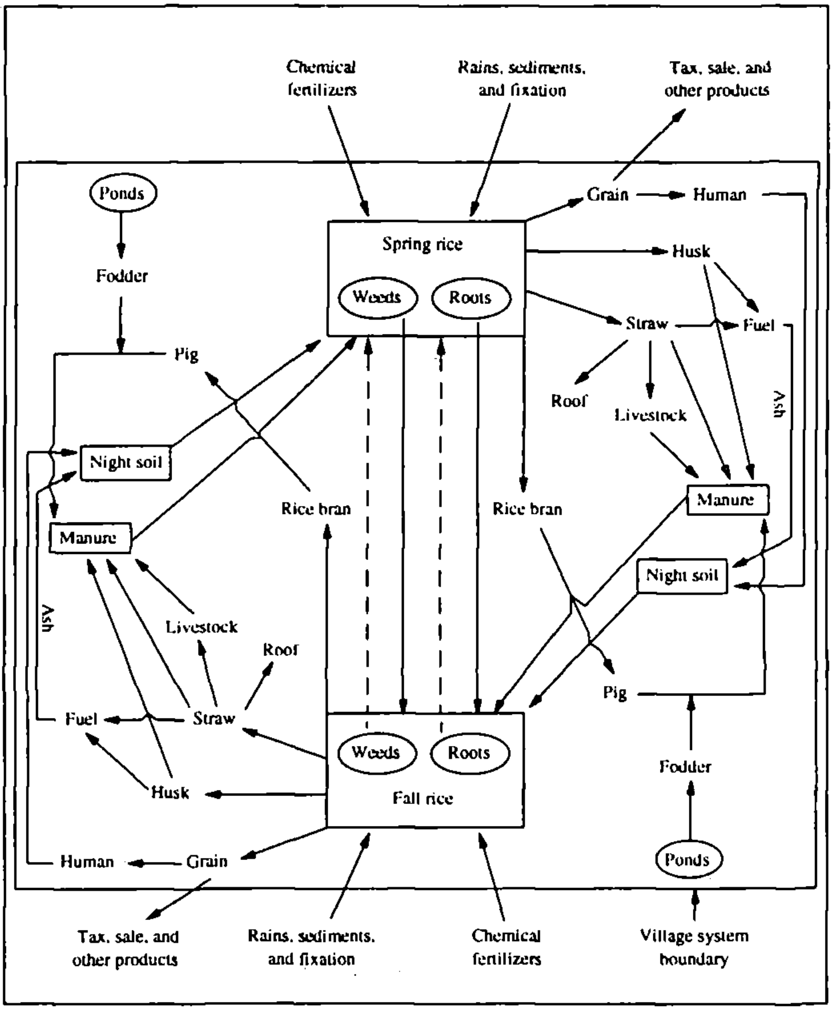


Figure 10.4 *Nutrient flows between double-cropped rice fields, households, and other subsystems (spring and fall).*

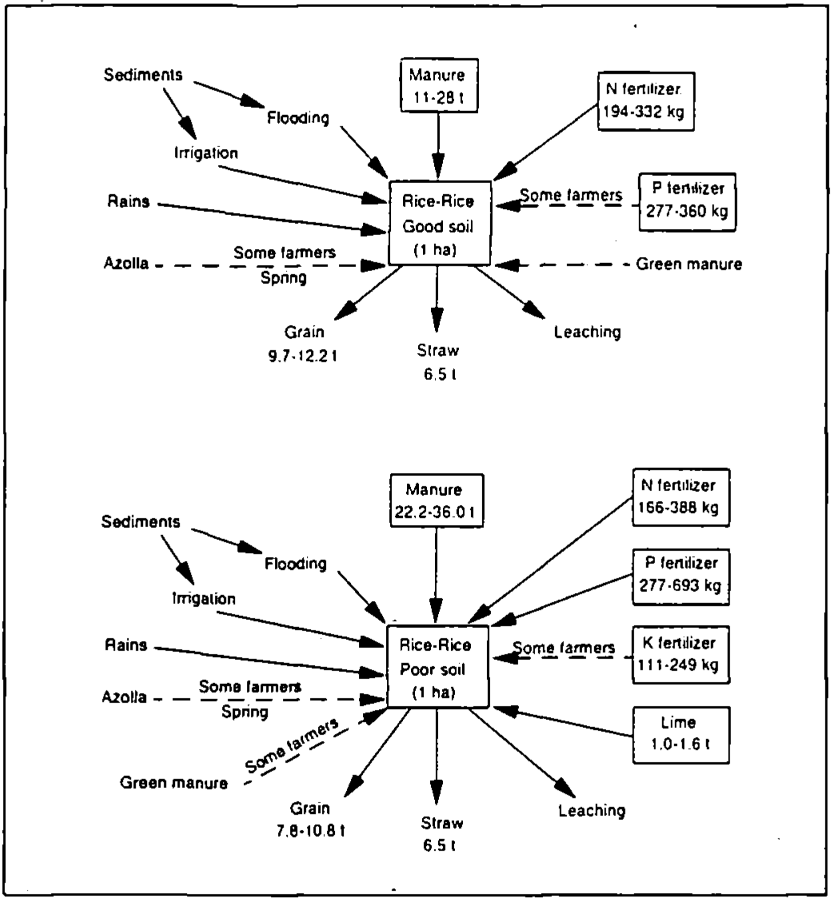


Figure 10.5 *Nutrient flows, double-cropped rice fields with good and poor soils.*

(Figure 10.6). Admittedly, these figures are preliminary as they were based on information obtained from interviewing a few farmers. The land allocation system allows each family several pieces of land to cultivate; some are as far away as 3 km from home. The distance of the field from home, and particularly from the transport route by which the manure can be carried by cart or bicycle, has an influence on the amount of manure applied to the field. Several farmers also complained that they did not have enough manure, because their land is small and not enough rice straw could be produced. Soil quality also varies from field to field, and farmers must adjust the rate of manure and fertilizer application according to their available resources. Thus, more detailed data are needed to arrive at reliable estimates. Nevertheless, the results

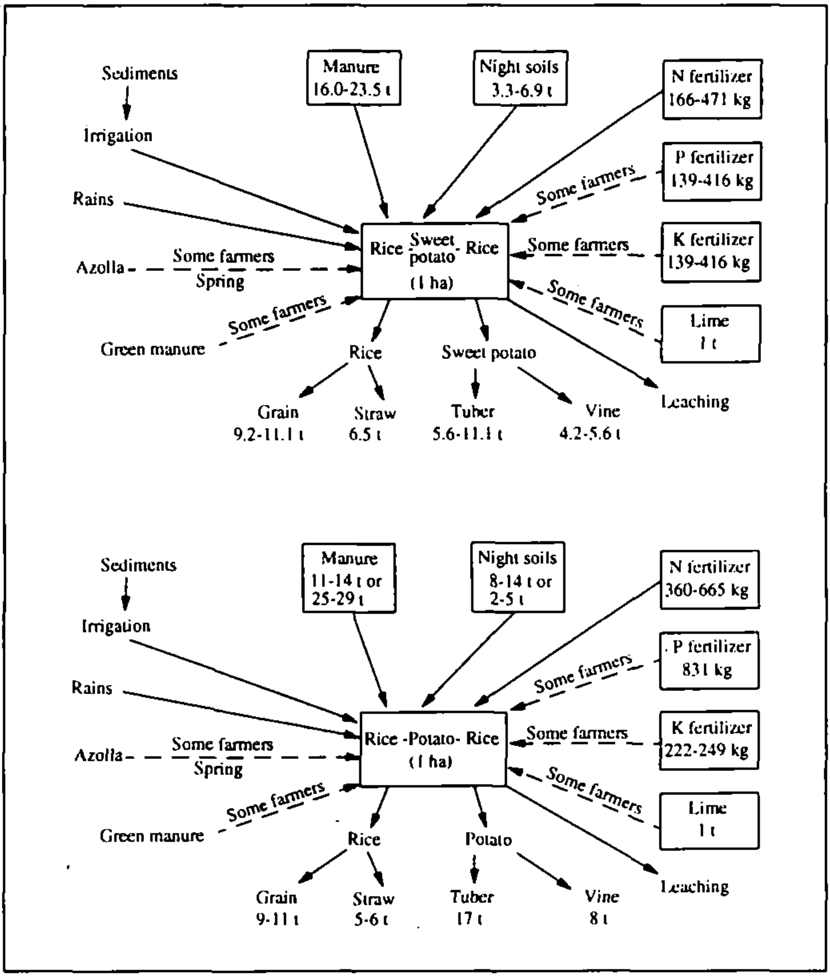


Figure 10.6 *Nutrient flows, triple-cropped fields (two rice and a third crop).*

should give an idea of the situation prevailing in Nguyen Xa Village.

Comparing the total input and output of nutrients in these land types, we assessed that the differences were small for all the land types. Negative balance, if there is one, would be more in the two rice crop fields with good soils, because some of those fields received less manure and fertilizers. For example, some fields of the farmers we interviewed received only 11 t (400 kg/*sao*) manure and 194 kg (seven kg/*sao*) urea/ha for the two rice crops, whereas 12,188 kg grain/ha (440 kg/*sao*) and 6,510 kg straw/ha (235 kg/*sao*) were removed. Nevertheless, the manure rate of 11 t/ha is still relatively high by general standards of fertilizer input in these types of systems. Thus, we concluded that, with the farmers' current soil management practices and current production levels, soil nutrients have been maintained at a more or less equilibrium status, and the land should be able to support the current level of production for a long time.[4]

NUTRIENT FLOWS AMONG SUBSYSTEMS AND OUTSIDE SYSTEMS

Figure 10.7 summarizes the nutrient flows among subsystems within the village system and between the village and outside systems. Most of these flows have already been discussed, and the remainder is largely self-explanatory. The diagram clearly shows the effectiveness of the nutrient flows among subsystems within the village, resulting in an efficient recycling of nutrients to the fields. It should be emphasized that a major component in the nutrient recycling pathway is pig raising. Any change that would cause a decrease in the level of this enterprise would also break the nutrient cycle, thus posing a major threat to the sustainability of the system unless some alternatives could be found to compensate for such a loss.

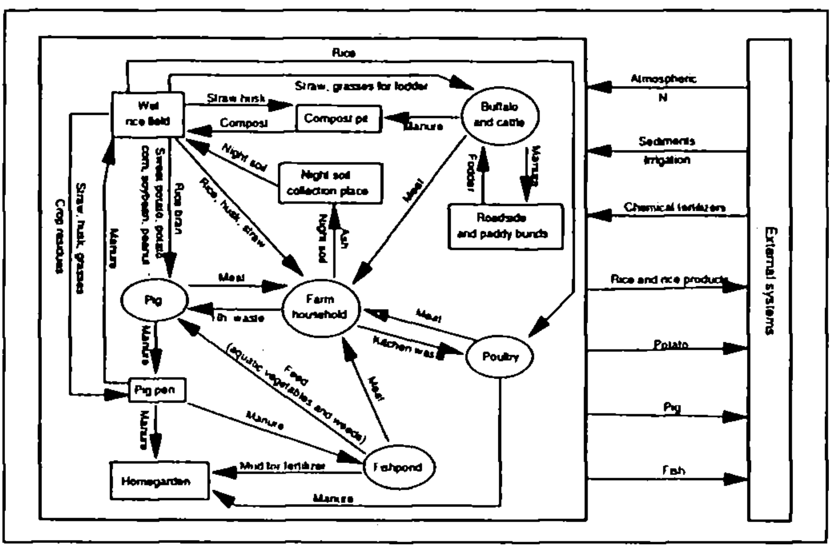


Figure 10.7 *Nutrient flows among village subsystems and between village and outside systems.*

CONCLUSIONS AND KEY QUESTIONS

It appears that under the situation of limited land and intensive cropping, Nguyen Xa villagers have done very well in managing soils. They apply a large quantity of manure, as well as chemical fertilizers. Nutrient recycling is very elaborated; just about everything possible is recycled to the field one way or another. With these practices, farmers have been getting high crop yields. The village system is relatively closed with regard to the nutrient flows in and out of the system. Our assessment indicates a close balance between inflow and outflow of nutrients both at the village level and the field level; the differences, if any, are expected to be small. The only case in which there might be a relatively larger negative balance is in the two rice crop fields with good soils, which receive lesser amounts of manure and chemical fertilizers, but this only occurs in some fields. It appears that, under the current practices and conditions, the land resource of Nguyen Xa Village would be able to sustain the current production level for a long time.

In the future, the situation is unlikely to be the same. The population will continue to increase. Although attempts are being made to create employment opportunities in the nonagricultural sector, the majority of the people are expected to still depend on agriculture for their living. The trend in what is called "modernization" will also create a greater demand for items that are currently considered unnecessary. These issues point out a pressing demand for further increases in production. At present, the land resource of Nguyen Xa Village appears to have been used to near its maximum capacity. Such considerations lead to the first key question.

Key Question 1: How much more increase in production can the land resource of Nguyen Xa Village support?

Although currently the agroecosystem seems to be operating at a near balance level of nutrient input and output, nutrient recycling also appears to occur at its maximum level. Further increases in production will increase the nutrient outflow from the field.

Key Question 2: Apart from increased use of chemical fertilizers, what means could be employed to balance the nutrient inflows to crops with the increased outflow, so that the increased production will not threaten the long-term sustainability of the land resource?

In this regard, the use of Azolla may be worth re-examining. It appears that the use of Azolla in Nguyen Xa Village was widespread in the past, but has greatly declined recently.

Key Question 3: What are the reasons for declining use of Azolla in Nguyen Xa Village, and what means could be employed to overcome these constraints?

The nutrient recycling system in Nguyen Xa Village has evolved to maintain a relatively balanced inflow and outflow of nutrients. This highly integrated system is also vulnerable to linkage breakdown against rapid changes in socioeconomic conditions. Although the changes will certainly be unavoidable, attempts should be made to maintain the important components in the nutrient recycling pathway.

Pig raising plays an important role in nutrient recycling. Any change that could cause a decrease in this enterprise will also break the nutrient recycling pathway and could pose a threat to the long-term sustainability of the land resource. Some farmers have already complained that their pig raising operates at a loss, except for the value of manure gained for crop production. If the cost of pig raising rises (costs of food, labor, or lower prices for sale of pork or pigs), this could decrease the value of pig raising to farmers sufficiently for them to cut back on this activity, despite their need for manure.

Key Question 4: How can pig raising in Nguyen Xa Village be maintained or even increased, and what incentives could be provided for pig raising?

It is well known that heavy use of agricultural chemicals and night soils causes soil and water pollution, which, in turn, leads to human health problems. Although farmers have long been using manure, night soil, and agricultural chemicals at a heavy rate, the degree of severity of soil and water pollution was not determined by our team.

Key Question 5: What is the current status of soil and water pollution in Nguyen Xa Village, and how can it be reduced?

It was evident from our investigation that manure and fertilizer use in Nguyen Xa Village varies from farmer to farmer and from field to field. Although our investigation points out some of the reasons, it is important to have a clear understanding of those reasons and the constraints that farmers face in maintaining the nutritional status of their soils for long-term sustainability.

Key Question 6: What are the current manure and fertilizer uses in the different land classes and soil types, and what are the main constraints to long-term maintenance of soil productivity?

As mentioned earlier, changes in socioeconomic conditions will be unavoidable and may result in changes of soil fertility management by farmers. Thus, it is important to monitor these changes when they occur and assess how they will affect the long-term sustainability of land productivity so that appropriate intervention can be employed if needed.

Key Question 7: How can the changes in soil fertility management by farmers be monitored and their effects on long-term sustainability of land productivity be assessed?

With rapidly increasing population levels, despite population control measures, production levels will have to increase simply to meet subsistence demand. In addition, expected increases in people's desire for modern services and commodities will result in a need to increase production levels still further to provide a surplus for exchange. Increasing production levels, however, will be difficult as the land has already been used to near its capacity. The system also depends heavily on nutrient recycling. Any change that would break the nutrient cycle would have detrimental consequences. The dependency of the system on imported chemical fertilizers also makes the system vulnerable. Thus, although the agroecosystem is sustainable as it currently exists, it stands at risk of unsustainability.

Key Question 8: How can farmers in Nguyen Xa Village become more capable of adapting themselves to the rapid changes in socioeconomic conditions and be able to maintain the quality of the land for the benefit of their descendants in future generations?

Endnotes

1. According to Angladette (1966:208), rainwater deposits 16 kg of N/ha at Hanoi.

2. Per *sao*, this is 300–500 kg manure, 6–8 kg urea, 15 kg superphosphate, and 3 kg KCl.

3. Per *sao*, this is 300–500 kg manure, 4–5 kg urea, 10 kg superphosphate or NPK, and 3 kg KCl.

4. A much more detailed study of nutrient flows in paddy fields in Nguyen Xa was conducted by a team of scientists from CRES, Agricultural University No. 1, the East-West Center, and the University of Hawaii in June 1992 (Patanothai 1992). The study confirms that most nutrients are in essential balance, although potassium appears to be withdrawn from the soil at a faster rate than it is replaced.

11. PROSPECTS FOR SUSTAINABLE DEVELOPMENT IN THE VILLAGES OF THE RED RIVER DELTA

A. TERRY RAMBO
LE TRONG CUC

The critical question to which we now turn is that of the future course of rural development in the Red River Delta. Can the very real gains achieved in living standards of the majority of peasants over the past 40 years be maintained in the long run? Can further economic growth be expected in the countryside in future years?

There are no simple answers to these questions. Nguyen Xa's development prospects, and those of the several thousand similar villages in the Red River Delta, are determined by a complex set of factors. These include questions of political economy, moral economy, and material economy.

THE POLITICAL ECONOMY

The character of the economic development policies adopted by the Vietnamese government and the degree of success it achieves in actually implementing new policies in the villages will strongly influence the course of rural development. This reflects the fact that much of what happens in the delta's villages occurs in direct response to external political and economic forces. The ongoing process of *doi moi* (national renovation), especially reforms in economic policy, has created a favorable environment for entrepreneurial activities in the countryside. Adoption of the household management system and introduction of the market mechanism for agricultural commodities have resulted in increased productivity and a much greater flow of foodstuffs into commercial trade channels. Centrally imposed administrative constraints on the freedom of farmers to make their own decisions about land use and residual distortions in the price structure of agricultural commodities may still act as a restraint on agricultural output. Continuation of the reform process may thus result in some further gains in production.

Changes in the macro-environment may also threaten agricultural sustainability. Especially worrisome is the prospect of cutbacks in the national rice-breeding program and the agricultural extension system being forced by the continued government budget deficit. Price increases on the world market for essential inputs, especially chemical fertilizers, could have a devastating impact on farm economies.

These and other questions of political economy are of great importance. Selection of appropriate economic policies is absolutely critical. But it should also be recognized that national policies, however enlightened they may be, have only limited power to transform constraints placed on rural development by social and cultural, demographic, resource, and environmental factors (Nguyen Manh Hung, Jamieson, and Rambo 1991; Jamieson, Nguyen Manh Hung, and Rambo 1992). We now turn to these latter factors that are all too often ignored or scanted in discussions of development policy.

THE MORAL ECONOMY

The farmers of the delta are not perfect economic men, operating wholly in terms of the logic of cost-benefit analysis. Although their economic decision-making displays a high level of rationality, they make their choices within a social and cultural context that is but poorly understood by outsiders. They are active participants in a complex social system. Their behavior is conditioned by cultural values that have evolved over centuries of historical experience. Thus, in assessing the probable behavior of the delta villagers, one must keep in mind their unique historical experiences—the past as they remember it, the present as they experience it daily, and the future as they anticipate it to be.

Nguyen Xa Village, like most villages in the delta, has a long history—one that remains vivid in the memories of its inhabitants. Signs of remembrance are encountered frequently: The first artifact shown to our visiting team by the village officials was a carefully painted battle map displaying how the local militia had repulsed an attack by a French armored group during the Resistance War. A large statue memorializing the guerrilla fighters of that war stands in front of the history museum directly across the road from the village offices. Immediately adjacent to the village is the district military cemetery with its seemingly endless rows of graves. Villagers see these symbols daily and are reminded of their collective sacrifices in the struggle against colonialism.

No monuments are needed to remind elders of the difficult life led by most peasants in the colonial period. The poor peasants—who constituted an absolute majority of the delta's population before 1954—lived on the very margin of human existence. A single bad harvest or an accident or illness was sufficient to destroy the means of survival for entire families. Their condition is well documented in careful empirical studies by French social scientists, notably Pierre Gourou's monumental *Peasants of the Tonkin Delta* (1936). Hy Van Luong's *Revolution in the Village* (1992), an ethnographic reconstruction based on oral histories collected in a village on the margins of the delta, describes in vivid detail the hardships of life before the revolution as remembered by poorer strata of village society. Above all else, memories of the terrible famine of 1945 continue to shape the elders' perceptions of current realities. In 1992, while interviewing farmers in a remote Dzao hamlet 250 km to the west of Nguyen Xa, we encountered men whose parents had given them to the mountain people to adopt rather than leave them to starve in Thai Binh. Whatever the shortcomings of the present system may be, they pale into insignificance against the harsh memories of the past.

Inevitably, however, memories of life in the colonial period are fading. Only those over age 50 personally experienced colonialism. Thus, to an ever-increasing extent, memories of the past are memories of life as lived since independence. Again, it appears that for most villagers, life is perceived as steadily getting better, especially since implementation of management reforms in the early 1980s and adoption of market mechanisms in 1988. On the average, people work harder than they did during the period of extreme cooperativization. However, they see improved returns to their labor in the form of considerably increased yields, higher retention of earnings by households, and greatly increased supplies of consumer goods that can be purchased with their surplus income. The many two-storied concrete houses built since 1988 offer visual evidence of increased household affluence. There are, of course, some households and individuals who are doing less well, at least in relative terms, than before the reforms. But so far, the disadvantaged represent a small minority whose basic needs are still met by the Cooperative's social welfare system.

Maintaining mechanisms of solidarity remains an important objective for many villagers, even though the current emphasis is on acquisition of wealth by individual households. Attempts to further "rationalize" agricultural production by converting rice fields to private ownership and consolidating plots into larger, more efficient holdings, however desirable such measures might be from an economic perspective, are unlikely to win wide acceptance. The moral economy thus constrains the future course of development within the existing framework of an agrarian system dominated by micro-scale subsistence-oriented family farms. This system has demonstrated its ability over the centuries to support the delta's dense peasant population.

THE MATERIAL ECONOMY

To the eyes of an outside observer, the most striking aspects of Nguyen Xa are its incredibly dense population, the intensity with which resources are managed, and the lack of diversity in the natural environment. That these factors are causally linked is clear. The high population density forces humans to exploit every possible resource to the maximum extent possible; as a result the natural environment has been irremediably altered and biological diversity reduced to the lowest level imaginable. These factors together interact to determine the sustainability of the agricultural system and to limit its potential for further development.

The Demographic Dilemma

It is extreme population pressure on limited natural resources that more than any other factor constrains the development prospects of the delta. The need to provide food for its vast peasant population under hyperdensity conditions already necessitates that every potentially arable plot of land be intensively cultivated to meet current grain production needs. Yet population continues to grow despite family planning programs and government-sponsored resettlement of excess people into frontiers. The rate of increase is slowing but, even under the most optimistic projections, there may be as many as one-third more stomachs to fill before growth is stopped 20 years from now. The current agricultural system cannot adequately support that many more consumers.[1]

The Nguyen Xa Village agroecosystem currently yields sufficient grain to meet the basic caloric subsistence needs of its human population. If the average annual rice yield of 2,851 t/paddy/yr for the village were to be divided equally among the resident population, each person would receive 292 kg of husked rice.[2] This is almost 100 kg in excess of the minimum nutritional requirement of 200 kg.[3] Even at the very low level of production achieved in 1986, there were 223 kg of rice/capita. In the best year, 1989, there was a healthy surplus, with 316 kg of rice available for each person. Maintaining the supply of rice at these levels is an impressive achievement, given the scarcity of land and frequent occurrence of environmental calamities.

Aggregate production data reveal little about the actual nutritional state of individuals, however. It is a commonplace of writings on the political economy of food in Asia that total supply is rarely the cause of shortages at the household level; instead, inequitable distribution among regions and individuals is the root cause of malnutrition and famine. This was certainly the case in the famine of 1945 (Nguyen The Anh 1985) and also seems to have been true in 1988 for the severe food shortages that affected Thanh Hoa Province and reportedly led to some deaths from starvation in remote areas there. Nguyen Xa has achieved a remarkable level of equitability in land distribution among households, but real differences in resources and wealth are still evident. Analysis of village records on landholding, production, and taxes for a sample of ten households shows that there is considerable variation among households in rice production on a per capita basis (Table 11.1). No household fails to satisfy its minimum nutritional requirement in years of average harvests, but in years with very poor harvests a few households appear unable to produce enough rice to feed themselves. Potatoes and maize from the winter catch crop presumably make up for the rice deficit, but household yield data for these crops were not available. Some households also sell pigs or handicrafts to obtain cash to buy extra rice, as was the case in 1991, to make up for the very serious shortfall in the spring harvest. Reserve stocks from the village granary may also be used to help families suffering unusually bad harvests due to natural calamities. In years of major disaster, the government may also lower taxes.

Although rice production is currently sufficient to meet minimum nutritional requirements of the village population, productivity will have to be increased considerably in the next several years to keep pace with the demands of a growing population; otherwise, nutritional standards will undergo serious decline. Assuming that no major out-migration occurs, Nguyen Xa Village will increase over the next

Table 11.1 Per Capita Production of Rice (sample of 10 households in Doi Thuc Khang, Nguyen Xa Village)

H.H. No.	No. of Members	Land Area (m^2)	Yield Average Year (kg/ paddy)	Yield Worst Year (kg/ paddy)	Tax (kg/ paddy)	Rice Aval. for Consumption Average Year (kg/capita)	Rice Aval. for Consumption Worst Year (kg/capita)
1	5	4,956	5,551	3,816	1,284	563	334
2	2	1,956	2,191	1,506	449	575	349
3	4	3,144	3,521	2,421	657	473	291
4	3	3,036	3,400	2,338	625	611	377
5	3	2,556	2,863	1,968	677	481	284
6	4	1,824	2,043	1,404	352	279	174
7	7	3,552	3,978	2,735	665	312	195
8	3	1,896	2,124	1,460	396	380	234
9	3	2,052	2,298	1,580	478	400	242
10	6	3,588	4,019	2,763	731	362	224
Average	4	2,856	3,199	2,199	631	444	270

Notes: Household size, area of fields, and tax payments were taken from the village record book for 1990. Production in average years was estimated using village average yield for 1981–89 of 11,164 kg/ha. Production in worst year was estimated using 1986 village average yield of 7,679 kg/ha. Conversion ratio of paddy to rice is 0.66.

20 years by 1,930 people for a total population of 8,370. If present yield levels are maintained, rice supply will drop to 225 kg/person in average years. This provides almost no surplus with which to build reserves for years when yields are below average. In years with bad weather when yields drop to the low level achieved in 1986, only 171 kg of rice/person will be produced, representing a shortfall of 30 kg beneath minimum requirements.

PROSPECTS FOR BOOSTING AGRICULTURAL PRODUCTIVITY

Over the centuries, the farmers of the delta have brought their environment under ever more complete control. The productivity of the system has been greatly increased by improved water control and through introduction of new technology. High-yielding varieties and chemical inputs, along with better managed irrigation, have resulted in much higher yields. Life looks like it can only improve: As one farmer said, he trusted science to continue to solve all of their production problems. Based on their experiences of steady increases in production since 1954, this appears to be a reasonable extrapolation. But, unfortunately, the future rarely conforms to linear projections of present trends. In the case of Nguyen Xa, most of the yield potential of wet rice agriculture has already been achieved; there is little room left for improvement.

The paddy fields of Nguyen Xa Village are among the most productive in the delta.[4] The average yield for two crops exceeds 11 t/ha in favorable years, while the best fields under optimal conditions already reportedly exceed the estimated maximum yield potential for the Red River Delta of 15 t/ha (Dao The Tuan:n.d.). A recent study has found that farmers in Nguyen Xa are already achieving 80 percent of the yield that it is theoretically possible to achieve under their soil and climatic conditions, given the genetic potential of currently planted rice varieties (Patanothai 1992). There is no "yield gap" in this system since it is virtually impossible to improve this level of performance even in experiment stations.

The high level of agricultural performance in Nguyen Xa is confirmed by analyzing the energetics of the agroecosystem. When all of the outputs of the paddy fields are taken into account, production per hectare of economically useful energy is extremely high compared to any other known agroecosystem. In a year with optimal growing conditions, a well-managed 1-ha plot of first quality land might yield as much as 15.5 t/paddy and 14 t of potatoes, along with 6.5 t of rice straw for fuel and buffalo fodder and 5.6 t of potato vines for pig feed. This represents a total energy value of 93.9 million kcal/ha/yr.[5] Approximately one-half (47.8 million kcal) is edible by humans. The total energy yield of the village rice fields (9,400 kcal/m^2/yr) is extremely high when compared to those reported for other agricultural crops grown in monocultures elsewhere in the world: 4,500 kcal/m^2/yr for maize in the United States (of which the edible portion is 1,510 kcal), 5,500 kcal for rice in Japan (1,840 kcal edible), and 4,100 kcal for white potatoes in the United States (2,040 kcal edible). Only sugarcane grown on a year-round basis in tropical Hawaii achieves a significantly higher NPP of 12,200 kcal/m^2/yr, of which 4,070 kcal is edible by humans (Odum 1971:54, Table 3-9).

The paddy field ecosystem is so productive because it captures solar radiation and transforms it into economically useful energy with a very high level of efficiency. The delta receives an average of 1.1×10^6 kcal solar radiation/m^2/yr (Vien Khoa Hoc 1988:16), of which 9,386 kcal/m^2 is captured in economically useful products. This represents 0.8 percent of the total solar energy available to the system. Although sugarcane grown under optimum conditions in Hawaii achieves an efficiency of 4.8 percent during its peak growth period (Odum 1971:45, Table 3-4), its efficiency falls to 0.8 percent when averaged over a 12-month growing season. The average efficiency of fertile ecosystems on a worldwide basis is estimated as 0.5 percent and for the biosphere as a whole only 0.1 percent (Odum 1971:44, Table 3-3). It is therefore unlikely that the current rate of energy capture of the best managed paddy fields in the delta can be significantly increased.

THE QUESTION OF THE SUSTAINABILITY OF DELTA AGRICULTURE

Simply maintaining current production levels in future years is problematic. Agriculture is now highly dependent on imported technology in the form of seed, fertilizer, pesticide, and fuel for irrigation pumps. Farmers cannot be sure that needed inputs will always be available when needed. So far, development and propagation of high-yielding varieties have just about kept up with the ability of pests to adapt to them (Chapter 9). There is no guarantee that this will continue in the future. For now, farmers have ready access to chemical fertilizers and pesticides, but they must now pay world market prices for most inputs.

Because it is so intensively managed, the agroecosystem of Red River Delta is highly vulnerable to even minor perturbations. A change in a pest variety, a run of bad weather years, or a shortfall in the supply of chemical fertilizer could cause production to decline precipitously, perhaps even collapse. And in an area of such dense population, the consequences could be a Malthusian disaster. But the system need not undergo sudden total collapse. Intensively managed agroecosystems also suffer from gradual degradation—the effects of which only become evident over a term of years or even decades. Evidence from elsewhere in Southeast Asia indicates that land as intensively cropped as that of Nguyen Xa's paddy fields tends to suffer serious yield decline within about 10 years (Multiple Cropping Project 1980). Without carefully managed fallows, rotation of crops, and continued inputs of organic fertilizers, the soil could lose its capability to sustain high levels of production.

Changes in social factors may also reduce the productivity and sustainability of the agroecosystem. For instance, it is clear that taxation policy has distinct consequences for people's agricultural and environmental practices. We need more careful studies of the relations between tax policy, people's farming practices, and the consequences for the environment.

The social organization of production may also affect long-term agroecosystem performance. Unlike Vinh Phu Province in the Midlands (Le Trong Cuc, Gillogly, and Rambo 1990), in Nguyen Xa the delegation of production decisions to individual households has not resulted in labor shortages. First, there is more than sufficient labor in Nguyen Xa. Second, the villagers already have many traditional mechanisms for sharing labor, such as mutual aid societies. Like other delta villages, Nguyen Xa has a highly complex and very effective social system for regulating social relationships and addressing production problems. The social system is held in place by a web of kinship, social responsibility, and affection. In fact, the fledgling Cooperatives built upon such traditional forms of cooperation, with the goal of expanding their scale and making them more "rational." The Cooperative, in attempting to displace these traditional relations, was sometimes less effective than the older forms had been, because it made people's obligations to one another too diffuse, occurring on too large a scale. With the decline of Cooperatives, these traditional forms have revived, but were somewhat altered by the preceding decades. Thus, the village today appears very similar structurally to what it must have been before 1945. By having built on traditional forms, rather than introducing completely new forms of social organization, the Cooperative maintained the base for what is today still a complex and effective social system.

With the recent decline in the Cooperative's strength, the organization of inputs and management of resources are being adversely affected. For instance, Azolla and pig manure are very important to maintaining soil fertility. However, with privatization of land management, there is no area left to grow Azolla for the community. All farmers currently raise pigs, although most say that they do not make a profit from the sale of pork. They just break even—except for the manure, which is the main organic fertilizer for the rice crop. There is a danger, however, that should the cost of feeding pigs increase, or the selling price of pigs or meat decrease, farmers could decide not to raise pigs and thus deprive themselves of an essential input to the long-term health of this system. The Cooperative or some other similar organization is needed to monitor inputs so that beneficial practices do not fall before the force of the market. Some practices must be maintained for sustainability of the system, even if not immediately profitable to individual farmers and their households.

Similarly, there is currently heavy overuse of common resources, such as roadside grazing areas or trees planted along roads and lanes. Aside from the resulting degradation, this also means that there are no mechanisms for improvement of these resources. The community and each individual farmer would benefit greatly if pasture could be improved. Similarly, planting of trees as windbreaks and sources of fuelwood could be of great value to all villagers. Such strategies can only be implemented, however, if effective social mechanisms are in place to control access to these resources. No such mechanisms currently exist in village society.

STRATEGIES FOR RURAL DEVELOPMENT IN THE RED RIVER DELTA: INVOLUTION, TRANSFORMATION, OR EVOLUTION?

The development strategy traditionally employed by the Red River Delta peasants has been labeled by Clifford Geertz (1963) as "involutionary." As population densities have increased, adaptation has taken the form of ever-greater intensification of wet rice agriculture. Higher yields per hectare are traded off for lower yields per hour of labor. Intensified management is substituted for the more abundant time and space that make land extensive systems productive with minimal human inputs. As Geertz (1963:35) describes the process with reference to peasant agriculture in Java:

> In addition to improving the general irrigation system within which the terrace is set, the output of most terraces can be almost indefinitely increased by more careful, fine-comb cultivation techniques; it seems almost always possible somehow to squeeze just a little more out of even a mediocre sawah [wet rice field] by working it just a little bit harder. Seeds can be sown in nurseries and then transplanted instead of broadcast;

> they can even be pregerminated in the house. Yields can be increased by planting shoots in exactly spaced rows, more frequent and complete weeding, periodic draining of the terrace during the growing season for purposes of aeration, more thorough plowing, raking, and leveling of the muddy soil before planting, placing selected organic debris on the plot, and so on; harvesting techniques can be similarly perfected . . . . Double cropping and, in some favorable areas, perhaps triple cropping can be instituted. The capacity of most terraces to respond to loving care is amazing.

For many centuries, the delta peasants successfully followed the involutional strategy. The human costs were immense, but the village system survived and replicated itself despite the increasing immiserization of much of the rural population. Following independence in 1954, the government sought to transform the traditional village-based agroecosystem into a larger scale "industrial–agricultural economic structure" (Vo Nhan Tri 1990). This new system was intended to employ an adaptive strategy relying on continuous capital-intensive technological innovation. Under this "transformational" strategy, massive efforts were made to expand irrigation systems, mechanize cultivation, employ chemical fertilizers and pesticides, and develop and disseminate high-yielding crop varieties. This attempt at rural transformation was strongly manifested in Nguyen Xa Village where a comprehensive irrigation and drainage system was constructed that made double cropping possible on most village rice land. At the same time, reconstruction and expansion of the dike system by the district and provincial governments gave the village almost total security from the threat of flooding.

Promotion of technological innovation was accompanied by an equally massive attempt to transform the social relations and ideology of the peasantry (Ho Ton Trinh 1985; Hy V. Luong 1992). Private landownership was abolished and all land placed under the control of village Cooperatives. Decisions about optimum land use (e.g., alignment of irrigation channels) could now be made on purely technological grounds without concern for the impact of such projects on a multitude of individual plots. Labor could be mobilized in vast quantities to construct dikes, canals, roads, and other productive infrastructure. A network of agricultural research and extension services was established to provide plant breeding and pest control services to the Cooperatives. At the same time, nationwide campaigns were launched to eradicate illiteracy and inculcate scientific ways of thought. Particular stress was placed on dissemination of modern medical knowledge and practices. A primary health care system was established that made at least rudimentary treatment accessible to all villagers.

Initially, it appeared that the new transformational strategy based on continuous technological and social innovation had successfully displaced the traditional involutional strategy. A self-accelerating process of rural development seemed to have been put in motion in the delta (Nguyen Khac Vien 1964). But the initial evident success of the transformational strategy almost entirely reflected the short-term gains achievable by ideological mobilization and injections of foreign technical assistance. After only a few years, agricultural productivity stagnated with rice harvests in the mid-1970s at substantially the same levels that they had been in the late 1950s. In the 17 years from 1958 to 1975, the average yield per hectare reportedly increased by only 3.9 percent (Vo Nhan Tri 1990:18). Because population grew by 63.6 percent during this period, per capita supply of paddy actually dropped from over 300 kg in 1958 and 1959 to under 200 kg in 1971–75. Only a substantial increase in production of maize and tubers maintained staple supplies at above starvation levels.[6]

Rural transformation could only have been successful in the delta in the long term if Vietnam had been able to make the takeoff into a self-sustaining process of industrialization and technological development. Unfortunately, the attempt at forced draft industrialization was largely unsuccessful (Fforde and Paine 1987; Dang T. Tran 1991; Vo Nhan Tri 1990). The industrial and scientific bases needed to maintain continuous technological innovation have not materialized, and the foreign assistance that helped to create the illusion of successful development has now almost ceased. Vietnam remains a very poor agrarian-based economy. This economy cannot even generate sufficient income to maintain existing levels of social and technical services in the countryside, let alone support continuous technological innovation and infrastructure construction.

At the village level the response has been, in effect, to abandon the transformational strategy and to return to the involutional approach. The large-scale management structures have been dismantled or greatly reduced in power while control over land and other means of production has been returned to individual households. Once again, increased production is purchased at the cost of ever-greater human labor inputs. The notorious predilection of peasants to engage in "self-exploitation" is a major factor contributing to the success of the recent economic reforms.

Renewed involution is occurring in a different environment than the one that existed in the delta before the August Revolution, however. Although peasant society was not totally transformed, the physical and technical infrastructure supporting agriculture was greatly improved. There is no little irony in the fact that the recent gains in agricultural production that many Western economists attribute to privatization are possible only because of rural development projects carried out as part of the socialist attempt to transform rural society. Individual farmers managing "private" plots in Nguyen Xa Village obtain the high yields they do now because they work land served by a reliable irrigation system, protected from floods by a vast dike system, and planted with high-yielding varieties bred by a national agricultural research system.[7]

Although successful in the past, it must be asked if the involutionary strategy of adaptation can continue to function as effectively in the future. Ultimately, any agroecosystem has limits beyond which additional labor inputs or finer tuning of management cannot further boost yields. The Nguyen Xa Village agroecosystem is already close to those limits. Yet the human population that must be supported by the system continues to grow. Deepening poverty of the peasantry as a whole is one possible outcome if currently functioning redistributive institutions remain effective. If permanent privatization of land tenure displaces the current periodic redistribution of communal lands, however, the outcome is likely to be a society differentiated into a few relatively well-off households (those controlling sufficient land to ensure their subsistence) and many poorer, land-short households. Neither outcome, either that of broadly shared poverty or that of differentiation of village society into a few rich households surrounded by many poor neighbors, is desirable. The delta peasants have already been down both of those roads. Both lead to dead ends.

AN EVOLUTIONARY ALTERNATIVE

Is there an alternative development strategy that might lead to a happier outcome for the delta peasantry? In our view the best hope lies in employing an "evolutionary" development strategy. Such a strategy combines the effort to control population growth and reduce human pressure on resources with attempts to improve agroecosystem performance through fine tuning while diversifying non-farm sources of employment and income for the rural population.

Population Control

Population control deserves a very high priority. The government already supports a strong effort to reduce fertility that has enjoyed considerable success. More could be done, however, particularly by improving the quality of birth control materials and offering adopters a greater range of choices with regard to techniques. But even if the family planning program enjoys total success, it will still be many years before population growth comes to a stop, let alone before any reduction in population pressure might occur. Thus, encouraging outmigration would seem to offer one of the quickest and most effective solutions to the problem of overpopulation. Between 1954 and 1975, the Vietnamese government sponsored several large-scale programs to resettle people from the Red River Delta to the Midlands and mountains in the northwest. Since unification in 1975, many additional people have moved to the Tay Nguyen plateau and to the Mekong Delta in the south. Altogether as many as 2.5 million people have moved to the frontiers since 1954. Although the total population of the delta has grown despite this outmigration, densities in the most densely settled provinces have declined significantly. Before World War II, 295 villages, mainly in the maritime provinces of Nam Dinh and Thai Binh, had densities in excess of 1,500 persons/km^2 (Gourou 1936:154). Today, Nguyen Xa is the only village in the delta at that level.

The often excessive external costs of the resettlement program must also be considered. In essence, this program simply transfers the cost of the delta's overpopulation to another society and environment. The New Economic Zones are typically located in the Midlands or Highlands, areas which have traditionally been the home of non-Kinh ethnic minorities. They are not environmentally or socially similar to the delta. Where Kinh have been resettled, their agricultural practices have often led to severe environmental damage on the hills such as deforestation, severe soil erosion, and downstream flooding. Social costs are also incurred both by indigenous inhabitants and new settlers (Gillogly and Tuyen 1992).

Thus, although some sort of outmigration program must continue, more effort should be made to move delta people into environments that are more similar to what they already have experienced. By doing so, they will improve the area, rather than bring about rapid, unplanned, and often deleterious changes that must then be corrected at great cost. Moving people into a more familiar environment might also decrease the high drop-out rate from current resettlement schemes. Unfortunately, however, the amount of undeveloped land suitable for such resettlements is small. Much of it is in the marginal zones of the Mekong Delta (Dong Thap Muoi, Ca Mau) where environmental conditions are less than optimal for rice agriculture. Expansion of employment opportunities in urban centers may offer a more viable alternative to further resettlement in marginal areas.

Improvement of Agroecosystem Performance

Improvements can be suggested in the way that individual components are managed, but because the existing agroecosystem is so tightly integrated it is difficult to make even small changes without adversely affecting the functioning of the total system. In fact, in such a highly developed system, it is likely that if a particular resource is not maximally used, there is a good reason for it. For instance, the relatively underdeveloped state of homegardens in Nguyen Xa has been noted in several chapters of this report. But given the lack of residential land, the focus on rice production, and possibly other environmental conditions (typhoons, high water table), homegardens offer a very limited potential for further development. Similarly, as was discussed in Chapter 9, planting of windbreaks might improve the stability of rice production in the system as a whole but is unlikely to be adopted because of its cost to individual farmers. In short, any innovation should only be introduced following detailed scientific research on relationships among the components of the system and on its human and environmental constraints. There is no room for mistakes here. And what changes can be made will probably appear small, and their results incremental at best. Finer tuning is the goal, not major restructuring of the agroecosystem.

Topics that deserve further research include how to realize the potential of homegardens; how to increase fish production without destroying the vegetables grown in the ponds; how to continue to use pesticides and fertilizers in the most efficient way to keep production high, while using chemical inputs in such a way so that diversity in the environment is not further destroyed; how to improve or at least maintain animal husbandry, especially to get the manure so badly needed for rice fields; and how to improve the quality of water resources for home use. These are just a few factors that need further research.

A major question in developing agriculture in the Red River Delta is that of how to increase biological diversity in the system. "Diversity" is a property of agroecosystem structure (Marten 1988). Biological diversity is measured in terms of the number of different kinds of biotic units (genes, species, communities) that interact with one another at any particular level in the ecosystems hierarchy. At the field level, diversity is measured in terms of genetic variability within the crop species (e.g., number of different rice varieties being planted). At the ecosystem level, diversity is measured in terms of the number of species found within a land use unit (e.g., the presence of rice, Azolla, ducks, and crabs in the paddy field system). At the landscape system level, diversity is measured in terms of number of different types of communities constituting the village agroecosystem (e.g., paddy fields, canals, ponds, and home-gardens).

At all biological levels—populations, species, or ecosystems—diversity is low in Nguyen Xa Village. It is as close an approximation of a completely monocultural agroecosystem as one is likely to encounter. *Oryza sativa* is the dominant plant species. Farmers depend on just a few rice varieties. Rice excludes almost all other plant species from the paddy fields that cover most of the surface area of the village landscape. Little physical space is left for other plant species to occupy, even those that might be adapted to the unstable environmental conditions characteristic of the wet rice cultivation areas. Non-rice crop species in the fields are few and generally, with the exception of potatoes, are represented by small populations with restricted genetic diversity. *Homo sapiens* is the dominant animal species.[8] The large human population consumes most of the energy captured by photosynthesis. Only a relatively small amount of energy remains to support other animal species, primarily domesticated animals. People are also active predators, placing wild populations of birds, fish, amphibians, and crustaceans under extreme hunting pressure. Wild plants (weeds) that might compete with rice are removed by human agency. It is remarkable that any wild species are able to survive at all in the few niches available to them within the landscape. Only some insects, notably houseflies, are able to maintain large populations. Micro-organisms are more successful, with the large human population supporting a considerable diversity of intestinal parasites and other micro-predators.

There are a number of reasons increasing biological diversity is urgent. One is to increase the range of foods available to villagers—more fruits, more meat, more fish—but it is especially critical to preserve the genetic diversity of rice. Over the centuries hundreds of traditional land races have evolved as adaptations to the multitude of micro-habitats in the delta. These traditional varieties represent an irreplaceable storehouse of genetic information on which plant breeders must draw to maintain the viability of current cultivars against changing environmental hazards. If this diversity is lost, the risk of precipitous failure of wet rice agriculture in the delta is greatly increased. Were it at all possible, we would recommend that a large number of conservation areas be set aside in the Red River Delta to preserve in situ varieties adapted to unique local conditions. Unfortunately, other methods for preserving genetic diversity must be found since this is not possible.

Diversifying Sources of Employment and Income

Traditionally, delta villagers relied on wage labor, petty trading, and production of handicrafts to cover income shortfalls from agriculture. These supplementary forms of employment were all viewed as less desirable than farming since they yielded lower returns per hour of work. They were primarily resorted to by landless households and farm households that lacked sufficient land to meet basic subsistence requirements (Gourou 1936).

Since adoption of the market mechanism, small-scale non-farm activities have enjoyed a renaissance in the delta villages. In Nguyen Xa today many households derive more cash income from small-scale craft production, especially food processing (making of sausage and candy, distilling of alcohol), than they do from their farming. Indeed, purchase of chemical inputs needed to maintain rice production is actually subsidized from these sideline activities. Villagers also engage in off-farm occupations to earn cash. People from Nguyen Xa even engage in seasonal migration to Hanoi to work as scavengers in the waste dumps during agricultural off-seasons. They do this in order to reduce pressure on household resources and to earn cash to purchase consumer goods for their families in the village.

Active promotion of small-scale rural industry may offer the best hope of alleviating the pressure of people on delta land. Particular attention should be given to development of local processing of agricultural products. Such industries will raise rural income by increasing the value-added component of normally low-value crops. They could also stimulate crop diversification, thus reducing the current overwhelming dependency on rice cultivation (Vo Tong Xuan 1992).

CONCLUDING REMARKS

We originally chose Nguyen Xa Village as our study site because it represented an extreme case from the standpoint of human ecology—the most densely populated village in the most densely populated province in the Red River Delta, which is itself one of the most densely populated rural regions in Asia, indeed anywhere in the tropics. Nguyen Xa thus offered us an ideal laboratory to examine the character of human interactions with the environment under conditions of hyperpopulation density that are likely to become typical rather than exceptional in much of rural Asia in the next 20 years. By studying Nguyen Xa, we hoped to gain some insight into what human-environment relations might be like regionally in the future.

Our findings offer cause for both hope and deep unease. On the one hand, the adaptation of peasant society to the difficult environment of the delta has been a remarkably successful one in both biological and cultural terms. Certainly if one accepts the view that the evolutionary success of a species is measured by its ability to capture a larger share of energy from its environment, then Nguyen Xa represents a true success story from the human standpoint. *Homo sapiens* is the ecological dominant among animals, and *Oryza sativa*, a domesticated plant that can be viewed as a cultural artifact incapable of surviving independently of people, is the dominant species in the vegetable kingdom. Thus, humans, and the few plant and animal species that are symbiotic with people, have taken control of the delta habitat.

Humans represent much more than "non-equilibrium dissipative systems," however, as biological organisms are referred to in the jargon of thermodynamic-based evolutionary theorists. They are also participants in complex symbolic systems of meaning and feeling; this participation makes the human species unique. Obtaining sufficient quantities of food energy to maintain life is critically important but so is having those calories in culturally preferred form (e.g., as rice rather than cassava) and the social setting in which they are consumed (e.g, sitting together with family members in one's own house). All of these things together add up to form a total standard of living of a population.

Historically, Asian societies with dense populations have provided very low standards of living to the majority of their citizens, as was the case in the Red River Delta in the colonial era. The most hopeful aspect of the Vietnamese revolution is its raising of the existence level of the poorest sectors of the peasantry above mere survival levels. The experience of Nguyen Xa since 1954 illustrates the extent to which effective redistributional policies in association with technological development can provide a very dense population with a relatively decent standard of living. This high standard of living represents more than simply having enough food to eat—although that is a very important part of it. It also includes access to basic health care and educational opportunities. Most important, it ensures the maintenance of a very rich and vibrant local cultural life and sense of community, both of which are abundantly manifested in Nguyen Xa and like villages throughout the delta.

This success is purchased at a very high cost in human effort, however. The delta farmers work long hours doing very heavy labor under often unpleasant, even dangerous, conditions. Anyone who has observed them working barefoot in the flooded paddies in January when the air temperature is 9° C or seen them walking bent under the weight of heavy baskets of manure in the intense heat and humidity of July is unlikely to romanticize their situation. Given a choice, few individuals from less densely settled regions would opt to live in the Red River Delta. Even the poorest farmers in the Mekong Delta have an easier time making their living and enjoy, on the whole, a more comfortable life-style. But, for those born and raised in villages like Nguyen Xa, there is no real choice. Resettlement in New Economic Zones is usually under conditions of even greater hardship and risk than they face in the delta and lacks the social amenities to which they have become accustomed to in their native villages.

Accompanying the high human costs of maintaining a population of such great density are serious environmental costs. In the 15,000 km^2 of the delta, not a single stand of wild vegetation remains. The landscape is a wholly anthropogenic one with almost no space or energy left free to support wild species. Pollution now even endangers the survival of aquatic organisms that had until now survived in rivers and other water bodies—one habitat that people cannot directly occupy. Such loss of natural biological diversity is unfortunate but, given the restricted extent of the delta compared to the total surface of Vietnam, the loss is not disastrous from an ecological standpoint. Other wetland habitats remain in less populated coastal areas that can provide protected areas for endangered wild species. The rapid erosion of the gene pools of important cultivars is much more of a cause for concern.

Our greatest concern, however, is that the rural resource system that has so far successfully met the subsistence needs of the delta's population will break down as continued population growth forces further intensification. The resource needs of a growing population increase linearly, but environmental response to such pressures is likely to be nonlinear. We are particularly concerned that the ability of the delta's heavily worked soils to sustain multiple cropping, and the ability of key cultivars to resist pests and diseases, may decline precipitously with consequent decrease in food production. Given the existing narrow margin between sufficiency and shortage, the human consequences of such environmental failure are not pleasant to contemplate. As the performance of the delta's agroecosystem is pushed toward its outer limit, the possibility of such breakdowns increases. Consequently, the search for better resource management strategies designed to minimize the possibilities of system failure deserves a very high priority on Vietnam's national scientific research agenda. This is true not just in the case of the Red River Delta, where population pressure is so manifest, but in the Midlands and Highlands as well, where more fragile ecosystems become vulnerable to degradation and collapse at much lower absolute densities.

Endnotes

1. We recognize that we are not the first to suggest that the delta's population has reached the limits of the carrying capacity of its agroecosystem. Writing in the 1930s, Pierre Gourou predicted that by 1984 the delta would have reached a population of 13 *million*: "The average density of the delta will then be double the current density. A worse situation seems inconceivable; it seems *impossible* that the delta, which provides insufficient nourishment for 430 persons per square kilometer today, can meet the needs of a population twice as large" (Gourou 1936:197). Today, the delta successfully supports more than twice as many people as it did when Gourou made his despairing forecast. Gourou wrote, however, before peasant agriculture had been

modernized. Use of chemical fertilizers and pesticides was unheard of, breeding of higher yielding rice varieties was only beginning, and large-scale irrigation systems were not even on the drawing boards. Since then, the technical basis of agriculture in the delta has been wholly transformed. All of the easy gains in productivity have already been made during this "green revolution," which is why the subsistence needs of the delta's increased population are being met. There are no grounds, however, for thinking that any existing technology can achieve comparable increases in productivity in the next 20 years.

2. This figure does not, of course, take taxation and production expenses into account. If these costs were entirely paid in kind, insufficient rice would be left to meet consumption needs. In fact, households use cash income from other activities to offset production costs of rice.

3. There is no consensus regarding the Vietnamese rice requirement. According to Pierre Gourou (1945:13), a ration of 400 grams of rice/day (1,450 kcal) is barely sufficient to meet the minimal average daily individual requirement of the peasants of the Red River Delta. This represents 146 kg of rice/person/yr. Gourou's estimate seems very low, and Norlund (1986:216) suggests that 500 g of rice (1,815 kcal) represents a more adequate daily ration. Norlund's suggestion is close to the current actual consumption level of 480 g/capita/day as revealed by a 1987 survey of food consumption of 5,040 households in the Red River Delta (UNICEF 1990:39, Table II.11). Annually, this represents 183 kg of rice (277 kg of paddy). UNICEF (1990:36) sets 340 kg of paddy equivalent (224 kg of rice) per person per year or 614 g/day (2,230 kcal) as the minimum level for nutritional self-sufficiency. The UNICEF figure is probably somewhat on the high side. According to Duong-Hong-Huy (1968:95), consumption of 1,914 calories meets the minimal adult metabolic requirement in central Vietnam. The larger physical stature of northerners (average height of 1,614 mm compared to 1,573 mm in the central region (Olivier 1968:83) and the colder wintertime temperatures in the Red River Delta would impose somewhat higher caloric demands. Children and elders (who compose a sizable percentage of the population) have lower caloric requirements, however. Nor is rice the sole source of food energy consumed by the delta peasants. Two hundred kg of rice/capita/yr (1,990 kcal/day) is probably a realistic estimate of the minimal requirement when averaged across the village population as a whole and when consumption of foods other than rice is allowed for.

4. In 1985 the average paddy yield for the Red River Delta as a whole was estimated at approximately 6 t/ha/yr (Vien Khoa Hoc 1988:23). In 1989, the spring crop yielded an average of 3.8 t/ha and the fall crop 3.3 t/ha (Tran Duc Vien 1991). Not all paddies can be double cropped so an annual average yield of 6 t/ha is plausible. Vietnamese yield data must be treated as suspect, however. Agricultural taxes are collected according to yields, so there is a strong incentive at the local level to underreport production. The Ministry of Agriculture is said to carry out sample harvesting surveys to empirically assess production, but the extent of coverage and reliability of these surveys are not known.

5. Energy production is estimated on the basis of the following energy equivalencies per kilogram: rice, 3,630 kcal; white potatoes, 760 kcal (wet wgt.); potato leaves and vines, 190 kcal (wet wgt.)—the latter value is that of New Zealand spinach—(all caloric values are from tables in USDA 1963); paddy straw and rice husks and chaff, 3,825 kcal (Bialy 1982:89). Paddy is assumed to yield 66 percent rice and 34 percent husks and chaff.

6. Data on annual agricultural production in north Vietnam from 1958 to 1975 have been assembled by Vo Nhan Tri (1990:19–20, Table 1.1). Tri employed official data, which he notes "should be used with caution" (ibid.:18). Given the extent to which villages were able to maintain their autonomy from the central authorities, considerable underreporting of yields probably occurred (Fforde 1989). The official figures are sufficiently grim, however, that they support Tri's conclusion that the effort to transform agricultural production through collectivization and technological innovation was not successful.

7. Adam Fforde (1989:xi) is only correct in claiming "the innate absence of significant scale economies in wet-rice cultivation" if he is referring to the process of farming at the field level. Development of an extensive agrarian infrastructure has unquestionably contributed to raising productivity of individual plots in the Red River Delta.

8. Human genetic diversity is probably also low in Nguyen Xa and other delta villages. All inhabitants are ethnic Vietnamese (Kinh) descended from a population that has been settled in place for many centuries. Sixty to 80 percent of all marriages are village endogamous. In exogamous marriages, in-marrying spouses are likely to come from within the same district, although some may be from other provinces as a result of contacts made during army service or while studying in institutions of higher education. Many of the small number of outsiders living in Nguyen Xa, mostly teachers, medical personnel, and other civil servants assigned there by the district government, are themselves natives of Thai Binh Province.

APPENDIX A

WORKSHOP PARTICIPANTS

1.	Bounthong Bouahom	Ministry of Agriculture and Forestry, Lao People's Democratic Republic
2.	Bui Huu Phat	University of National Economics, Socialist Republic of Vietnam (SRV)
3.	Gladys A. Cruz	University of the Philippines, Baguio, the Philippines
4.	Cu Viet Ha	Division of Science and Technology, Ha Son Binh Province, SRV
5.	Dao Anh Thu	University of Transportation, SRV
6.	Diep Dinh Hoa	Institute of Ethnology, SRV
7.	Dinh Xuan Hung	INFORTERA, SRV
8.	Kathleen Gillogly	University of Michigan, USA
9.	Karyono	Institute of Ecology, Padjadjaran University, Bandung, Indonesia
10.	Le Dong Tan	Institute of Ecology and Biological Resources, National Center for Scientific Research, SRV
11.	Le Hai Quang	Center for Natural Resources Management and Environmental Studies (CRES), University of Hanoi, SRV
12.	Le Thanh Tam	Center for Geography and Resources, National Center for Scientific Research, SRV
13.	Le Thi Van Hue	CRES, University of Hanoi, SRV
14.	Le Trong Cuc	CRES, University of Hanoi, SRV
15.	Le Van Lanh	CRES, University of Hanoi, SRV
16.	Le Van Thu	University of National Economics, SRV
17.	Luu Thi Thao	Center for Geography and Resources, National Center for Scientific Research, SRV
18.	Harold J. McArthur	University of Hawaii at Manoa, USA
19.	Nghiem Phuong Tuyen	CRES, University of Hanoi, SRV

20.	Nguyen Duc Minh	Center for Forest Ecology and Environment, Forestry Research Institute, SRV
21.	Nguyen Hung Long	Institute of Labor Medicine Research, Hanoi, SRV
22.	Nguyen Quang Minh	Division of Science and Technology, Nghe Tinh Province, SRV
23.	Nguyen Quoc Hai	Ministry of Health, SRV
24.	Nguyen Thi Tuyet Mai	University of Forestry, SRV
25.	Nguyen Thu Phuong	CRES, University of Hanoi, SRV
26.	Aran Patanothai	Khon Kaen University, Thailand
27.	Pham Van Phe	Agricultural University No. 1, SRV
28.	Pham Xuan Thao	Division of Science and Technology, Thai Binh Province, SRV
29.	Phan Huy Binh	Faculty of Geography, University of Can Tho, SRV
30.	Phan Minh Chau	Centre for Environmental Monitoring and Management, Meteorological and Hydrological Service, SRV
31.	Phan Minh Nguyet	Ministry of Education and Training, SRV
32.	A. Terry Rambo	East-West Center, Hawaii, USA
33.	Charmaine Rambo	University of Oregon, USA
34.	Manu Seetisarn	Chiang Mai University, Thailand
35.	Tran Duc Vien	Agricultural University No. 1, SRV
36.	Tran Kieu Hanh	National Center for Scientific Research, SRV
37.	Tran Thu Phuong	CRES, University of Hanoi, SRV
38.	Truong Quang Bich	Cuc Phuong National Park, SRV
39.	Vu Quyet Thang	CRES, University of Hanoi, SRV
40.	Vu Xuan Truong	Department of Labour and Population Distribution, SRV
41.	Peter Xenos	East-West Center, Hawaii, USA

APPENDIX B

RESEARCH TEAMS

Agroecosystem Team
Le Trong Cuc
A. Terry Rambo

Biodiversity Team
Karyono
Dinh Xuan Hung
Dao Anh Thu
Nguyen Duc Minh

Stability Team
Manu Seetisarn
Nguyen Thu Phuong
Pham Van Phe
Le Dong Tan
Phan Huy Binh

Livestock Team
Bounthong Bouahom
Bui Huu Phat
Cu Viet Ha
Le Van Thu
Le Van Lanh
Pham Xuan Thao

Resilience Team
Harold J. McArthur
Vu Quyet Thang
Tran Kieu Hanh
Phan Minh Chau

Autonomy and Solidarity Team
Diep Dinh Hoa
Kathleen Gillogly
Le Thi Van Hue
Nguyen Quang Minh
Nguyen Hung Long

Equitability Team
Gladys A. Cruz
Nghiem Phuong Tuyen
Charmaine Rambo
Nguyen Quoc Hai
Nguyen Thi Tuyet Mai
Truong Quang Bich

Demography and Labor Team
Peter Xenos
Tran Thu Phuong
Luu Thi Thao
Vu Xuan Truong

Sustainability Team
Aran Patanothai
Tran Duc Vien
Le Thanh Tam
Phan Minh Nguyet

APPENDIX C

SCHEDULE FOR WORKSHOP ON SUSTAINABLE RURAL RESOURCES MANAGEMENT AND BIOLOGICAL DIVERSITY CONSERVATION IN HANOI AND THAI BINH, 15–26 JULY 1991

Monday, 15 July	
Morning	Briefing on Red River Delta (Tran Duc Vien) Briefing on social organization of Nguyen Xa Village (Diep Dinh Hoa)
Afternoon	Team meetings—plan research
Tuesday, 16 July	
Morning	Team meetings
Wednesday, 17 July	
Morning	Depart hotel at 7:00 A.M.; 3-hour trip to Thai Binh
Afternoon	Meeting with province officials
Thursday, 18 July	
Morning	Meeting with Dong Hung District officials
Afternoon	Survey tour of district First visit to Nguyen Xa Village
Friday, 19 July	Field research
Saturday, 20 July	Field research
Sunday, 21 July	Field research
Monday, 22 July	Field research; preliminary analysis and report writing
Tuesday, 23 July	Field research
Wednesday, 24 July	
Morning	Report writing
Afternoon	Present synthesis of findings to province officials
Thursday, 25 July	
Morning	Return to Hanoi
Afternoon	Report writing
Friday, 26 July	
Morning	Report writing
Afternoon	Present reports at CRES
Saturday, 27 July	Visiting scientists leave Hanoi

REFERENCES

Ali, A. B. 1990. "Some Ecological Aspects of Fish Populations in Tropical Rice Fields." *Hydrobiologica* 190(3): 215–222.

Angladette, Andre. 1966. *Le Riz*. Paris: G-P. Maisonneuve et Larose.

Bialy, Jan Roderic. 1982. Energy Flows in Subsistence Agriculture: A Study of a Dry Zone Village in Sri Lanka. PhD dissertation, University of Edinburgh, Scotland.

Bormann, F. H., K. R. Smith, and B. T. Bormann. 1991. "Earth to Hearth: A Microcomputer Model for Comparing Biofuel Systems." *Biomass and Bioenergy* 1(1): 17–34.

Bui Cong Binh, Trong Khue, Nguyen The Lap, and Ha Tri Dung, eds. 1986. *Ngay Sinh Thu 18* (The eighteenth birthday). Thai Binh: Committee on Population and Family Planning.

CCSC (Central Census Steering Committee). 1990. Vietnam Population Census—1989. Sample results. Hanoi: CCSC.

Centre for Women's Studies. 1990. *Selected Indicators on Women's Status in Vietnam 1975–1989.* Hanoi: Statistical Publishing House.

Conway, Gordon R. 1984. "What Is an Agroecosystem and Why Is It Worthy of Study?" in A. Terry Rambo and Percy E. Sajise (eds.), *An Introduction to Human Ecology Research on Agricultural Systems in Southeast Asia*, pp. 25–38. College, Laguna: Univ. of the Philippines at Los Banos.

Conway, Gordon R. 1987. "The Properties of Agroecosystems." *Agricultural Systems* 24:95–117.

Cook, Earl. 1976. *Man, Energy, Society.* San Francisco: W. H. Freeman.

Dao The Tuan. n.d. *Les systemes agraires du delta du Fleuve Rouge* (Agricultural systems of the Red River Delta). Vietnam Agricultural Science Institute, Hanoi. Unpublished manuscript.

Department of Statistics. 1992. *Statistics Yearbook 1985–1991.* Hanoi: Statistical Publishing House.

Diep Dinh Hoa, ed. 1990. *Tim Hieu Lang Viet* (In search of understanding of the Vietnamese village). Hanoi: Social Science Publishing House.

Duong-Hong-Huy. 1968. *Enquete sur la Nutrition au Village de Co-Man, Province de Quang-Nam* (Nutritional survey of Co-Man Village, Quang-Nam Province). These pour le doctorat en medecine (Diplome d'Etat), Faculty of Medicine, Saigon University, Vietnam.

Dutt, Ashok K., and Margaret Geib. 1986. *Atlas of South Asia.* Boulder: Westview Press.

FEA. 1991. *The Far East and Australasia 1991.* 22nd ed. London: Europa Publishing.

Fforde, Adam. 1989. *The Agrarian Question in North Vietnam, 1974–1979: A Study of Cooperator Resistance to State Policy.* Armonk, NY: M. E. Sharpe.

Fforde, Adam (ed.), Siep Littooy, Claes Corlin, and Nguyen Dinh Huan. 1989. Cooperatives, Families and Development in North Vietnam: Some Experiences from the Forest, Trees and People (FTP) Project—Full Report of the Socio-economic Follow-up Study. FTP Project, Bai Bang, Vinh Phu Province, Vietnam.

Fforde, Adam, and Suzanne H. Paine. 1987. *The Limits of National Liberation: Problems of Economic Management in the Democratic Republic of Vietnam, with a Statistical Appendix.* London: Croom Helm.

Geertz, Clifford. 1963. *Agricultural Involution: The Process of Ecological Change in Indonesia.* Berkeley: Univ. of California Press.

General Statistical Office. 1992. *Nong, Lam, Ngu nghiep Viet Nam (1976–1991)—Cac vung trong diem san xuat hang hoa* (Statistical data of Vietnam's agriculture, forestry and fishery [1976–1991]—The Pivotal Areas of Commodity Production). Hanoi: Statistical Publishing House.

Gillogly, Kathleen A., and Nghiem Phuong Tuyen. 1992. *Cao Lan Culture and Biodiversity in Historical Context: Environmental Change Among an Ethnic Minority of the Midlands of Northern Vietnam.* Indochina Initiative Working Paper No. 3. Honolulu, HI: East-West Center.

Gourou, Pierre. 1931. *Le Tonkin. Indochine Francaise.* Paris: Exposition Coloniale Internationale.

Gourou, Pierre. 1936. *Les Paysans du Delta Tonkinois* (Peasants of the Tonkin Delta). L'Ecole Francaise d'Extreme-Orient. (Reprinted by Mouton, Paris, 1965.)

Gourou, Pierre. 1945. The standard of living in the Delta of Tonkin (French Indo-China). French Paper No. 4. Ninth Conference of the Institute of Pacific Relations. Typescript.

Henry, Yves. 1932. *Economie Agricole de L'Indochine.* Hanoi: Government General de L'Indochine.

Ho Ton Trinh. 1985. "Ideology, Culture, and the Human Environment," in Karl L. Hutterer, A. Terry Rambo, and George Lovelace (eds.), *Cultural Values and Human Ecology in Southeast Asia,* pp. 307–320. Michigan Papers on South and Southeast Asia No. 27. Ann Arbor, MI: Univ. of Michigan Center for South and Southeast Asian Studies.

Hutterer, Karl L. 1982. *Interaction Between Tropical Ecosystems and Human Foragers: Some General Considerations.* EAPI Working Paper. Honolulu, HI: Environment and Policy Institute, East-West Center.

Hy V. Luong. 1992. *Revolution in the Village: Tradition and Transformation in North Vietnam, 1925–1988.* Honolulu, HI: Univ. of Hawaii Press.

Jamieson, Neil L. 1991. *Culture and Development in Vietnam.* Indochina Initiative Working Paper No. 1. Honolulu, HI: East-West Center.

Jamieson, Neil L., Nguyen Manh Hung, and A. Terry Rambo, eds. 1992. *The Challenges of Vietnam's Reconstruction.* Indochina Institute Papers. Fairfax, VA: George Mason Univ.

Khon Kaen University. 1987. *Proceedings of the 1985 International Conference on Rapid Rural Appraisal.* Rural Systems Research and Farming Systems Research Projects, Khon Kaen, Thailand.

Le Trong Cuc, Kathleen Gillogly, and A. Terry Rambo, eds. 1990. *Agroecosystems of the Midlands of Northern Vietnam.* Occasional Paper No. 12. Honolulu, HI: Environment and Policy Institute, East-West Center.

Luo Shi Ming and Lin Ri Jian. 1991. "High Bed-Low Ditch System in the Pearl River Delta, South China." *Agriculture, Ecosystems and Environment* 36(1-2): 101-109.

Marten, Gerald G. 1988. "Measurement Problems in Agroecosystem Analysis: A Critique of System Properties," in Kanok Rerkasem and A. Terry Rambo (eds.), *Agroecosystem Research for Rural Development: Selected Papers Presented at the Third SUAN Regional Symposium on Agroecosystem Research,* pp. 32-58. Chiang Mai, Thailand: Multiple Cropping Center, Chiang Mai University.

Multiple Cropping Project. 1980. "An Interdisciplinary Perspective of Cropping Systems in the Chiang Mai Valley: Key Questions for Research." Faculty of Agriculture, University of Chiang Mai, Thailand.

Ngo Vi Lien. 1928. *Nomenclature des communes du Tonkin.* Hanoi: Le Van Tan.

Nguyen Khac Vien. 1964. "Water, Rice and Men: Hung Yen Province 1963-." *Vietnamese Studies,* No. 2. Hanoi.

Nguyen Manh Hung, Neil L. Jamieson, and A. Terry Rambo, eds. 1991. *Environment, Natural Resources, and the Future Development of Laos and Vietnam: Papers from a Seminar.* Indochina Institute Papers. Fairfax, VA: George Mason Univ.

Nguyen The Anh. 1985. "Le famine de 1945 au Nord-Viet-Nam." *The Vietnam Forum* 5:81-100.

Norlund, Irene. 1986. "Rice Production in Colonial Vietnam, 1900-1930: Production, Consumption, Market Relations and Social Differentiation," in Irene Norlund et al. (eds.), *Rice Societies,* pp. 203-229. Riverdale, MD: The Riverdale Co.

Odum, Eugene P. 1971. *Fundamentals of Ecology.* 3rd ed. Philadelphia: W. B. Saunders.

Olivier, Georges. 1968. *Anthropologie des Cambodgiens.* l'Ecole Francaise d'Extreme Orient, Paris.

Patanothai, Aran. 1992. "Rural Resource Management in the Red River Delta of Vietnam: A Case Study on Land Use Sustainability in a Highly Intensive and Densely Populated Area." Unpublished preliminary report. Honolulu, HI: East-West Center.

Pham Xuan Dai. 1990. *Co cau dan so hai xa thuan nong o tinh Thai Binh va Quang Nam-Da Nang* (The population structure of two wholly agricultural villages in Thai Binh and Quang Nam-Danang provinces). *Xa Hoi Hoc* 30(2): 24-26.

Rambo, A. Terry. 1973. *A Comparison of Peasant Social Systems of Northern and Southern Viet-Nam: A Study of Ecological Adaptation, Social Succession, and Cultural Evolution.* Monograph Series III. Center for Vietnamese Studies, Southern Illinois University, Carbondale, IL.

Rambo, A. Terry. 1983. *Conceptual Approaches to Human Ecology.* Research Report No. 14. Honolulu, HI: Environment and Policy Institute, East-West Center.

State Department of Topography. 1975. *Tap Ban Do Nong Nghiep Tinh Thai Binh* (Map of agriculture in Thai Binh Province). Hanoi: State Department of Topography.

Thai Binh Department of Statistics. 1991. *Thai Binh Statistics.* Vietnam: Thai Binh Province.

Toan-Anh. 1968. *Nep Cu Lang Xom Viet-Nam* (Traditional customs of Vietnamese villages). Khai-Tri, Saigon.

Tran Duc Vien. 1991. General Ideas About Humans, Resources, and Agroecosystems of the Red River Delta. Prepared for the SUAN-EWC-CRES Workshop on Sustainable Rural Resources Management and Biological Diversity Conservation. Hanoi: CRES.

Tran T. Dang. 1991. *Socialist Economic Development and the Prospects for Economic Reform in Vietnam.* Indochina Initiative Working Paper No. 2. Honolulu, HI: East-West Center.

UNICEF. 1990. *Viet Nam: The Situation of Children and Women.* United Nations Children's Fund, Office of the Representative, Hanoi.

USDA. 1963. *Composition of Foods.* Agricultural Handbook No. 8, United States Department of Agriculture. Washington, DC: U.S. Government Printing Office.

Vien Khoa Hoc Ky Thuat Nong Nghiep Viet Nam. 1988. *Nong Nghiep Sinh Thai. Ket Qua Nghien Cuu Khoa Hoc 1981–1986* (Ecological agriculture: Summary of scientific research 1981–1986). Hanoi: Agriculture Publishing House.

Vietnamese Studies. The Traditional Village (I), Vol. 61; The Traditional Village (II), Vol. 65. Hanoi: Xunhasaba.

Vo Nhan Tri. 1990. *Vietnam's Economic Policy Since 1975.* Singapore: Institute of Southeast Asian Studies.

Vo Tong Xuan. 1992. "The Challenges of Agricultural Development in Vietnam," in Neil L. Jamieson, Nguyen Manh Hung, and A. Terry Rambo (eds.), *The Challenges of Vietnam's Reconstruction*, pp. 98–109. Indochina Institute Papers. Fairfax, VA: George Mason Univ.

PLATES

Photographs by A. Terry Rambo and Harold J. McArthur

Plate 1. Aerial view of the Red River Delta.

Plate 2. Village in the Red River Delta.

Plate 3. Besides buffalo, cattle is used to plow paddy fields.

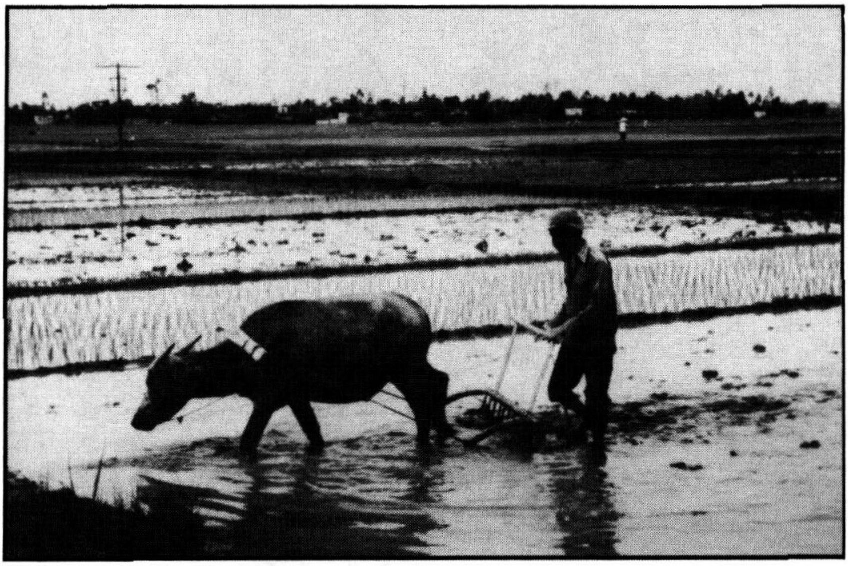


Plate 4. Here, a buffalo is used to harrow paddy fields.

Plate 5. Human power is used to harrow paddy fields, because of a shortage of draft animals.

Plate 6. After plowing, because of a shortage of draft animals, human power is used to hoe by hand to break up clumps of soil and to turn under remaining ratoon rice plants and weeds.

Plate 7. Farmers use the two-person water scoop to transfer water from a canal into a paddy field containing insufficient water.

Plate 8. Transplanting with line string, for placement of seedlings into straight rows.

Plate 9. Piles of rice straw, which is the principal fuel used for cooking, are left in the field to dry.

Plate 10. Manure being transported to the field for use as fertilizer.

Plate 11. Mixing manure, which farmers need for rice cultivation.

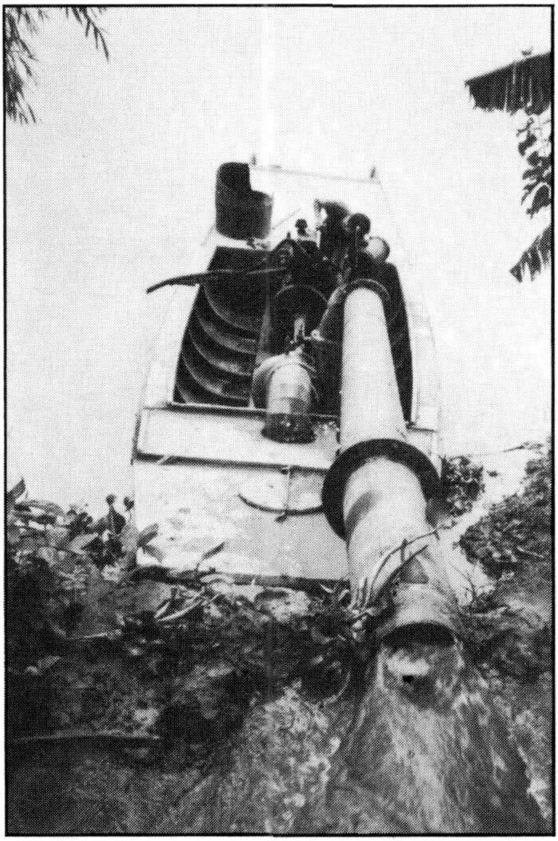


Plate 12. Boat pump, which provides an emergency backup to the pumping stations along the Thong Nhat Canal.

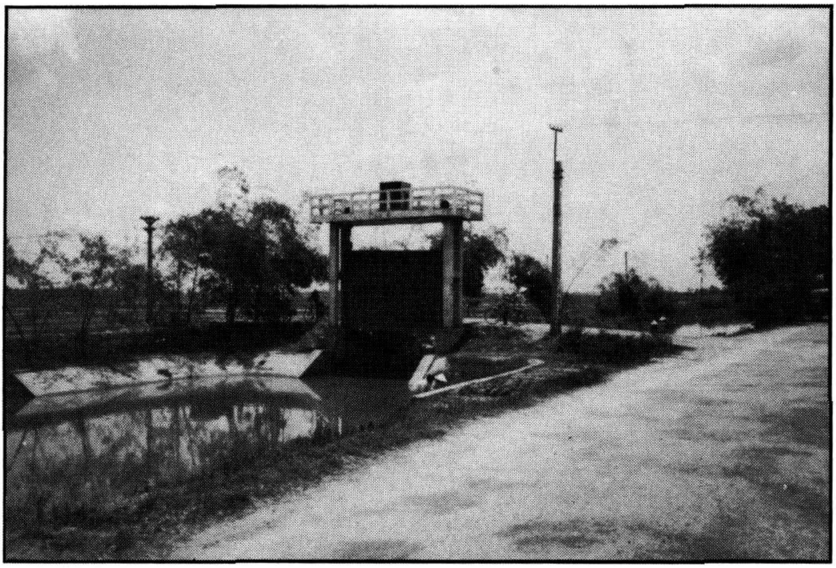


Plate 13. Irrigation gate in Thong Nhat Canal.

Plate 14. Transporting rice husks for use as cooking fuel or for making compost by mixing with manure.

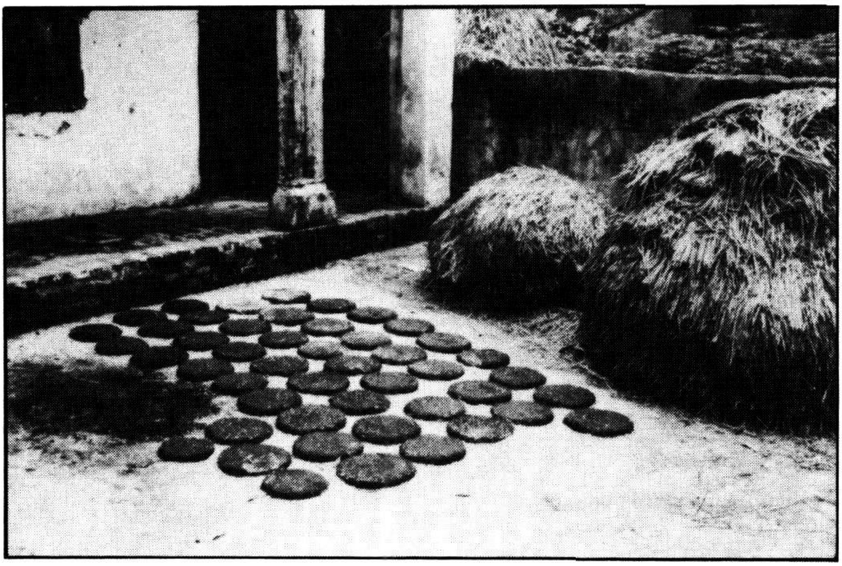


Plate 15. Briquettes, a mixture of coal dust and earth, are left in the sun to dry. These briquettes are another main source of fuel.

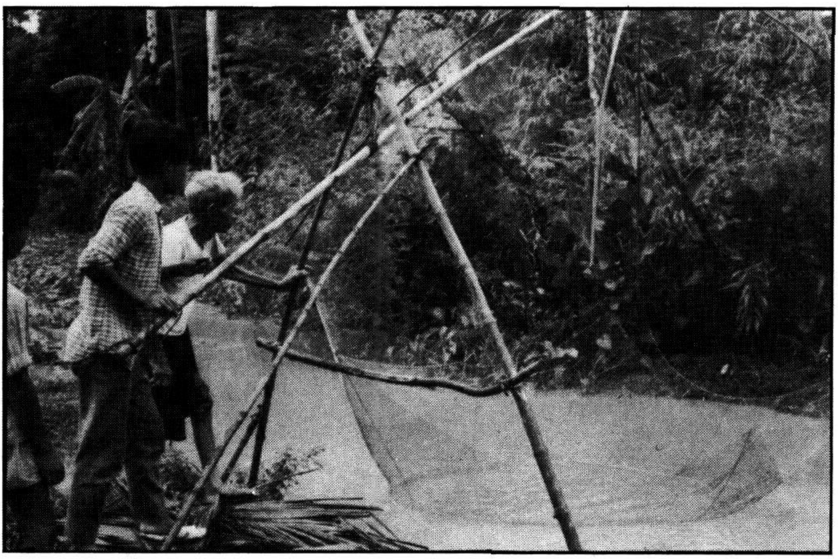


Plate 16. Catching fish in the village's irrigation canal, which is an open access resource.

Plate 17. Diversity of homegarden products being sold at the village central market.

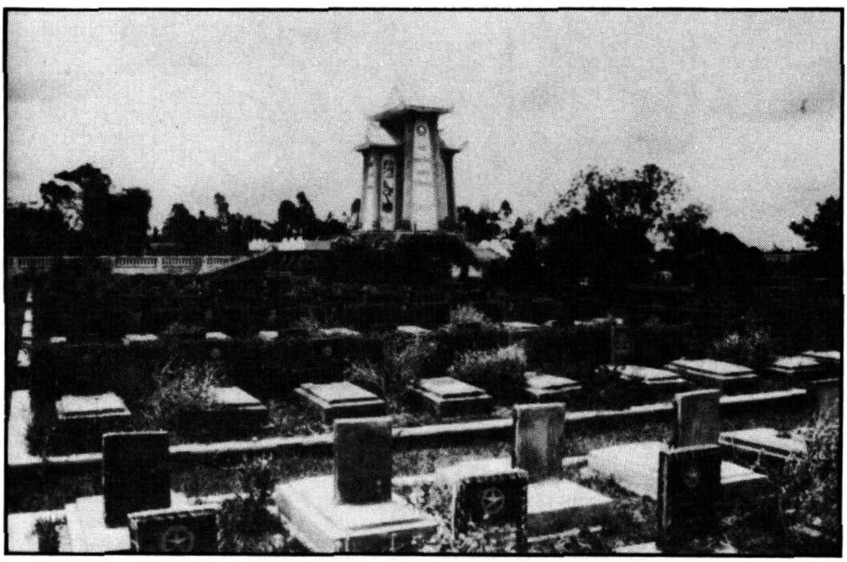


Plate 18. Cemetery in Nguyen Xa Village in memory of villagers who gave their lives while serving their country.

Plate 19. Poster encouraging villagers to participate in the Family Planning Program (as part of the women's liberation movement).

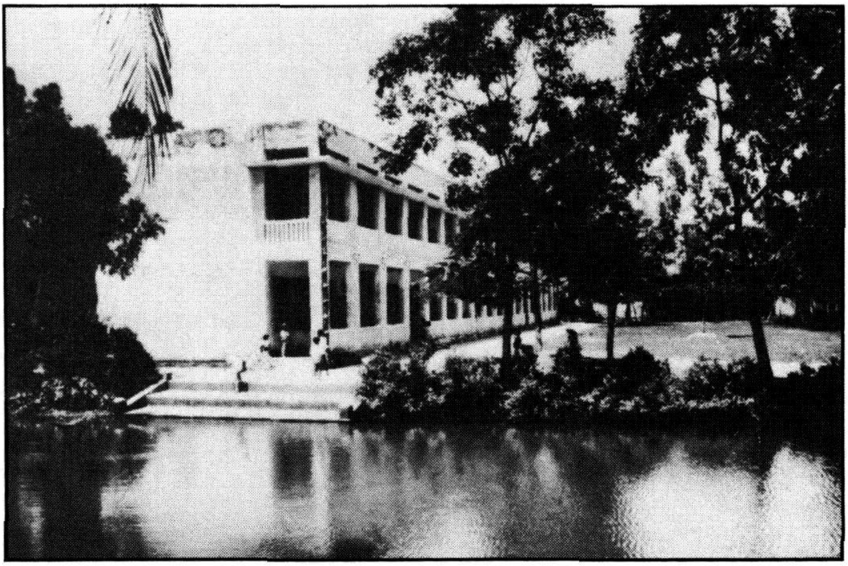


Plate 20. Primary school in Nguyen Xa Village.

OCCASIONAL PAPERS
OF THE PROGRAM ON ENVIRONMENT

14. *South Asian Seas: A Review of the Oceanography, Resources, and Environment,* by Philomène A. Verlaan. 1991, x, 54 pp. ISBN 0-86638-147-3.

13. *Keimami sa vakila na liga ni Kalou* (Feeling the hand of God): *Human and Nonhuman Impacts on Pacific Island Environments,* by Patrick D. Nunn. Revised edition, 1992, viii, 69 pp. ISBN 0-86638-154-6.

12. *Agroecosystems of the Midlands of Northern Vietnam: A Report on a Preliminary Human Ecology Field Study of Three Districts in Vinh Phu Province,* by Le Trong Cuc, Kathleen Gillogly, and A. Terry Rambo, editors. 1990, xiv, 232 pp. ISBN 0-86638-134-1. (Also in Vietnamese; translated by Nghiem Phuong Tuyen and Vu Minh Hoa.)

11. *Conservation or Conversion of Mangroves in Fiji: An Ecological Economic Analysis,* by Padma Narsey Lal. 1990, xii, 108 pp. ISBN 0-86638-132-5.

10. *International Conference on the Sea of Japan: Transnational Ocean Resource Management Issues and Options for Cooperation,* by Mark J. Valencia, editor/author. 1989, xiv, 239 pp. ISBN 0-86638-116-3.

8. *Water in Nepal: An Interdisciplinary Look at Resource Uncertainties, Evolving Problems, and Future Prospects,* by Dipak Gyawali. 1989, xii, 126 pp.

6. *Forestry Research Capacity in the Asia-Pacific Region: An Evaluation Model and Preliminary Assessment,* by David N. Bengston, Hans M. Gregersen, Allen L. Lundgren, and Lawrence S. Hamilton. 1988, x, 96 pp.

4. *Maritime Jurisdiction in East Asian Seas,* by J. R. V. Prescott. 1987, vi, 72 pp.

3. *International Conference on the Yellow Sea: Transnational Ocean Resource Management Issues and Options for Cooperation,* by Mark J. Valencia. 1987, vi, 165 pp.

2. *Applying Ecology to Land Management in Southeast Asia,* by David E. Harper, Daniel B. Botkin, Richard A. Carpenter, and Brian W. Mar. 1987, x, 148 pp.

Available from the Publication Sales and Distribution Office, EWC
($5 each plus postage).

The U.S. Congress established the East-West Center in 1960 to foster mutual understanding and cooperation among the governments and peoples of the Asia-Pacific region, including the United States. Officially known as the Center for Cultural and Technical Interchange Between East and West, it is a public, nonprofit institution with an international board of governors. Principal funding for the Center comes from the U.S. government, with additional support provided by private agencies, individuals and corporations and more than 20 Asian and Pacific governments.

The Center promotes responsible development, long-term stability and human dignity for all people in the region and helps prepare the United States for constructive involvement in Asia and the Pacific through research, education and dialogue. It provides a neutral meeting ground at which people with a wide range of perspectives exchange views on topics of regional concern. Some 2,000 scholars, government and business leaders, educators, journalists and other professionals from throughout the region annually work with the Center's staff to address topics of contemporary significance.

The Program on Environment (formerly the Environment and Policy Institute) was established in October 1977 as a unit of the East-West Center. Reconciling development with the environment by bringing social systems and natural systems into harmony with one another is the overall objective of the Program on Environment (ENV). Achievement of this objective involves both maintaining environmental quality and improving the quality of human life. To help attain these interlocked goals, ENV draws on the knowledge base of the natural and social sciences to develop and disseminate new tools for policymaking, management, education, and research.

ISBN 0-86638-157-0