CASH CROP ADOPTION BY PEASANT HOUSEHOLDS:
AN EMPIRICAL ANALYSIS FROM THE MIDDLE MOUNTAINS OF NEPAL

by

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A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF

THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE

in

THE FACULTY OF GRADUATE STUDIES

Department of Agricultural Economics

We accept this thesis as conforming
to the required standard

THE UNIVERSITY OF BRITISH COLUMBIA

April 1995

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ABSTRACT

Peasant households in the Middle Mountains of Nepal are faced with a myriad of problems and challenges as they attempt to improve their living conditions. Vegetable cash crop production is regarded as a possible solution to alleviating rural poverty by many households and policymakers. This study deals with the case of vegetable cash crop adoption by peasant households in a peri-urban area near Kathmandu. The two objectives of this study are to identify the determinants of vegetable cash crop adoption by peasant households, and to examine the implications of this adoption.

This research is based on a detailed household-level survey of peasants in the Jhikhu Khola Watershed, located about 40 km east of Kathmandu. The sample is divided into households that produce vegetable cash crops, and those that do not.

A dichotomous logistic model is used to determine the significant factors for the adoption of vegetable cash crops. For the second objective, the survey data is analysed to understand the implications of vegetable cash crop adoption. The effects of adoption are assessed by comparing two vegetable cash crops, potato and tomato, with two staple food crops, maize and rice.

The results of the adoption/non-adoption logistic model indicate that access to irrigation water has the greatest impact on growing vegetable cash crops. There is a positive relationship between access to irrigation water and adoption of vegetable cash crops by the surveyed households. The level of formal education attained by the male household head also increases adoption rates. Difficulty with inorganic commercial fertilisers and predominantly red soils both have a negative impact on the choice to produce vegetable cash crops.

An examination of the implications of cash crop adoption reveals some interesting results. Although tomatoes are the most profitable crop, many households incurred losses by cultivating potatoes due to changes in the operational environment. Households that
adopt cash crops have higher returns from maize than households that choose not to adopt cash crops. Finally, in terms of food security, cash crops do not appear to adversely affect a household’s staple food production.
# TABLE OF CONTENTS

**ABSTRACT** .................................................................................................................. ii  
**TABLE OF CONTENTS** .................................................................................................. iv  
**LIST OF TABLES** ......................................................................................................... vii  
**LIST OF FIGURES** ....................................................................................................... viii  
**ACKNOWLEDGEMENTS** ................................................................................................. ix  
**DEDICATION** ................................................................................................................ x  
**CHAPTER ONE: INTRODUCTION**  
1.1 Agricultural Development ......................................................................................... 1  
1.2 Problem Statement ..................................................................................................... 4  
1.3 Thesis Overview ......................................................................................................... 5  
**CHAPTER TWO: BACKGROUND**  
2.1 Overview ..................................................................................................................... 6  
2.2 Peasant Households .................................................................................................... 6  
2.2.1 The Economic Definition of Peasants .................................................................. 6  
2.2.2 Issues Pertaining to the Definition of Peasants ..................................................... 7  
2.2.3 Uncertainty and Risk ............................................................................................ 10  
2.3 The Cash Cropping Debate ......................................................................................... 12  
2.3.1 Criticism Framework ............................................................................................ 12  
2.3.2 Food Production Implications ............................................................................. 13  
2.3.3 Food Security ....................................................................................................... 15  
2.3.4 Instability ............................................................................................................ 18  
2.3.5 Income ................................................................................................................. 18  
2.3.6 Testing Determinants of Cash Cropping ............................................................... 21  
**CHAPTER THREE: RESEARCH SETTING**  
3.1 Overview ..................................................................................................................... 23  
3.2 The Study Area .......................................................................................................... 23  
3.2.1 General Geography ............................................................................................ 23  
3.2.2 Topography ......................................................................................................... 26  
3.2.3 Climate ................................................................................................................ 26  
3.2.4 Site Selection ....................................................................................................... 30  
3.2.5 The Village Development Committees Under Study ........................................ 30  
3.3 Sample Selection and Composition ......................................................................... 33  
3.4 Cultural and Socio-Economic Environment of the Study Area ............................... 36  
3.4.1 Religious and Cultural Practices .......................................................................... 36  
3.4.2 Family Size and Literacy Level ........................................................................... 36  
3.4.3 Off-Farm Employment ......................................................................................... 37  
3.4.4 Land Holdings ..................................................................................................... 38
<table>
<thead>
<tr>
<th>3.4.5</th>
<th>Brief Review of the Survey Data</th>
<th>39</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.5</td>
<td>Agricultural Production</td>
<td>40</td>
</tr>
<tr>
<td>3.5.1</td>
<td>Historical Agrarian Production</td>
<td>40</td>
</tr>
<tr>
<td>3.5.2</td>
<td>Introduction of New Crop Varieties</td>
<td>42</td>
</tr>
<tr>
<td>3.5.3</td>
<td>The Commercialisation of Vegetable Crops</td>
<td>42</td>
</tr>
<tr>
<td>3.6</td>
<td>Current Market Infrastructure</td>
<td>47</td>
</tr>
<tr>
<td>3.7</td>
<td>Choosing Not to Adopt a Vegetable Cash Crop</td>
<td>53</td>
</tr>
<tr>
<td>3.8</td>
<td>Adverse Effects of Inorganic Fertiliser</td>
<td>53</td>
</tr>
</tbody>
</table>

**CHAPTER FOUR: THE MODEL**

<table>
<thead>
<tr>
<th>4.1</th>
<th>Overview</th>
<th>57</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.2</td>
<td>Theoretical Considerations</td>
<td>57</td>
</tr>
<tr>
<td>4.2.1</td>
<td>Historical Development of the Logit Model</td>
<td>58</td>
</tr>
<tr>
<td>4.2.2</td>
<td>A Comparison of Linear and Logit Regression Models</td>
<td>59</td>
</tr>
<tr>
<td>4.2.3</td>
<td>The Logit Model</td>
<td>62</td>
</tr>
<tr>
<td>4.2.4</td>
<td>Rational Choice Theory and the Logit Model</td>
<td>64</td>
</tr>
<tr>
<td>4.2.5</td>
<td>Estimation of the Logit Model</td>
<td>67</td>
</tr>
<tr>
<td>4.2.6</td>
<td>Interpretation of Logit Model Results</td>
<td>69</td>
</tr>
<tr>
<td>4.2.7</td>
<td>Hypothesis Tests</td>
<td>73</td>
</tr>
<tr>
<td>4.3</td>
<td>Structure of the Empirical Model</td>
<td>75</td>
</tr>
<tr>
<td>4.3.1</td>
<td>Socio-economic Determinants</td>
<td>76</td>
</tr>
<tr>
<td>4.3.2</td>
<td>Resource Endowment Determinants</td>
<td>79</td>
</tr>
<tr>
<td>4.3.3</td>
<td>Caveats</td>
<td>81</td>
</tr>
<tr>
<td>4.3.4</td>
<td>Specification of the Empirical Model</td>
<td>82</td>
</tr>
</tbody>
</table>

**CHAPTER FIVE: MODEL RESULTS**

<table>
<thead>
<tr>
<th>5.1</th>
<th>Model Results</th>
<th>84</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.2</td>
<td>Interpretation of Estimated Coefficients</td>
<td>86</td>
</tr>
</tbody>
</table>

**CHAPTER SIX: IMPLICATIONS OF VEGETABLE CASH CROP PRODUCTION**

<table>
<thead>
<tr>
<th>6.1</th>
<th>Overview</th>
<th>90</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.2</td>
<td>Profitability and Costs of all Crops</td>
<td>90</td>
</tr>
<tr>
<td>6.3</td>
<td>Returns of Growers and Non-Growers</td>
<td>103</td>
</tr>
<tr>
<td>6.4</td>
<td>Comparative Uncertainty and Risks</td>
<td>103</td>
</tr>
<tr>
<td>6.5</td>
<td>Vegetable Cash Crop Expansion</td>
<td>106</td>
</tr>
<tr>
<td>6.6</td>
<td>Food Security</td>
<td>108</td>
</tr>
</tbody>
</table>

**CHAPTER SEVEN: SUMMARY AND CONCLUSION**

<table>
<thead>
<tr>
<th>7.1</th>
<th>Summary</th>
<th>113</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.2</td>
<td>Conclusions</td>
<td>114</td>
</tr>
<tr>
<td>7.3</td>
<td>Recommendations and Future Research</td>
<td>116</td>
</tr>
</tbody>
</table>

**NOMENCLATURE**

| 119 |

**WORKS CITED**

| 120 |

**APPENDIX 1: VILLAGES INCLUDED IN THE SAMPLE**

| 127 |
LIST OF TABLES

Table 1. Descriptive Statistics of Selected Variables ......................................................... 39
Table 2. Illustrative Values of a Dichotomous Logit Model .................................................. 71
Table 3. Logit Estimates of Vegetable Cash Crop Adoption .................................................. 84
Table 4. Interpretation of Results ......................................................................................... 87
Table 5. Production Costs and Gross Margin Estimates of Maize ....................................... 92
Table 6. Production Costs and Gross Margin Estimates of Rice ........................................... 93
Table 7. Production Costs and Gross Margin Estimates of Potato ....................................... 94
Table 8. Production Costs and Gross Margin Estimates of Tomato ..................................... 95
Table 9. Variable Cost Disaggregation of All Crops .............................................................. 99
Table 10. Returns to Labour and Labour Requirements of All Crops ................................. 101
Table 11. Grower and Non-Grower Returns to Land and Labour for Maize ..................... 103
Table 12. Gross Margin and Yield Variances of All Crops .................................................. 104
Table 13. Farmers’ Reasons for Growing Maize ................................................................. 109
Table 14. Average Resource Allocations to Maize and Maize Yields ................................. 111
LIST OF FIGURES

Figure 1. The Kabrepalanchowk District ................................................................. 24
Figure 2. The Village Development Committees of the Jhikhu Khola Watershed ........ 25
Figure 3. The Terraced Hillsides of the Jhikhu Khola Watershed ............................ 27
Figure 4. The Red Soils of the Watershed ............................................................... 27
Figure 5. The Arniko Highway Through the Jhikhu Khola Watershed ....................... 28
Figure 6. The Major Towns in the Watershed in Relation to the Arniko Highway ....... 29
Figure 7. The Village Development Committees Included in the Sample ................... 32
Figure 8. Spring Rice Crop Grown on Irrigated, or Khet, Field ............................... 41
Figure 9. Compost Used to Fertilise the Field ....................................................... 41
Figure 10. A Woman Tends her Potato Crop ......................................................... 46
Figure 11. Tomato Cash Crop Being Cultivated Next to Maize ............................... 46
Figure 12. Loading Vegetables for the Market ....................................................... 49
Figure 13. Setting Potatoes by the Arniko Highway for the Market ......................... 49
Figure 14. Carrying Vegetables to the Market ....................................................... 50
Figure 15. Kalimati Vegetable Wholesale Market in Kathmandu ............................ 52
Figure 16. Vegetables Being Sold at the Retail Level in Kathmandu ....................... 52
Figure 17. Animal Dung Being Dried on the Side of the House for Fuel .................... 56
Figure 18. Cropping Calendar of All Crops ............................................................ 99
ACKNOWLEDGEMENTS

As in any endeavour of this nature, there are many people who made this thesis possible. I am indebted to the following people: Dr. Ron Shearer, for helping me keep this madness in perspective and for being the best boss I have ever had; Dr. Marty Puterman, for showing me the way in 20 minutes; Dr. Ashok Kotwal, for agreeing to be on my committee when I was at my wit’s end, and for being so positive about my thesis; Dr. Villia Jefremovas, for listening to my ramblings, and giving me direction and moral support when I needed it; and Kathy Shynkaryk for being so terrific.

I would also like to thank my friends in Winnipeg and Vancouver, for their support and for listening to my complaints good-naturedly. I would especially like to thank Laura Cain, Andrea Harris, and Michelle Soucie - you guys made UBC a fun place to be. Victoria Watson deserves a special note of thanks for patiently explaining logit models, pseudo-R$^2$, and SHAZAM outputs, and for answering all my obtuse questions. My thanks also to Sunil Rao, who gave me ever-so-helpful advice regarding grad school, the mysteries of statistics, and the most inspiring pep talks ever!

I would like to thank Martin Carver and Sandi Brown for sharing their knowledge and experiences of Nepal with me. In Nepal, I would like to thank Mr. R. Werner and Mr. P. Wennubst of the FAO, who made me feel my work was worthwhile and interesting, and who generously shared their insights and their friendship with me. I would also like thank Fernanda Wennubst, for feeding me the best pasta in all of Asia. I would like to extend my gratitude to Mr. Shah and the MRM team for making things as easy as possible for me. I am especially indebted to Subba and Mrs. Bhatterai, my friends and colleagues in the field - it would have been very dull without you. Also in Nepal, I would like to thank Mr. Norkyel and the people of Hotel Garuda who made me feel at home in the Himalayan kingdom. My eternal gratitude to the people of the watershed for answering my seemingly silly questions, and for helping me put life into perspective.

I would like to thank Mr. and Mrs. McQueen for welcoming me into their home and hearts. I would also like to thank my family for their generous support and undeserving admiration. To Divya I dedicate all the d’s and b’s in this thesis, and to Rolie I dedicate pages 51-69 (have any more bonds?). Finally, needless to say, I am indebted to James McQueen - your humour, unfailing support, and intelligence have taught me more than a thing or two, and have kept me sane - I could not have done this without you.
DEDICATION

To Mom and Dad
CHAPTER ONE
INTRODUCTION

1.1 Agricultural Development

The overwhelming majority of the world’s poorest people, over 70 per cent, live in rural areas and are primarily engaged in peasant agriculture. It is estimated that over one billion people belong to these peasant households. Consequently, development economists have increasingly recognised that the agricultural sector of low-income developing countries must be transformed into the dynamic and leading component in any overall economic development strategy. If “development” is to take place and become self-sustaining, it must start in the agricultural sector (Todaro 1994; Ellis 1988).

In Nepal, 90 per cent of the people live in rural areas. The agricultural sector employs 93 per cent of the labour force; it contributes to about 60 per cent of the Gross Domestic Product (GDP), and accounts for 60 per cent of Nepali exports (UNDP 1993; Shah and Aryal 1992). Consequently, the necessity of improving the conditions of the people in rural areas through development of the agricultural sector is of even greater importance.

Peasants of the Middle Mountains of Nepal are increasingly being faced with challenges as they struggle to improve their well-being. Factors such as population pressure, the changing nature of various markets, price fluctuations, unfavourable input-output price ratios, and changes in soil productivity are forcing these farmers to consider alternatives to their present agricultural practices. One alternative that has been gaining popularity amongst a number of Nepali farmers is the production of vegetable cash crops (Shah and Aryal 1992; Shah and Raut 1992; Budathoki, Gurung and Lohar 1992; Shrestha and Werner 1992). Government authorities have also targeted vegetable production as an integral part of the overall development strategy for this small Himalayan kingdom.
All peasant households produce a variety of agricultural output, some for their own needs, and the rest, to varying degrees, for the market. Many Nepali peasant households, however, are increasingly becoming engaged in distinctively more market-oriented agricultural activities, such as vegetable cash crop production. This is especially true of peasants located in peri-urban areas who have relatively easy access to markets and are consequently more aware of signals from the market.

In the past, the “green-belt” around Kathmandu, the capital of Nepal, has been the main source of agricultural food commodities for the city. The Newari\textsuperscript{1} Jyapoo farming community in the Kathmandu Valley\textsuperscript{2} has historically produced a large proportion of the vegetables sold and consumed in the Kathmandu market and other nearby areas (Pandey 1992). As the population of the valley has grown, however, this agriculturally fertile region is being converted for urban and industrial uses. Consequently, peasant households, in the peri-urban area surrounding the Kathmandu Valley, that previously produced mainly for their own needs, are changing their agricultural production activities. Now they are choosing to produce vegetable cash crops to meet the demands of the urban areas in the Valley that can no longer be met by producers in the disappearing “green-belt”.

The case of the Jhikhu Khola Watershed, where this study was conducted, is a particularly illustrative example of this phenomenon. The Jhikhu Khola Watershed, in the Middle Mountains of Nepal, is about 40 km east of Kathmandu. The Arniko Highway, which connects Kathmandu to Tibet, runs through the centre of this watershed. This highway is a unique feature of the watershed as most areas of Nepal can not be reached by paved roads. This presents a number of opportunities to the farmers in the watershed, such as access to markets.

\textsuperscript{1}The Newars are a Nepali ethnic group who are considered to be the original inhabitants of the Kathmandu Valley.
\textsuperscript{2}Kathmandu is located in the Kathmandu Valley, which is primarily comprised of three cities, Kathmandu, Lalitpur (or Patan), and Bhaktapur.
Many peasant households in the Jhikhu Khola Watershed that previously were primarily subsistence-oriented are increasingly adopting vegetable cash crops in response to the needs of the markets in the Kathmandu Valley and other nearby towns along the Arniko Highway between the watershed and Kathmandu. In fact, vegetable production has increased so much in the watershed that Panchkhal, a sub-region of the Jhikhu Khola Watershed, is considered to be part of the important North-South vegetable production corridor (Shah and Aryal 1992).

His Majesty’s Government of Nepal (HMG/N) has been keenly interested in horticulture since the inception of the Agricultural Council in 1937. A separate Department of Horticulture was formed in 1967 to assist in production due to the increased demand for horticultural products. Under a re-organisation plan, this department was later amalgamated with other related departments into the Department of Agriculture.

The democratically-elected government of Nepal has made horticulture development a priority as stated in the Agriculture Policy and Priority Note. In the HMG/N Plan for Vegetable Development in Nepal, initially proposed in 1990, the government gave increased vegetable production “priority...so as to increase rural income, improve nutrition of people [sic] and increase export earning(s)” (Aryal 1990, 4). The stated goal in the programme is to reach a per capita per annum vegetable consumption of 64 kg by the year 2000 (Aryal 1990). Moreover, with the re-establishment of the Department of Horticulture in the Master Plan for Horticulture Development in Nepal (1991), the emphasis on horticulture development has gained new significance.

Peasant households that choose to adopt vegetable cash crops can realise significant benefits (Shah and Aryal 1992; Shah and Raut 1992; Carson 1992). Vegetable cash crop production has already been identified as an activity that can raise incomes, and may increase the standard of living for peasant households in Nepal (APROSC 1987; Shrestha and Werner 1992). In their socio-economic study of farm households in the
Jhikhu Khola Watershed, Kennedy and Dunlop showed that a high profit can be earned from selected vegetables (Kennedy and Dunlop 1989).

1.2 Problem Statement

Despite the interest on behalf of many peasant households, government support, and the apparent benefits of growing vegetables, controversy surrounds the adoption of cash crops. A cursory review of the literature on the topic appears contradictory. It is often argued that the adoption of cash crops by primarily subsistence-oriented peasant households results in maladaptation which can adversely affect staple food production, household income, and rural employment (Maxwell and Fernando 1989). Evidence linking cash crop adoption with these potential pernicious outcomes, however, is controversial.

This suggests a more thorough examination of the effects of vegetable cash crop adoption by peasant households in the Middle Mountains of Nepal. In addition, a theoretical and empirical investigation of the behaviour of peasant households in the Jhikhu Khola Watershed is crucial. After all, these peasant households have limited resources available to them, therefore, any decision they make regarding what crop to grow involves a careful assessment of which crop to allocate their scarce resources, cash crops or staple food crops. A better understanding of the factors that determine vegetable cash crop adoption by these peasants can provide insight into their production constraints, the decision-making process, and which households are most likely to adopt these crops. An analysis of the determinants of vegetable cash crop adoption will assist planners and policy-makers in formulating appropriate strategies to support these households.

The objectives of this study are twofold: the first objective is to identify and analyse the relevant factors that affect a household’s decision to grow a vegetable cash crop; the second objective is to examine the implications of vegetable cash crop adoption.

In order to test the determinants of vegetable cash crop adoption, a statistical logit model is employed. The model attempts to identify the significant factors in adopting...
vegetable cash crops in a lucid manner. Cross-sectional peasant household data from the Jhikhu Khola Watershed are used to empirically test and analyse this model. Household characteristics are hypothesised to be essential factors in analysing vegetable cash crop adoption. A variety of household characteristics, such as education level of the household head and soil quality, are considered in the empirical analysis.

An analysis of the implications of adoption is also undertaken. The effects of adoption are assessed by comparing cash crops with staple food crops. The evaluation of the effects, both positive and negative, consists of an assessment in the following five areas: a) the profitability and costs of both cash and staple crops; b) the returns of those households that do, and those that do not, adopt a cash crop; c) the risks and uncertainties involved in the production of cash and staple crops; d) the perceived constraints to cash crop expansion; e) and finally, the effect of cash crop adoption on food security.

1.3 Thesis Overview

The second chapter provides a brief overview of the economic definition of peasants and a review of the literature of cash cropping and studies similar in nature to this paper. The setting of the study is described in Chapter three, along with the motivation for choosing the region. The theoretical foundation for the empirical model, and the empirical model itself are discussed in Chapter four, while the results are presented and examined in Chapter five. In Chapter six, the implications of adopting vegetable cash crops are discussed. Finally, Chapter seven offers a summary and concluding remarks.
CHAPTER TWO
BACKGROUND

2.1 Overview

In order to establish the framework of this study, a brief overview is given of peasant households and the cash cropping literature. The term peasant, the unit of analysis in this study, conjures a number of different images; as such, the definition of peasants that is used in this study is outlined, along with issues relevant to peasants. In addition, an explanation is given for uncertainty and risk in relation to peasants. The issue of cash cropping is extremely contentious, as a survey of the literature reveals. Critics of cash cropping deny that real benefits can be attained from producing cash crops; conversely, proponents argue that the production of cash crops can alleviate poverty. Various cash cropping studies from different developing countries and Nepal are reviewed, and the relevant results are presented.

2.2 Peasant Households

An economic definition of peasants, issues relevant to this definition, and uncertainty and risk are briefly outlined in this section.

2.2.1 The Economic Definition of Peasants

In his excellent book on peasants, Ellis (1988) describes peasant production as a type of agricultural production where the peasant farm household is neither fully integrated into the wider economy, nor is it wholly insulated from the pressures of that wider economy.3 Peasant populations have one foot in the market, and the other in subsistence agriculture. Most of the one billion people who belong to peasant households live in low-income developing countries where they may comprise as much as 70 per cent

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3This section is adapted from Ellis (1988), Chapters 1 and 5.
of the population. These peasant households are rarely prosperous, often living in precarious situations, and include some of the poorest people in the world.

Although the term "peasant" does have derogatory connotations in ordinary usage, it has certain distinguishing characteristics that make it preferable to other terms when describing the farm household that is the subject of this study. The two integral characteristics are the "partial integration into markets" of peasant households, and the "limitations in the operation of market principles" in the peasant economy (Friedmann 1980, 164). Due to these characteristics, the following definition of peasant is used in this study:

"Peasants are farm households, with access to their means of livelihood in land, utilising mainly family labour in farm production, always located in a larger economic system, but fundamentally characterised by partial engagement in markets which tend to function with . . . imperfection." (Ellis 1988, 12).

This definition is centred around the concept that peasants are only partially integrated into incomplete markets. The decision-making process of peasant households is based on this fundamental idea, which has two aspects. The first is the varying degree to which peasants are committed to the market;\(^4\) the second aspect is the incomplete development of the markets which confront peasants.

### 2.2.2 Issues Pertaining to the Definition of Peasants

The following points should be noted with respect to this definition:

a) it distinguishes peasant production from other kinds of farm production, be this plantation, estate, or commercial family farm;

b) it does not mistakenly identify peasants with stagnation and tradition;

\(^4\)This also implies a variable capacity to withdraw from the market and still survive.
c) it encompasses the household as the unit of analysis, the larger economy, and the interaction between them;

d) it is relevant for economic analysis, in that it delineates the economic conditions of peasant farm households which differ analytically from the conditions of other farm enterprises;

e) it does not ascribe any notion of economic irrationality to peasants; rather peasant households are engaged in the pursuit of household goals like any other economic agent;

f) it indicates the inadequacies of terms like "traditional", "subsistence", and "small" which are often used to describe the peasant farm household. These terms refer to value-laden production techniques or psychological factors, are incomplete, or have little theoretical content;

g) it distinguishes peasant farm households from the commercial family farm, its nearest relation, which is completely integrated into functioning markets. By doing so, it makes explicit the main purpose of most rural development policies, which seems to be to accelerate the transformation of peasant households to commercial family farms;

h) it does not enforce a rigid criterion by which the transition from a peasant farm household to a commercial family farm can be marked. According to the definition, peasants cease to be peasants when they become wholly committed to cash crop production in fully formed markets. Rather than a strict delineation from one operational environment to another, the degree of specialisation and commitment to market transactions is the main criterion.

This definition does not exclude other socio-economic characteristics associated with peasant communities. Wider aspects of this definition include the concepts of transition, markets and exchange, internal differences, dominant economic activity, land and labour, and cash crop production. The idea of transition injects a sense of history and
change, and also implies adaptation. The speed of change, however, and the outcome of this transition are not known, nor can they be determined in advance. Transition means "that peasants are never just 'subsistence' or 'traditional' cultivators (terms often used by agricultural economists to describe them) caught in a timeless vacuum"; rather, they are "undergoing a continuous process of adaptation to the changing world around them" (Ellis 1988, 5).

Another relevant feature of peasant communities is that peasant households are part of a larger economic system (Wolf 1966, 8). Peasant production is exposed in some degree to market forces since they participate in this larger system. Even if peasants are only active in markets for a small proportion of their requirements, the inputs and outputs of the farm household are "subject to valuation by the wider market, at prevailing prices" (Ellis 1988, 6).

The relationship of peasants to the market is stressful since markets provide both opportunities and pressures for peasants. An example of the pressures that peasants are confronted with is the exercise of unequal market power, which is an indicator of imperfect markets. In general, markets "are not fully formed when they are spatially fragmented due to poor transport and communications" (Ellis 1988, 11). This is the case in the Jhikhu Khola Watershed. Poor access to and availability of information is a fundamental problem in most developing countries. Typically the relatively small segment of society (such as merchants or officials) that does have access to essential market information wields unequal market power over others who do not (peasants).

Peasants are not a homogeneous group, all with the same status and prospects within their communities. Social and economic differences do exist within these communities. Rather, they are "always and everywhere typified . . . by internal differentiation along many lines" (Mintz 1974, 93). In this context, "differentiation" denotes differences in social status.
For the purposes of this study, peasants are farmers who obtain their livelihood from the land, though crop cultivation and livestock management, to varying degrees. Typically in peasant communities land is much more than another factor of production. It is the "long term security of the [household] against the hazards of life, and it is part of the social status" (Ellis 1988, 8) of the household within the village or community. It is generally accepted that reliance on family labour is a defining characteristic of peasant households. This does not exclude the use of hired labour, nor the sale of labour by household members. In fact, for some households this may be essential for their survival. This is another link between the wider market, in this case the labour market, and the peasant household.

Many peasants sell a portion of their output in the market for cash, whether grown specifically for sale, or because production was in excess of household consumption requirements (Maxwell and Fernando 1989). For the purposes of this study, a cash crop is defined to be a crop grown specifically for the market. By engaging in cash crop production, and thereby participating in markets (output markets and perhaps factor markets), peasant households may be able to improve their living standard; conversely, they may be ruined by such problems as adverse price trends.

2.2.3 Uncertainty and Risk

It is widely recognised that a high degree of uncertainty characterises peasant households in developing countries. Before continuing with risk and uncertainty, a definition of these terms will help elucidate the following discussion. Risk refers to the subjective probabilities attached by household decision-makers to the likelihood of the occurrence of different events. Risk is used to describe the entire mechanism by which households make decisions with respect to uncertain events. Uncertainty refers in a

5Note that other rural dwellers such as landless labourers, plantation workers, pastoralists, and nomads are excluded when referring to peasant households.
descriptive sense to the character of the economic environment confronting peasant farm households; "an environment which will contain a wide variety of uncertain events to which households will attach various degrees of risk, according to their subjective beliefs of the occurrence of such events" (Ellis 1988, 83).

This uncertainty is quite serious and pervasive in low-income developing countries for several reasons: a) markets are unstable where information is poor and other imperfections are common; b) the insecurity of poor peasant families due to low social and economic status; c) vagaries of state action can exacerbate problems that peasants face; d) the effect of weather, pests, diseases and other natural calamities is unknown; and e) due to the sheer poverty of so many peasant households, the uncertain outcome of events can make the difference between survival and starvation.

Peasant agriculture in developing countries is subject to types of uncertainty which are not so prevalent in the organised production structures of high-income industrial countries. The four types of uncertainty relevant to this study are market fluctuations, social uncertainty, state action, and output uncertainty. Output prices are not known at the time that production decisions are made. This is common to agriculture world-wide and is a major reason for state intervention in agricultural markets in many countries. This problem is heightened where there is a lack of information and markets are imperfect; these features are characteristic of peasant agricultural systems in low-income developing countries.

Social uncertainty refers to insecurity caused by differing degrees of access households have to resources within a peasant economy. The varying levels of access is determined by a household's socio-economic position within the community.

The peasant economy is susceptible to the vagaries of decisions made by the state which may change greatly, from one moment to the next, one political coup to the next, and one visit by the International Monetary Fund (IMF) to the next. The level of this type
of uncertainty varies across space and time; nevertheless, it can not be overlooked in the economic study of peasants.

Output uncertainty is the final type of uncertainty relevant to this study. This is also known as yield uncertainty. It refers to the unpredictable impact on output, or yields, of weather, pests, disease, and other natural calamities. Adverse weather conditions can affect the outcome of planting decisions at any stage, from planting, cultivation, to harvesting of the crop. The capacity to combat pests and disease may depend on the ability of the household to purchase inputs, and this can vary from one household to the next.

2.3 The Cash Cropping Debate

The cash cropping debate involves a number of different issues and concepts. Some are relevant to this study, while others are not. This section provides an overview of the issues involved by reviewing the literature of cash cropping undertaken in various countries, including Nepal.

2.3.1 Criticism Framework

A number of the criticisms against cash cropping are not relevant to the situation in the Jhikhu Khola Watershed. These criticisms relate to issues such as definitions, exports, and intensive use of capital. The debate involves different definitions of the term “cash crop”, different levels of analysis, and different crops. In their systematic overview of the variegated cash crop literature, Maxwell and Fernando (1989) identify four definitions in the literature: a) all marketed surplus; b) non-staple agriculture; c) non-food agriculture; and d) export agriculture. Livestock and forest products are included in these definitions. Not all of these definitions, however, are relevant to this study. As mentioned earlier, cash crops are defined in this study to be a crop grown for commercial purposes.

Most of the analysis of cash cropping deals with export crops because internationally comparable data sets tend to be only available at the national level. Much of this export crop analysis is also not relevant to this study since the cash crops grown in the
watershed are being produced to meet domestic needs and demands; they are not produced for export purposes. Consequently, the adverse effects related to declining terms of trade, leading to "immiserising growth" are not pertinent (Prebisch 1950; Singer 1984; Lewis 1969; Lappe, Collins, and Fowler 1977; Wanders 1993).

Critics of cash cropping also argue against the large scale capital-intensive methods by which the crops are produced (Maxwell and Fernando 1989). Again, this is not the case in the watershed since the peasant households under study are involved in strictly small-scale, labour intensive cash crop production systems.

Some of the characteristics of the "best case" cash crop are: a) the crop should be a food crop; b) it should have a short maturation period; and c) it should be labour intensive (Maxwell and Fernando 1989). The case of vegetable cash crop production in the Jhikhu Khola Watershed is an example of this "best case" scenario. Peasant households have begun to produce vegetable cash crops (potato and tomato), which are obviously food crops; they have relatively short planting and harvesting periods; and as will be shown later, potato and tomato are labour-intensive crops.

2.3.2 Food Production Implications

The effects of cash crop production on staple food production is a controversial issue. A series of case studies conducted by researchers at the International Food Policy Research Institute (IFPRI) suggest that yield increases in staple food production associated with cash crop production offset the negative impact of reduced input allocations to the staple food crop (Bouis and Haddad 1990; Kennedy 1989; Kennedy and Cogill 1987; von Braun, de Haen, and Blanken 1991; von Braun, Puetz, and Webb 1989). For instance, in their study of co-operative members in Guatemala, von Braun, Hotchkiss, and Immink (1989) found that the availability of the staple food crop, maize, is not reduced as a result of cash crop production. In fact, on average, cash crop producers tend to have similar or higher amounts of maize available compared to non-growers. This is
true despite their relatively lower land and labour inputs to maize. Household-level production is maintained due to higher yields.

Immink and Alarcon (1993) found that Guatemalan farmers with diversified production patterns have more types of own-produced foods available for consumption, leading to partial substitution of own-produced foods for staple crops like maize. Peters and Herrera (1994) found similar results in their results in their study of tobacco growers in Malawi. Tobacco is the highest value crop in the study area, and maize is the main staple crop. On average, tobacco growers tend to have larger land holdings and larger households; they also tend to devote a smaller proportion of their land to maize, relative to non-growers. Despite these factors, households that grow tobacco, on average, produce about the same amount of maize per capita as do non-growers. Thus, similar per capita maize harvests indicate that tobacco production does not displace maize production.

As von Braun and Kennedy (1987) correctly observe, cash crops do not always compete for resources with staple food crops. Cash crops may be grown in different seasons, or in different locations with soils or altitudes inappropriate for the staple crops. The authors analysed national aggregate data from 78 developing countries. From their findings, von Braun and Kennedy conclude that in fact the area allocated to cash crops is positively correlated with growth in staple food production; they also found that growth in the share of land allocated to cash crops was generally associated with increased food crop production per capita.

von Braun and Kennedy do qualify their findings by stating that the effects of increased cash cropping may be positive, negative, or neutral on food availability. The nature of the effect depends upon the operational environment; that is, it depends upon the degree of market imperfections, infrastructure development, government policies, and technical support. Nevertheless, von Braun and Kennedy do demonstrate that cash crop production is not mutually exclusive with food production.
This appears to be the case in the Jhikhu Khola Watershed. Due to climatic conditions and other factors, cash crops do not necessarily compete with staple food crops. As will be shown later, the majority of households that choose to produce vegetable cash crops do in fact have sufficient amounts of staple food available for their needs.

2.3.3 Food Security

A major concern of the “food first” proponents is the issue of food security. A household is said to be in a “secure food position when it always, throughout the seasons and over the years, has the ability to acquire the food needed to maintain the health of all its members” (von Braun, Hotchkiss, and Immink 1989, 53). Cash cropping is regarded by some critics as an enemy of food security. At the household-level, it is argued that cash crop production undermines access to food by the production of non-food crops, exotic crops, and complete substitution of basic food crops with cash crops (George 1976; Lappé, Collins, and Fowler 1977, 1986; Twose 1984).

The production of non-food crops, such as coffee, jute, and animal feed crops can adversely affect the production of basic food crops. Thus, even though a country is able to produce record levels of cocoa or coffee, the producing areas may still be classified as “food-deficit” regions because the households are unable to grow sufficient amounts of food (Lappé, Collins, and Fowler 1977, 1986; Twose 1984).

Critics of cash cropping have often been concerned more specifically with exotic commodities that are grown to supply local elites or foreign markets (George 1976; Lappé, Collins, and Fowler 1977, 1986; Mackintosh 1977). This production of luxury crops exacerbates food shortages in the production areas since scarce resources are devoted to these exotic crops instead of staple food crops (Lappé, Collins, and Fowler 1977).

Complete substitution of food crops with cash crops is also identified as a mechanism that can reduce the food security position of a household. Barkin, Batt, and De
Walt (1990) illustrate the numerous drawbacks of complete specialisation with country analyses from Asia, Latin America, Africa, and the Middle East.

The cash crop production systems under examination in this study do not fall under any of the three categories just mentioned. The cash crops are vegetables, so they are obviously food crops. These vegetables have been cultivated in kitchen gardens for the last 15-20 years by a few households; they have not, however, traditionally been grown as cash crops. Also, these vegetables, tomato and potato, have long been a part of Nepali diet and cuisine. The "non-traditional" aspect of these vegetable crops is that only relatively recently have households begun to produce them specifically for the market. These vegetable cash crops do not fall under the same category as grain-fed beef being raised in Central or South America to supply the American market (Lappé, Collins, and Fowler 1977).

Neither are the households in the watershed specialising in cash crop production; that is, they are peasants who choose to incorporate a vegetable cash crop into their production system. They are not completely replacing their staple food crop with cash crops. By diversifying their production and growing food crops in addition to their staple food crops, these households are also able to diversify their food consumption patterns. This is regarded to be an important benefit by cash crop supporters in terms of production and consumption growth (Watkins 1963; Baldwin 1966; Hirshman 1977; Hubbard 1986).

Pinstrup-Andersen (1983) identifies four key aspects of the cash crop/food security issue: a) food availability; b) ability of the household to obtain food; c) desire to obtain food; and d) intra-household distribution. Using this framework, von Braun and Kennedy (1986) undertook a detailed literature survey for IFPRI on the effect of cash cropping on food consumption and nutrition. There were not many studies available on household food consumption at the time; von Braun and Kennedy were able to identify only nine studies. Three of these are from Kenya (Hitchings 1982; Rabeneck 1982; Fleuret and Fleuret 1980, 1983) two each from Mexico and Papua New Guinea (Dewey 1979; Hernandez et al.
1974; Lambert 1978; Harvey and Heywood 1983), and one from Tanzania (Lev 1981). The variety of cash crops that are dealt with in these studies is also limited, as six of the nine studies deal with coffee. von Braun and Kennedy conclude that no trend may be discerned from these studies due to differences in methodological approaches; that is, cash cropping may or may not have adverse effects on nutrition, and hence on food security.

This conclusion is consistent with other studies on cash cropping and food security (Longhurst 1988). The Food and Agricultural Organisation (FAO) conducted two studies in Africa, one of tea in Kenya, and the other of cotton in Zambia. These studies concluded that nutritional status was independent of cash crop production (FAO 1984).

Kennedy (1994) found that sugarcane production in Kenya led to a very small, positive effect on nutrition. This benefit at the household level, however, does not appear to have a dramatic influence on pre-schoolers. von Braun, Hotchkiss, and Immink (1989) conducted a study of Guatemalan co-operative where the peasants produce non-traditional vegetables for export. They found that these co-operative members still allocate, on average, over half their land to staple food crops, and that household income increases as a result of cash crop production. Due to this significant home production, coupled with increased incomes, the average co-operative member household spends 14 per cent more per capita on food; that is, food purchases increase despite cash crop production.

In his overview of the effect of commercialisation on food expenditure from eleven case studies, Bouis (1994) concludes that commercialisation has resulted in higher calorie intakes, due to increased incomes. He also concludes that cash cropping is not detrimental to nutrition.

Pre-school children tend to be the most vulnerable members of peasant households. Consequently, a number of studies, most notably IFPRI studies, examine the effects of cash cropping on the health and nutritional status of children. Using the same

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eleven studies, Kennedy (1994) concludes that there is clear negative effect of cash crop production on children's health and nutrition. This conclusion is tempered by the additional observation that the various cash cropping schemes did not decrease child morbidity, at least in the short and medium run.

2.3.4 Instability

Despite whatever short-term advantages of cash cropping, instability may reduce these benefits. At the "household-level, instability may be associated with production risk or market risk" (Maxwell and Fernando 1989, 1681). Thus "compared with the farmer ... who lives on what he grows and thus vulnerable only to variations in his own output ... the grower of cash crops ... is vulnerable to both output fluctuations and shifts in marketability of commodities" (Sen 1981, 126). This adverse effect of cash crop production may be offset; although cash cropping entails a market risk, selling a proportion of the output may help to offset the production variability of staple food crops. In a study in Sudan, Reeves (1984) argued that farmers diversified risk by producing a wide variety of cash and staple crops, with cash crops acting as a hedge against the failure of food production "which is generally riskier due to climatic and crop specific characteristics" (Reeves 1984, 102). Shahabuddin (1982) argues that Bangladeshi farmers try to avoid "market-place risk" by devoting a large share of their land holdings to staple crops. For those farmers, however, whose incomes from farming activities are insufficient to meet subsistence needs, it is rational to devote a relatively higher acreage to cash cropping; this is true despite greater price variance because the returns from cash cropping maximise their chances of survival (Shahabuddin 1982, 95 and 100).

2.3.5 Income

Proponents of cash crop production claim that households can realise increases in income by producing these crops (Bouis and Haddad 1990; Kennedy 1989; Kennedy and Cogill 1987; von Braun, de Haen, and Blanken 1991; von Braun, Puetz, and Webb 1989).
In many countries, cash crop production has been identified as a means to alleviate rural poverty. As already mentioned, the Nepali government has explicitly selected the production of vegetable cash crops as a mechanism to increase rural incomes.

In a sugarcane study in Kenya, Kennedy (1994) observed that the per capita incomes of sugarcane farmers are significantly higher than farmers who do not grow sugarcane\(^7\) (Kennedy 1994). Interestingly, in a follow-up study, both in real and nominal terms, incomes per capita of the sugarcane producers were higher than non-producers.

In their study of Guatemalan peasants, Immink and Alarcon (1993) observed that growers of cash crops earned higher per capita monthly incomes than did non-growers. On average, cash growers’ monthly incomes were 8 to 30 per cent higher than maize growers. Similarly, von Braun, Hotchkiss, and Immink (1989) found that net returns to land and labour were higher both for vegetable cash croppers compared to staple crops, and the net returns of staple crops cultivated by cash croppers in comparison to non-growers.

Recent studies conducted in Nepal illustrate that households may be able to increase their incomes by growing vegetable cash crops. Shah and Aryal (1992) estimated gross returns from various vegetables in their study of horticulture development in Nepal. In five districts in Nepal, gross returns per hectare were two to seven times that of the national average returns from maize. Even compared to paddy, the gross returns from selected vegetables were 2.5 times that of paddy. Similar results were found in a study of vegetable production undertaken in the same district as this study (APROSC 1987).

Kennedy and Dunlop (1989) undertook a detailed household-level survey in the Jhikhu Khola Watershed. The objective of their research was to understand the farming/household system in the watershed. The authors hoped to learn the constraints faced by farmers, and their aspirations. The research was carried out in two stages; one

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\(^7\) Ksh 2,591 vs Ksh 1,924. Ksh is the abbreviation for the Kenyan shilling.
area (Panchkhal) was studied in the first phase, while in the second phase surveys were undertaken in two other areas in the watershed, Baluwa and Rabi-Opi.

Methods based on the Rapid Rural Appraisal (RRA) approach were used in gathering the data. This approach involved interviews with farm families, key informants, and observation. The interviews were semi-structured. The authors' purpose was to understand the farming/household system in the watershed, not to produce statistical results.

The sample was a cross-section of caste/ethnic groups, various income levels, ridge and valley farmers, farms with different aspects, and remote and easily accessible farms. Simultaneous and separate interviews were undertaken of both the male and female household heads.

In terms of production constraints, Kennedy and Dunlop found that the main obstacle faced by peasant households was the lack of irrigation water, and obtaining inputs. The inputs include fertiliser, labour, equipment, and improved seed. Problems relating to inorganic commercial fertiliser, such as the unavailability of the right type of fertiliser at the right time, were highlighted by farmers as production constraints. Kennedy and Dunlop note that about half the farmers made comments suggesting dependence upon inorganic fertiliser. Farmers mentioned that they have to use more inorganic fertiliser each year in order to maintain their yields. Other problems were also mentioned by farmers. In Rabi-Opi, 48 per cent of farmers mentioned disease as a limitation. Many of these same problems are still prevalent in the watershed.

Despite the positive effects on income from cash crops illustrated by the studies cited here, the gains in nominal income could be offset by increases in the price of food and non-food items. If local markets function effectively, such that food supplies can move relatively easily from one region to another, cash crop production need not affect local food prices. If, however, markets are unable to respond to decreased food supplies due to administrative or logistic constraints, real incomes may not in fact increase.
2.3.6 Testing Determinants of Cash Cropping

The study by von Braun, Hotchkiss, and Immink on non-traditional crop production in the Guatemalan Highlands is quite extensive. This study examines the effects of increased cash cropping by peasant households on agricultural production, income, employment, food expenditures, food consumption, and child nutritional status. The focus of the study is a vegetable cash crop exporting co-operative, situated in the Western Highlands in Guatemala. The peasants in the co-operative are cultivating vegetables that have traditionally not been grown in the area (snow peas, broccoli, and cauliflower) for export purposes. The analysis and results of the study are based upon two detailed household-level surveys undertaken in six villages in 1983 and 1985.

As in the study on hand, von Braun, Hotchkiss, and Immink test for the determinants of export crop growers, assess the profitability and risks of cash and staple crops, and analyse the effects of producing cash crops on staple food crops. Using a statistical probit model, the authors found that household characteristics are significant in determining which households adopt an export vegetable cash crop. As mentioned earlier, their analysis shows that the non-traditional cash crops are more profitable than maize and beans, the staple crops. The net returns per hectare for snow peas, for example, are on average 15 times greater than those for maize. The labour requirements, however, are also much greater for snow peas; consequently, the returns of snow peas per family unit of labour are only twice as high as that for maize. They also found that growers attained higher maize yields than non-growers, so that cash crop production is not detrimental to food production and availability.

This chapter gave a brief overview of the economic situation of peasants and the cash cropping literature. Various cash cropping studies from different developing countries and Nepal were reviewed, along with the relevant situation in the Jhikhu Khola Watershed. It was shown that the vegetable cash crops under study, potato and tomato, do not fall under the areas of concern; that is, they are food crops, they are not exotic cash
crops, they are not capital-intensive, and households are not completely specialising in their production. In fact, the case of vegetable cash crop production in the Jhikhu Khola Watershed is an example of “best case” cash crops.
CHAPTER THREE
RESEARCH SETTING

3.1 Overview

A brief description of the research area is given in this chapter. The physical characteristics of the watershed are characterised. After explaining the selection and composition of the study sample, the cultural environment of the Jhikhu Khola Watershed is described. In order to understand the environment in which these peasant households operate, the agricultural context of the watershed is outlined, both past and present. Valuable insights into the motivations for growing, and not growing, vegetable cash crops can be gained by examining the market infrastructure, and other factors that are taken into account by households in the watershed. Finally, the effects of inorganic commercial fertiliser are presented.

3.2 The Study Area

3.2.1 General Geography

Nepal is administratively divided into five regions, which are subdivided into a total of 75 political districts. These districts in turn are further divided into local political areas known as Village Development Committees (VDCs). The Jhikhu Khola Watershed is located in the Kabrepalanchowk District, about 40 km east of Kathmandu (see Figure 1). The district office is located in the town of Dhulikhel, which attracts more foreign tourists each year. Geographically the watershed is situated in the Middle Mountains of Nepal. It is comprised of thirteen VDCs in total, illustrated in Figure 2.
Figure 2. The Village Development Committees of the Jhikhu Khola Watershed.
3.2.2 Topography

The altitude of the study area ranges from 835m to 1800m above sea level. The hills are situated in an east-west direction throughout the watershed (see Figure 3). Structurally, the watershed is quite complicated. The most important and active fault in the area appears to be along the Jhikhu Khola. This fault has affected the stability of the adjoining hill slopes, resulting in landslides (Dongal 1991). The soils are a mixture of sandy, clay, and loam types in the watershed. Alluvial loam soil is common in lands adjoining the Jhikhu Khola, with rich loam soils in the ridges, illustrated in Figure 4.

As mentioned earlier, the main paved road in the watershed is the Arniko Highway, illustrated in Figure 5. Transportation of produce and people occurs mainly on this highway as buses and minibuses travel from the Tibetan border to Kathmandu, shown in Figure 6.

3.2.3 Climate

The climate is sub-tropical, with temperatures ranging from a maximum of about 40°C during the summer months to a minimum of about 3°C in the winter. On a monthly basis rainfall can range from a low of 0 mm to 350 mm during the monsoons. Occasionally there will be some rainfall in January, and at times hail storms do occur during March and April.

The climate is quite diverse throughout the watershed, and is quite conducive to the production of a wide variety of crops virtually year-round. For instance, in many areas temperate cole crops, such as cauliflower and cabbage, can be grown during the winter, and various tropical vegetables can be grown in the summer months. Varying altitudes and aspects create numerous micro-climatic zones that allow the production of the same crops at different times of the year.

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8 The Jhikhu Khola is the main river in the watershed.
9 Carver, Martin, PhD. candidate. 1995. Personal communication with author, 14 February, Vancouver.
Figure 3. The Terraced Hillsides of the Jhikhu Khola Watershed.

Figure 4. The Red Soils of the Watershed.
Figure 5. The Arniko Highway Through the Jhikhu Kholo Watershed.
Tomatoes, for example, can be planted in some areas during the latter part of winter, and harvested in April-May when vegetables are in short supply in Kathmandu (Kennedy and Adhikari 1989). Tomatoes can also be planted in July and harvested in October, during the Nepali festival of Desain, when they fetch an extremely high price.10

3.2.4 Site Selection

The Jhikhu Khola Watershed was selected for this study because it is the site of the Mountain Resources Management (MRM) project, a joint collaboration between the University of British Columbia (UBC) and the MRM research team in Nepal. The main focus of the MRM project, which is based at the International Centre for Integrated Mountain Development (ICIMOD), is resource dynamics and degradation in the Middle Mountains of Nepal, where resource pressures are greatest.11

The watershed was chosen by MRM as the project area for several reasons. The motivations most pertinent to this study are: a) it is representative of the densely populated watersheds in the Middle Mountains, and consequently, it has been undergoing intensified agricultural use of the land; b) the infrastructure in the watershed is largely typical of other watersheds in the Middle Mountains, with the exception of the Arniko Highway;12 nevertheless, this road provides relatively easy access to the field which has played an important role for this study and the MRM project in general; and c) the rural economy in the Jhikhu Khola Watershed is predominantly agriculture in nature.

3.2.5 The Village Development Committees Under Study

Due to limited resources for the field research, this study was conducted in three of the VDCs in the watershed, Panchkhal, Baluwa-Devabhumi, and Rabi-Opi. A list of the villages included in the sample is given in Appendix 1. The specific location of these VDCs

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10 During Desain, the prices of selected vegetables have been reported to be four to six times their average annual price.
11 This section is based upon information from the MRM Annual Report, various years.
12 The highway is a five hour walk from the most remote village.
is illustrated in Figure 7. These three VDCs were chosen as they were included in a series of socio-economic studies undertaken earlier by the MRM project team. These previous studies provided some baseline data for this study.

Panchkhal was selected mainly due to its diverse geography, cropping practices, and caste/ethnic groups. The Arniko Highway primarily passes through Panchkhal, thus providing a "combination of road frontage and remote areas." (MRM 1989, 18). A government Horticulture Research Farm is also located in this VDC.

For the purposes of this study, Panchkhal was chosen because the peasant households here tend to be well integrated into rural factor and product markets. Many peasant households grow at least one vegetable cash crop. The most important crops are grown under irrigated conditions. The area is known for the quality of some of its agricultural produce; thus farmers are able to procure a premium for these crops in Kathmandu.13

Baluwa was originally selected as it is the most centrally located VDC, and because it covers a large portion of the North facing slopes in the Jhikhu Khola Watershed. It has been included in the sample for this study since it is slightly more isolated from rural markets, relative to Panchkhal. Nevertheless, a number of households produce a vegetable cash crop, and though irrigation facilities and viable water sources are more limited, many households are still able to irrigate their most important crops.

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13Potatoes from Panchkhal are well-regarded by wholesalers in Kathmandu.
In contrast, households in Rabi-Opi are in relative isolation from factor and product markets. Markets tend to be further away, not as accessible due to poorer road conditions and higher elevations than in Panchkhal and Baluwa. More importantly, peasant households must rely on seasonal monsoon rains as the main source of water for their crops. Most households primarily produce for their own needs, relative to those in Panchkhal and Baluwa. Rabi-Opi was included in the original socio-economic surveys as “it is located at a considerable distance from the main road to Kathmandu, has steep slopes, and is dominated by dry land agriculture” (MRM 1990, 25).

3.3 Sample Selection and Composition

The household-level data used in this study was collected between January 1993 and April 1993. The approach used in collecting the data and the sample composition was based upon the socio-economic studies conducted and supervised by Kennedy and Dunlop (1989) in the Jhikhu Khola Watershed. Semi-structured interviews based on modified RRA techniques were employed in gathering the household-level data. RRA techniques have been used by other researchers to gather similar data (Kennedy and Dunlop 1989; Tamang 1992; Budathoki, Gurung, and Lohar 1992). The interview team included a Nepali female interpreter (Mrs. Bhattarai), a Nepali male interpreter who was with the MRM project (Mr. K. Subba), and the author. Mrs. Bhattarai and the author interviewed the woman farmer, while Mr. Subba questioned the male household head.

Both the male and female household heads were interviewed as they made the decisions for the household. Separate, but simultaneous interviews were undertaken of both men and women household heads; that is, after a brief explanation of the purpose of the survey by the field team, the male and female household heads were taken to different

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14 Kennedy and Dunlop conducted the first survey in Panchkhal themselves. The other surveys, though supervised by them, were actually conducted by members of the MRM research team.
areas of the farm, out of earshot of one another, and then they were interviewed. This ensured independent answers from both individuals.

Both men and women farmers were interviewed in recognition of the important role played by women on the farm, and in the division of labour along gender lines (Kennedy and Dunlop 1989; Tamang 1992). As explained by Kennedy and Dunlop, there were a couple of other advantages to this procedure: a) simultaneous interviews considerably reduced the time required to complete the interviews; and b) although the questionnaires for the men and women are different, a system of cross-checks could be incorporated into the surveys (Kennedy and Dunlop 1989). During the interview process, it was found that the women were generally more honest in their responses than the men. It is hypothesised that since women are generally not consulted by government agencies and other groups who interview farmers in the area, they are not as cynical as the men, and hence are more open and honest about their situation.

The questionnaires were semi-structured and were comprised of both open-ended and close-ended questions. Interesting points were pursued and discussed as they arose. Farmers were encouraged to contribute their own observations. The information covers recall periods specific to the nature of the data. Information was gathered relating to production activities, household resources, problems, land tenure arrangements, livestock, and household consumption. The questionnaire administered to the men is given in Appendix 2, while the women's questionnaire is in Appendix 3.

The sample consists of 64 households from the three VDCs, Panchkhal, Baluwa, and Rabi-Opi. Included in the survey are a wide variety of production systems, and ethnic/caste groups. Due to the diverse geographic and climatic conditions, both intensive and single cropping systems were included in the survey sample. The survey is spread over households that have adopted vegetable cash crops and those that have not incorporated a vegetable cash crop into their production patterns. Numerous ethnic/caste groups live in the watershed. As a result, only the seven major groups were included in the sample. The
caste/ethnic groups are Sarki, Kami, Danuwar, Tamang, Newar, Chettri, and Brahman. The first two are considered to be “untouchables”, while the Brahman caste is the high priestly caste. The other caste/ethnic caste groups fall somewhere between these two extremes.

The households interviewed by the MRM project in its earlier socio-economic studies in Panchkhal, Baluwa, and Rabi-Opi were used in this study. This allowed the use of existing base-line data in common areas where the earlier studies and this study overlapped. Although every effort was made to interview the same households, circumstances did not always allow a complete re-sampling. Such factors as absent household heads who were working elsewhere forced the inclusion of different peasant households that had not been interviewed in the earlier studies. When this occurred, another household with the same characteristics, such as caste/ethnic category, was randomly selected from the same village.

It is widely recognised that all sample surveys can be riddled with biases, from the conceptual stage in the beginning, to the analysis stage at the end. After all, as described by Warwick and Lininger,

“Survey research is never an aseptic process executed in a sociopolitical vacuum and guided solely by the canons of the scientific method. It is very much a human endeavor influenced by the researcher’s own values and expectations as well as external obligations, conventions, and pressures.” (Warwick and Lininger 1975, 37).

Appropriate measures were taken during the research and questionnaire design phases to minimise biases; for instance, the questionnaires were reviewed by other researchers in the field, both Nepali and non-Nepali. A pilot study was conducted in the watershed to further refine the survey. Triangulation methods were used during and after

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15 At the time of this study, a number of household heads were working in brick or carpet factories in the Kathmandu Valley.
the interview process to cross-check the quality of the responses. Group farmer interviews were held in the watershed to validate the data. Nepali and non-Nepali experts were frequently consulted to check the collected information, as were a limited number of secondary sources. The socio-economic studies carried out by MRM mentioned earlier were also used to validate the survey data.

In order to augment the household-level data, numerous people were informally interviewed, such as shopkeepers and patrons in the watershed and in Dhulikhel, middlemen, origin traders, government officials, hotel and restaurant personnel in the watershed and in Kathmandu, wholesalers, and government personnel at the vegetable wholesale market in Kathmandu.

3.4 Cultural and Socio-Economic Environment of the Study Area

3.4.1 Religious and Cultural Practices

The majority of Nepalis follow a complex blend of Tantric Buddhist and Hindu religious beliefs and practices. Due to a dynamic religious tradition whereby a variety of religious beliefs have been welcomed and adopted, a caste system has developed in Nepal. This system divides Nepali society along ethnic and occupational lines. Each caste/ethnic group occupies a position in the system. This system, however, is not rigid since a family can change its position by such means as financial success or marriage. The caste system has developed to ensure that cultural and economic privileges generally tend to accrue to certain elite caste/ethnic groups.

3.4.2 Family Size and Literacy Level

The average size of households in the sample is 6.7 persons. The majority live in an extended family home environment. Generally the male household head’s parents live with

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16 Recall, the district office is located in Dhulikhel.
the family, along with any children, older sons and their wives. The daughters tend to get married in their mid to late teens, and move to their husband’s family’s house.

The literacy rates\(^{17}\) are 59 per cent for men, and 12 per cent for women. On average, the men have received 3.9 years of education, while women have received a mere 0.7 years. The national literacy rates are 38 per cent for men, and 13 per cent for women, with 3.2 mean years of schooling for men, and 1.0 for women (UNDP 1993).\(^{18}\) The level of education attained by women in the watershed are comparable to the national figures. On the other hand, a much larger proportion of the men in the watershed are literate, compared to the national figures; in terms of mean years of schooling, the men in the Jhikhu Khola Watershed are only slightly ahead of the national average. The average years of schooling received by school-aged boys under 15 is 2.1, and for girls this figure is 1.6. Eighty-two per cent of school-age boys attend school, while only 58 per cent of the girls do.

Although women lag far behind men in terms of education, more girls are now attending school than their mothers, and more are staying in school longer than before. From the figures presented here, girls have received more than double the number of years of education than the generation before them.

3.4.3 Off-Farm Employment

Stable employment off the farm is limited in the watershed. The only non-agricultural industries that exist to any significant extent are brick manufacturing and tourism. Urban growth in the Kathmandu Valley has generated a demand for bricks. This has had spill-over effects in the peri-urban areas as well. This industry, however, operates more at a cottage industry level. Consequently, this sector provides few full-time, well-

\(^{17}\)Literacy rate is defined to be the percentage of persons aged 15 and over who can, with understanding, both read and write a short simple statement on their everyday life.

\(^{18}\)These literacy rates are from 1990, the most recent that are available.
paying, secure jobs. Although some expensive hotels and resorts are situated in the Jhikhu Khola Watershed, again the jobs are not well-paying. Job security is not guaranteed.

A number of households have a family member who works in the Kathmandu Valley, usually in a carpet or brick factory, or perhaps as taxi drivers. There were even a few instances of households that have sons who work in India. These household members who worked in Kathmandu or in India typically either do not remit money, or they may send some money during special occasions.

A few households have family members who are teachers in nearby villages. Typically these families have invested much of this off-farm income in good quality land with irrigation facilities. There was one instance of a military man whose family lives in the watershed. He spends most of his time in Kathmandu, while the wife and adult son take care of the family’s farm. Due to the husband’s military salary, the family’s land holdings are quite substantial, and they own over one hectare of relatively high quality land with good irrigation. In this case, the family regularly receives money from the husband’s salary.

3.4.4 Land Holdings

The average land holding in the study area is 17.6 ropani, or about 0.88 of a hectare; this is small by most standards. Non-irrigated lands, on which irrigated rice cannot be grown, are called bari. Dryland agricultural methods are practised on bari land. Irrigated land is known as khet land. Although khet land is the preferred land type, almost one third (31 per cent) of the households interviewed only cultivate bari land. The average bari holding is 11.9 ropani (0.60 ha), while the average khet holding is only 5.7 ropani (0.29 ha). The latter is less than half the bari holdings.

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19Land holding is defined to be land from which the household receives some return, either through ownership or cultivation of the land.
20Land sizes in the watershed are measured in terms of the Nepali land unit, ropani, which is approximately 500 m².
3.4.5 Brief Review of the Survey Data

A brief review of some of the data that was collected from the household surveys is provided in Table 1. Various demographic, social and economic variables are listed, along with their descriptive statistics. Some of these will be used later in the model, while others are given for background information.

Table 1. Descriptive Statistics of Selected Variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Median</th>
<th>Std. Dev.</th>
<th>Std. Error</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous Variables</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bari Land</td>
<td>11.93</td>
<td>8.50</td>
<td>11.40</td>
<td>1.43</td>
<td>0.00</td>
<td>60.00</td>
</tr>
<tr>
<td>Khet Land</td>
<td>5.68</td>
<td>4.00</td>
<td>6.76</td>
<td>0.85</td>
<td>0.00</td>
<td>28.00</td>
</tr>
<tr>
<td>Household Size</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>1.66</td>
<td>1.00</td>
<td>0.98</td>
<td>0.12</td>
<td>1.00</td>
<td>5.00</td>
</tr>
<tr>
<td>Women</td>
<td>1.86</td>
<td>2.00</td>
<td>1.01</td>
<td>0.13</td>
<td>1.00</td>
<td>5.00</td>
</tr>
<tr>
<td>Children</td>
<td>3.17</td>
<td>3.00</td>
<td>1.96</td>
<td>0.24</td>
<td>0.00</td>
<td>9.00</td>
</tr>
<tr>
<td>Education</td>
<td>3.03</td>
<td>3.00</td>
<td>3.20</td>
<td>0.40</td>
<td>0.00</td>
<td>10.00</td>
</tr>
<tr>
<td>Dummy Variables</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fertiliser</td>
<td>0.36</td>
<td>0.00</td>
<td>0.48</td>
<td>0.06</td>
<td>0.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Water</td>
<td>0.67</td>
<td>1.00</td>
<td>0.47</td>
<td>0.06</td>
<td>0.00</td>
<td>1.00</td>
</tr>
<tr>
<td>RedSoil</td>
<td>0.41</td>
<td>0.00</td>
<td>0.50</td>
<td>0.06</td>
<td>0.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Source: Household surveys.

The first set of variables are continuous variables, while the second set are dummy variables with only two possible values, zero or one. The first two variables describe the land holdings of the sample households. The household size has been disaggregated by men, women, and children. The average number of men, women, and children in the sample is 1.66, 1.86, and 3.17, respectively. The last continuous variable is the number of years of formal education of the male household head. The average number of years of schooling of the male household head is just over three years.

The second set of variables are dummy variables. The first variable, Fertiliser, is a measure of households that experienced significant problems using commercial inorganic...
fertiliser; the second variable, Water, is an indicator of peasant households that have access to irrigation water. The last variable, RedSoil, quantifies the number of households that have mainly poorer quality red soils.

3.5 Agricultural Production

3.5.1 Historical Agrarian Production

In the past, mixed farming systems have traditionally been, and continue to be, the main production system in the Jhikhu Khola Watershed. The farming environment is a complex, multi-dimensional system in which crop production, livestock management, and forestry are all integrated.

In terms of crop production, farm households in the study area have historically grown a variety of grains, oil seeds, and vegetables. The main staple crops are rice and maize. For many years, households that owned or cultivated khet land grew one rice crop on their khet land, and one maize crop on their bari land. Maize was inter-cropped with various beans and various summer vegetables. This production pattern was followed for many years.

Vegetables that have traditionally been grown in the study area include radish, pumpkin, squash, various gourds, and greens such as broadleaf mustard. Other vegetables such as cabbage, potato, and onion were considered to be luxury items that farmers bought from major urban centres during festivals and other special occasions.

\(^{21}\) This practice of inter-cropping maize with beans continues today.
Figure 8. Spring Rice Crop Grown on Irrigated, or Khet, Fields.

Figure 9. Compost Used to Fertilise the Field.
3.5.2 Introduction of New Crop Varieties

A Mexican wheat variety (*Lorma*) was introduced in the 1960s, and improved varieties of rice were introduced to Nepal and the study area in the 1970s (Upadhyaya 1993; Kennedy and Adhikari 1989). These events brought about a dramatic change in cropping patterns in the watershed. Two crops of wheat were planted, in addition to, or in some cases, instead of maize. Rice yields more than doubled (Kennedy and Adhikari 1989). The introduction of these new crop varieties coincided to some extent with increased population pressures. Agricultural production systems were adjusted by incorporating double and triple annual crop rotations to meet the increasing food demands of the households. This increased cropping intensity resulted in the need for more fertilisers to sustain the fertility of the soil (Wymann 1991).

Until fairly recently, households replenished the organic and nutrient requirements of the soil by applying compost and manure on their crops, illustrated in Figure 9. Households make compost by decomposing a mixture of animal manure, animal bedding, crop residues, and forest litter. These higher-yielding varieties, however, have been developed to respond to inorganic fertilisers; as such, they are more responsive to inorganic fertiliser than are traditional varieties (Upadhyaya 1993). Inorganic fertilisers, then, began to be used in the 1980s (Shah and Schreier 1991) to meet the increased nutrient demands of the crops in order to sustain production, and to meet the requisite fertiliser needs of the new varieties.

3.5.3 The Commercialisation of Vegetable Crops

The commercialisation of vegetables in the Jhikhu Khola Watershed can be attributed to a number of developments. The completion of the Arniko Highway more than 30 years ago first gave people in the watershed relatively easy access to Kathmandu and the Kathmandu Valley. Although Kathmandu is only about 40 km away, many people were able to go to the capital for the first time in their lives only after the highway was
built. Farmers from the watershed became more aware of other possibilities and opportunities as they were exposed to vegetable cultivation in the Kathmandu Valley, especially by the Jyapoo vegetable farmers. A few innovative farmers from the Jhikhu Khola Watershed bought seeds in Kathmandu, or directly from farmers in the Kathmandu Valley, or from government agencies (Kennedy and Adhikari 1989). This exposure to different agricultural practices outside the watershed both encouraged households to produce a greater variety of vegetables, and enforced the idea of producing a commodity for the market.

The second development that contributed to the commercialisation of vegetable crops was the movement of people from the Kathmandu Valley to the study area. Newars from the Kathmandu Valley came and settled in the Jhikhu Khola Watershed. These Newars were familiar with vegetable production and marketing techniques from their experience with, and exposure to, the Newari Jyapoo vegetable farmers in the Kathmandu Valley. After they settled in the watershed, they began to grow vegetables that they knew of from the valley, and would sell their surplus production. Typically, these vegetables had traditionally not been cultivated in the Jhikhu Khola Watershed. Newars were traditionally shopkeepers, so they were interested in producing crops for commercial purposes. Some of these Newars opened little shops in the watershed once they were financially capable of such an undertaking. They would then sell vegetables grown by other farmers.

The third development was the opening of the government extension farm in Panchkhal. The Panchkhal Horticulture Farm opened in the late 1970s, and mainly provided seeds and other extension services to the surrounding areas. For instance, the Horticulture Farm began to develop and promulgate tomato seeds about 15 years ago, mainly for kitchen gardens. After the farm opened, farmers had access to extension

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22 Seeds from a local tomato variety were distributed by the farm.
services and seeds within the watershed, and did not have to travel to the Kathmandu Valley.\textsuperscript{23}

The final development that facilitated the commercialisation process was the establishment of a Japanese aid project in the watershed. A group of Japanese Oversees Co-operation Volunteers came to the Jhikhu Khola Watershed in 1984. They were instrumental in helping farmers to procure various inputs such as seeds, pesticides, and pesticide sprayers. They popularised vegetable cash crop production in the area mainly by providing inexpensive, reliable transportation to local markets and to Kathmandu where the vegetables could be sold. The project volunteers would obtain the best price possible on behalf of the farmers (APROSC 1987).

The first vegetable to become a major cash crop in the watershed was the potato (Figure 10). About 20 years ago potatoes were grown only by a few households, and on a small scale in kitchen gardens. They were considered to be a luxury food, and hence were not widely grown. Seeds were difficult to obtain, and the markets had not developed in the watershed to accommodate wide-scale production and selling of the crop. The Department of Agriculture established a seed production programme nearby, thus enabling farmers to acquire good quality seed relatively easily. It is estimated that by 1989, potatoes were grown on about 80 per cent of the khet land in the Panchkhal VDC alone. Net returns of potato producers were estimated to be about three to four times the cost of production (Kennedy and Adhikari 1989).

Currently, tomatoes have become a very popular cash crop, shown in Figure 11. The main reasons appear to be that they have relatively low fertiliser and water requirements, and relatively inexpensive seed costs. Although potatoes have higher water and fertiliser requirements, and the seed price is high, they are preferred to tomatoes by a

\textsuperscript{23}The government had decided to sell the farm, but as of early 1993, no firm offers had been put forth by any confirmed buyers. A skeleton staff had been retained at the Panchkhal Horticulture Farm. The farm effectively had been closed since the year before. No extension services were being offered at the farm during the undertaking of the field research for this study.
number of households. These households prefer producing and selling potatoes because they are harvested all at once and the cash is received in one lump sum. Tomatoes, on the other hand, are continuously harvested over some time,\textsuperscript{24} and the money is received in small sums over that period. Depending upon the peasant households' cash needs, some prefer a one-time large payment, while others prefer the continuous cash flow over a few weeks.

\textsuperscript{24}Tomatoes can be harvested for one month, or more.
Figure 10. A Woman Tends her Potato Crop.

Figure 11. Tomato Cash Crop Being Cultivated Next to Maize.
As already mentioned, the vegetable cash crops examined in this study are potatoes and tomatoes. Other vegetables, such as cabbage, bell peppers, and cauliflower, are grown in the watershed. These latter crops, however, are not grown on a significant scale for commercial purposes by many households. Potatoes and tomatoes are by far the most widely grown vegetable cash crops in the Jhikhu Khola Watershed, and hence are the focus of this study. One reason why these vegetables are so widely grown is that they can be grown in different seasons, or in different locations with soils or altitudes inappropriate for the staple crops. As a result, they do not necessarily compete with staple food crops.

3.6 Current Market Infrastructure

The output markets in the Jhikhu Khola Watershed are still developing, and thus are not completely integrated. There are now a number of channels that farmers can use to sell their vegetable cash crops; they can use the services of middlemen, buses, their own labour, or origin traders to get their vegetable cash crop to the market.

Middlemen from Kathmandu and other nearby towns now come to the watershed to procure vegetables. They make contact with farmers and collect the vegetables directly from the farmers' field. A price is offered by the middleman, and payment is generally made at the time of the pickup.

Some farmers prefer to take their harvested produce directly to the market themselves, using one of three possible methods: a) public transportation; b) private minibus, or c) human labour. The public transportation system consists of buses that travel on the Arniko Highway to and from Kathmandu, with numerous stops along the way. A charge is levied for both the farmer and every container that the farmer loads onto the bus. A farmer may go all the way to Kathmandu, or may choose to sell his or her produce in one of the larger towns on the way.

Private minibuses also operate in the watershed, shown in Figure 12. Most of these minibuses are owned by families who live in the area. A few are owned by operators who
live in the Kathmandu Valley, and who travel out to the watershed to collect vegetables. Farmers make arrangements with the minibus owner who picks up their vegetables at a pre-designated time and location (Figure 13). A charge is levied per vegetable container. The produce is usually sold for the farmer in Kathmandu. Occasionally the minibuses will only go to nearby towns.

The third option available to people is human labour (see Figure 14). Poorer households that have limited financial resources typically carry their vegetables on their backs to nearby towns, and sell them there. Or, if adequate family labour is unavailable, they will hire porters to carry the produce to the market.

In Kathmandu, there is just one vegetable wholesale market, the Kalimati Vegetable Wholesale Market (Figure 15). Both retailers (Figure 16) and consumers come to this market to buy vegetables. Some farmers may choose to sell directly to consumers, but most farmers from the watershed go around to the different wholesaler stalls and try to get the highest possible price for their vegetables. Very few of the farmers included in the sample have established connections with any wholesaler in Kalimati Market, or in any of the nearby towns; as such, farmers are unsure of what price they will receive.

Virtually all of the trading in Kalimati Market is completed by 2 p.m. Farmers who are unable to obtain a reasonable price must stay in Kathmandu for the night and try again the next day. At the time of this study, Kalimati Market did not have any cold storage facilities, thus farmers with perishable vegetables like tomatoes are at a disadvantage. Spoilage, which is a problem during harvest and transportation of the vegetable, is exacerbated by this type of delay. Farmers are then forced to accept whatever price is offered, just so they are able to unload their produce and return home. The added expense of staying in Kathmandu, and paying for food and lodging, increases their costs and lowers their net returns.
Figure 12. Loading Vegetables for the Market.

Figure 13. Setting Potatoes by the Arniko Highway for the Market.
Figure 14. Carrying Vegetables to the Market.
Although farmers generally are able to secure a higher price\textsuperscript{25} in Kalimati Market than from middlemen, some are deterred by the problems of having to quickly find a buyer, the vexations of the trip itself,\textsuperscript{26} and the possibility of extra financial expenditures incurred by staying overnight in Kathmandu. This latter group of farmers prefers to simply sell their vegetable cash crop to the middlemen.

Apart from middlemen, there are also a few origin traders in some of the market towns in the Jhikhu Khola Watershed, namely in Tamaghat and Tinpiple.\textsuperscript{27} Peasant households from various villages in Baluwa and Panchkhal go to the origin traders in Tamaghat, while farmers in Rabi-Opi deal with the traders in Tinpiple. Although they deal mostly in tomatoes, these origin traders will handle any vegetable that a farmer wants to sell. These origin traders may or may not have established connections with wholesalers in Kathmandu. They typically hire a minibus or a truck, and have one of their men go with the driver to Kalimati Market to get the best price possible. The farmer is paid for his/her vegetable crop upon delivery to the origin trader.

Although there are increasingly more hotels and resorts in the watershed that cater to foreign tourists, they are not targeted by farmers as potential customers because these hotels and resorts buy their vegetables from farmers in the Kathmandu Valley. They claim that the variety and quality that they require is not available from local farmers. These hotels and resorts have contracts with farmers or provision stores in the green-belt around Kathmandu in the Kathmandu Valley.

\textsuperscript{25}Prices offered by middlemen who go to the watershed tend to be 10 to 20 per cent lower than prices in Kalimati Market.
\textsuperscript{26}Farmers must leave as early as 2 or 3 in the morning, depending on where they live in the watershed, to reach Kalimati Market by 5 a.m., when it opens, so that they can obtain a good price for their vegetable cash crop.
\textsuperscript{27}There were two origin traders in Tamaghat and four in Tinpiple at the time of this study.
Figure 15. Kalimati Vegetable Wholesale Market in Kathmandu.

Figure 16. Vegetables Being Sold at the Retail Level in Kathmandu.
3.7 Choosing Not to Adopt a Vegetable Cash Crop

An examination of the reasons cited by farmers as to why they choose to not grow a cash crop indicates that the choice is not entirely a trade-off between returns and risks. There are four basic reasons why peasant households choose not to grow a vegetable cash crop at all. First, although they may well understand the possible benefits that they can obtain from adopting a vegetable cash crop, they feel that they would rather allocate their household resources to a staple food crop, such as maize. By growing a successful maize crop, the household ensures food for itself, feed for the animals, and a source of fuel. Maize cobs and stalks are burned to provide heat and used as cooking fuel.

The fear of risks involved with an unknown cash crop is another reason some peasant households choose not to devote resources to a vegetable cash crop. Unfamiliar production techniques, unknown pesticide problems, and unsure net returns are some of the reasons cited by peasant households that are reluctant to grow these crops.

The third reason cited by some farmers for not growing a vegetable cash crop is the incomplete markets that they face. As explained in the previous section, markets are still developing in the watershed; consequently, the transaction costs that result from the problems and inconveniences of these incomplete input and output markets prevent some households from producing vegetable cash crops. Finally, some peasant households have extremely limited household resources, and thus are unable to devote any resources to the production of vegetable cash crops.

3.8 Adverse Effects of Inorganic Fertiliser

The increased use of inorganic fertilisers could well result in soil acidification and accelerated nutrient leaching (Shah and Schreier 1991; Wymann 1991; Tamang 1992). A possible solution to problems caused by the excessive use of inorganic fertilisers is the intensive use of compost to replenish the organic content of the soil (Tamang 1992; Ridley

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28 Examples are ammonium sulphate and urea.
1991); however, there are two limiting constraints to the heavy concentrated use of compost. The first constraint is the shortage of manure in the watershed (Shah and Schreier 1991). Animal manure is used both for agricultural purposes and for fuel. The shortage of manure is partially due to the greater manure requirement for agricultural purposes as cropping intensities have increased. The shortage is also due to the increased need for manure for fuel purposes. Cow and waterbuffalo dung are dried and then used as cooking fuel, illustrated in Figure 17. In the past, households would supplement dung fuel with fuel wood from nearby forests.

A number of farmers (both men and women) who were interviewed claimed that access to these forests, however, is being limited through various methods. Some examples are: collection of forest matter is only allowed only during certain weeks in the year; only fallen branches can be collected; if branches can be cut from trees, only branches of a certain length can be cut; and finally, charge is levied by the community in some areas for forest litter and/or wood.

Other observations from the field support these claims. For instance, during the course of the interviews, forest management meetings were encountered as they were being held in different villages. Quite often, issues such as limiting access to the forests were being discussed at these meetings. Some women were cooking as they were being interviewed. A number of them used dried animal dung as cooking fuel; when they were asked about this practice, several said that they were using dung more often now due to the limited availability of fuel wood in their area. Thus it appears the need for, and use of, animal manure for fuel is on the rise.

The second constraint for intensive compost application is the limited access to the forests. Forest litter is used as bedding and feed for the animals; it is subsequently mixed into the compost pile, and allowed to decompose. Households, however, are unable to gather adequate amounts of litter as access to the forests has become quite restricted in most areas of the watershed. As the availability of forest litter is becoming more limited,
not only does the organic composition of the compost change, but more importantly, less is produced.

Instead of relying on chemicals to act as substitutes for biological diversity in stabilising production, peasant households can diversify cropping patterns thereby minimising ecologically harmful agricultural practices. By producing vegetables, households not only diversify cropping patterns, but they also make a greater variety of foods available for household consumption.

In summary, the research area has a number of interesting and unique characteristics, such as the Arniko Highway. The sample consists of 64 households from three VDCs with different resources and characteristics. The cultural and agricultural context of the Jhikhu Khola Watershed was described in order to help understand the environment in which these peasant households operate.
Figure 17. Animal Dung Being Dried on the Side of the House for Fuel.
CHAPTER FOUR
THE MODEL

4.1 Overview

The model used in this study is described in this chapter. The first section explains the theoretical background, while the empirical model is outlined in the second section. A sound understanding of the theory is required for two reasons; first, it provides the theoretical foundation and justification for use of the model; and second, it allows one to understand the results of the model and how they can correctly be interpreted. The variables employed in the empirical model are fully described, as are the reasons for their inclusion. Finally, the empirical adoption model is specified at the end of this chapter.

4.2 Theoretical Considerations

It is hypothesised that a number of factors enhance the adoption of a vegetable cash crop by a household in the Jhikhu Khola Watershed. Some examples of these factors are household caste/ethnic group, availability of water for irrigation purposes, and expected gross margins. These ideas are formalised in a statistical model with the probability of adoption being explained by economic and social variables; analysis of these variables is achieved by this econometric approach. It is important to note that the true underlying probabilities of adoption or non-adoption are not actually observed; rather, the outcome is observed.

The statistical model incorporates the information provided by the surveyed households and relates the adoption/non-adoption variable to the other economic and social variables. The model will indicate the importance of the various factors in determining vegetable cash crop adoption by a household with a particular set of characteristics. Specifically, a logit model is employed to test the determinants of vegetable cash crop adoption by peasant households.
This econometric approach is used for a number of reasons. First, it is used because of the hypothesised dependency of the adoption/non-adoption decision upon economic and social factors. Second, the econometric approach allows one to analyse this causal relationship, whereas other statistical methods can obscure the analysis of causal models. Finally, while other simpler statistical methods may be used to analyse the degree of association between variables, they do not adequately provide information about the magnitude of any effects or the strength of any relationship (Hanushek and Jackson 1977).

4.2.1 Historical Development of the Logit Model

The application of the logit model, or the logistic regression model, in econometric analysis originates from three different fields of study, namely applied mathematics, experimental statistics, and economic theory.

The logit model was used originally to model human population growth. It was applied to model various living populations "from banana flies to the human population of the French colonies in North Africa" (Cramer 1991, 40-41).

Statistics is the second discipline where the logit model has developed. It has been used in the statistical analysis of bio-assay, or the application of probability models to biological experiments. These "all-or-nothing" response are known as quantal responses in this field. The probit model, however, was used to analyse the data in the biological experiments, not the logit model. The probit model was regarded as the reputable model and consequently was used by researchers in various fields. Indeed, the probit model was also used in early economic applications of bivariate probability models. Aitchison and Brown (1957) followed the established preference of biologists for the probit model, illustrating that economists at that time did not consider the logit model to be a valid analytical tool.

The full potential and applicability of the logistic regression model was not appreciated until Truett, Cornfield, and Kannel (1967) used it in a heart study. In 1969
Theil generalised it from a bivariate to a multinomial model. McFadden and other American economists extensively applied the multinomial logit model to various empirical studies. They "made it academically respectable by providing a theoretical framework in the utility theory of discrete choice" (Cramer 1991, 41).

By linking the logit model to the abstract mathematical theory of rational, or discrete choice, the model and the interpretation of the estimated coefficients can be discussed in a nomenclature familiar to economists.

4.2.2 A Comparison of Linear and Logit Regression Models

The question of whether or not a household adopts a vegetable cash crop can be best analysed with a model in which the dependent variable is dichotomous in nature. That is, the question involves a two-category, or qualitative, dependent variable - adoption/non-adoption of a vegetable cash crop. Such categorical phenomena require a different approach from the linear regression model. The two regression models most frequently used to predict dichotomous outcomes are the probit and the logit models. Though both models yield similar results, the logit model is preferred because of its ease of use, and its historic development in the field of economics. The logit model, or logistic regression model, is used in this study.

The linear and logistic regression models share similarities, though they do have different underlying mathematical bases. As with the linear regression model, the logit model "provides a flexible, general-purpose modelling strategy with straightforward interpretation" (Hamilton 1992, 217). The logistic regression, however, requires a key assumption about the distribution of the dependent variables.

The first similarity between the models is the clear a priori asymmetry between the independent variables and the dependent variable. It is assumed that there is a causal

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29 Techniques for modelling dichotomies extend to dependent variables with three or more categories, known as polytomous variables. See Agresti (1990), or Hosmer and Lemeshow (1989) for more information.
relationship between the independent variables and the dependent variable. Within this causal context, the simple linear regression and the logit model can be used, within their limitations, as a framework for empirical analysis. Second, both models were originally designed to analyse experimental data. This should be noted when interpreting their empirical applications. Finally, like the linear regression model, the logit model can be generalised to quite sophisticated variants.\(^30\)

Although linear regression models, such as ordinary least squares (OLS), can be used to analyse models with dichotomous dependent variables, this approach results in several problems. The most important problem relates to the error term. Consider modelling the case of a Nepali peasant household that adopts a vegetable cash crop. Let the dependent variable be \(Y\), with some explanatory variable \(X\), as in the following simple univariate model:

\[
Y_i = \beta_0 + \beta_1 X_i + u_i \quad (1)
\]

where:

\(Y_i\) = dependent variable for household \(i\)

\(\beta_0, \beta_1\) = unknown parameters

\(X_i\) = independent variable \(X\) for household \(i\)

\(u_i\) = error term for household \(i\).

For household \(i\), the dependent variable \(Y\) is assumed to be a linear function of some explanatory variable \(X\), where \(\beta_0\) and \(\beta_1\) are unknown fixed parameters, or the regression coefficients.\(^31\) The term \(u_i\) is the disturbance, or stochastic error term, and may be positive or negative in value. The \(Y\) variable is one if the household adopts a vegetable cash crop, and zero otherwise. Then, for any value of \(X\), there exists only two possible error terms. In order to see this, rewrite (1) as:

\(^{30}\)See Hamilton (1992) for a discussion of these alternative variants.

\(^{31}\)\(\beta_0\) and \(\beta_1\) are the intercept and slope coefficients, respectively.
\[ u_i = Y_i - \beta_0 - \beta_1 X_i \]  

Now when \( Y_i = 1 \) (household \( i \) adopts a vegetable cash crop)

\[ u_i = 1 - \beta_0 - \beta_1 X_i \]  \hspace{1cm} (2a)

and when \( Y_i = 0 \) (household \( i \) does not adopt a vegetable cash crop)

\[ u_i = -\beta_0 - \beta_1 X_i \]  \hspace{1cm} (2b)

If a linear model \( E[Y_i] = \beta_0 + \beta_1 X_i \)\(^{32}\) is correct, then the variance of these errors depends upon \( E[Y_i] \) and therefore upon \( X_i \). Due to the dichotomous nature of \( Y \), and hence the dependence of \( E[Y_i] \) on \( X_i \), the error term actually follows a binomial distribution. This makes the constant-variance, or homoscedasticity, assumption untenable.\(^{33}\) The linear regression coefficient estimates are then unbiased, but not efficient. Furthermore, standard error estimates are biased, invalidating hypothesis tests and confidence intervals.

The linear regression models have a more fundamental limitation than heteroscedastic error terms. Predicted values from (1) may be interpreted as probabilities. This straightforward interpretation deteriorates at the extreme values of \( X \). Specifically, the predicted \( Y \) value falls outside the zero to one range. By definition, however, probabilities must lie between zero and one. Indeed,

"... any linear model with [a] non-zero slope eventually predicts values greater than one or less than zero. Impossible predictions derived from reasonable \( X \) values tell us that the model is unrealistic, which implies that we are estimating parameters that do not exist." (Hamilton 1992, 220).

In order to more realistically model probabilities, the following two features are required in a model: a) as \( X_i \) increases, \( Y_i \) increases but does not fall outside the \{0,1\}

\(^{32}\) \( E[Y_i] \) is the expected value of \( Y_i \), or the population mean of \( Y_i \).

\(^{33}\) A weighted least squares technique may be used to overcome this problem of heteroscedastic error terms. See Hamilton (1992) for further details.
range; and b) the relationship between \( Y_i \) and \( X_i \) is non-linear, that is, "one which approaches zero at slower and slower rates as \( X_i \) gets smaller, and approaches one at slower and slower rates as \( X_i \) gets very large" (Aldrich and Nelson 1984, 26). The logit model allows the prediction of probabilities that do not fall outside the \{0,1\} range. That is, it approaches, but never exceeds the \{0,1\} boundaries.

### 4.2.3 The Logit Model

Recall Equation (1). Assuming \( E[u_i] = 0 \), to obtain unbiased estimators, (1) can be re-written as:\(^{34}\)

\[
E[Y_i | X_i] = \beta_0 + \beta_1 X_i
\]  \( (3) \)

Let \( P_i \) be the probability that \( Y_i = 1 \); that is, household \( i \) grows a vegetable cash crop. Let \( 1 - P_i \) be the probability that \( Y_i = 0 \), that is, household \( i \) does not grow a vegetable cash crop. By the definition of mathematical expectation, the following result is obtained:

\[
E[Y_i] = 0(1 - P_i) + 1(P_i) = P_i
\]  \( (4) \)

A comparison of (3) and (4) reveals that they can be equated as follows:

\[
E[Y_i | X_i] = \beta_0 + \beta_1 X_i = P_i
\]  \( (5) \)

Now consider the following representation of the vegetable cash crop adoption model specified by (5):

\[
P_i = \frac{1}{1 + e^{-\beta_0 - \beta_1 X_i}}
\]  \( (6) \)

where \( e \) is the base of the natural logarithm.\(^{35}\) For conciseness, rewrite (6) as:

\[
P_i = \frac{1}{1 + e^{-z_i}}
\]  \( (7) \)

where \( z_i = \beta_0 + \beta_1 X_i \).

---

\(^{34}\)This section is adapted from Gujarati (1988), pp. 480-483.

\(^{35}\)Note: \( e = 2.71828 \).
Equation (7) represents the "cumulative logistic distribution function", which is a specific type of cumulative distribution function (CDF).\textsuperscript{36} It is symmetric about a $Z_i$ of zero, and imposes no constraints on $Z_i$. It is the distribution function of a logistic random variable whose variance is $\pi^2/3$. Two details should be noted in (7): first, $Z_i$ ranges from $-\infty$ to $+\infty$, and $P_i$ ranges between zero and one;\textsuperscript{37} second, $P_i$ is non-linearly related to $Z_i$.\textsuperscript{38} Thus, the logistic distribution function satisfies the two requirements of a realistic probability model outlined earlier.

If $P_i$, the probability of growing a vegetable cash crop is given by (7), then $1-P_i$, the probability of not growing a vegetable cash crop is:

$$1 - P_i = \frac{1}{1 + e^{Z_i}}. \quad (8)$$

Equations (7) and (8) can be re-written as:

$$\frac{P_i}{1 - P_i} = \frac{1 + e^{Z_i}}{1 + e^{-Z_i}} = e^{Z_i}. \quad (9)$$

Now $\frac{P_i}{1 - P_i}$ is simply the "odds ratio" in favour of growing a vegetable cash crop. In other words, it is the ratio of the probability that household $i$ will adopt a vegetable cash crop to the probability that it will not adopt a vegetable cash crop. For example, if $P_i = 0.8$, the odds of household $i$ growing a vegetable cash crop are:

$$= \frac{P_i}{1 - P_i}$$

$$= \frac{0.8}{0.2}$$

$$= 4.0.$$

\textsuperscript{36}The CDF of a random variable $X$ is simply the probability that it takes a value less than or equal to $X_0$, where $X_0$ is some specified numerical value.

\textsuperscript{37}Note that as $Z_i \to +\infty$, $e^{-Z_i}$ tends to zero, and as $Z_i \to -\infty$, $e^{Z_i}$ increases indefinitely.

\textsuperscript{38}Hence $P_i$ is non-linearly related to $X_i$. 
It means the odds are 4 to 1 in favour of household \( i \) growing a vegetable cash crop.

An interesting result is obtained if the natural logarithm of the odds from Equation (9) is computed:

\[
L_i = \ln\left(\frac{P_i}{1 - P_i}\right) = \ln e^{Z_i} = Z_i.
\]

Recall that \( Z_i = \beta_0 + \beta_1 X_i \). Thus \( L_i = \beta_0 + \beta_1 X_i \).

\( L_i \) is called the "logit", and hence "logit regression" refers to models with a logit as the left-hand-side variable, as shown below:

\[
L_i = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \ldots + \beta_{k-1} X_{ik-1}.
\]

If the logit (\( L \)) is a linear function of \( X \) variables, then the probability (\( P \)) is a non-linear sigmoid, or S-shaped function. In such models, "predicted probabilities approach but never reach [nor] exceed, the boundaries of 0 and 1". Thus, the "logit regression provides a more realistic model for probabilities than does linear regression" (Hamilton 1992, 221).

For a given set of \( X \) values and estimated coefficients, logits (\( \hat{L} \)) can be estimated in a similar manner as the dependent \( Y \) variable in linear regression models. Reversing the logit transformation yields predicted probabilities (\( \hat{P} \)) if \( Y = 1 \):

\[
\hat{P} = \frac{1}{1 + e^{-\hat{L}}}.
\]

Thus, for given \( X \) values, the actual probability of adopting a vegetable cash crop can be computed from (10). It can be seen from (10) that though logit models are linear in \( X \), they are non-linear with respect to odds or probabilities.

### 4.2.4 Rational Choice Theory and the Logit Model

The logic of this section is based on Aldrich and Nelson (1984). Mathematical psychology was the first field to employ non-linear probability models that were derived

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39Aldrich and Nelson (1984), pp. 35-37. The rational choice perspective on behaviour was advanced by Luce and Suppes (1965), and placed in an econometric framework by McFadden (1973).
from formal rational choice theory. The concept of "probabilistic choice" resulted from the need of theorists in this field to "explain variations in repeated experimental measurements of individual preferences" (Cramer 1991, 48). As mentioned earlier, McFadden (1973) later explained this rational choice perspective on behaviour within an econometric framework.

In order to explain the logit model within the rational choice paradigm, consider the following representation of household behaviour: Let $Y_i$ be an observation on the behaviour of household $i$, where the household is faced with the choice of selecting between two alternatives. The first alternative is to grow a vegetable cash crop, and the second is not to grow a vegetable cash crop. Rational choice theory claims that the household has preferences over these two alternatives, and it will choose the most preferred alternative. More specifically, the household is assumed to attach utilities to these alternatives.

Let $U_{i1}$ be the utility household $i$ derives from alternative one, and $U_{i2}$ be the utility from alternative two. Note that these utilities are neither observed, nor measured. It is assumed that household $i$ will choose alternative one if $U_{i1} > U_{i2}$, otherwise it will choose alternative two if $U_{i1} < U_{i2}$.

Assuming the preferences are a linear function of exogenous variables, the preferences can be modelled as follows:

$$U_{i1} = \alpha_{01} + \alpha_{11}X_i + v_{i1}$$
$$U_{i2} = \alpha_{02} + \alpha_{12}X_i + v_{i2}$$

where:

$\alpha_{01}, \alpha_{02} =$ unknown parameters

$\alpha_{11}, \alpha_{12} =$ unknown parameters

---

\( X_i \) = exogenous variable

\( v_{i1}, v_{i2} \) = approximation errors, and/or random aspects of behaviour.

It is assumed for simplicity that there is only one exogenous variable. This can easily be extended to incorporate multiple explanatory variables. If \( U_{i1} \) is greater than \( U_{i2} \), then \( U_{i1} - U_{i2} > 0 \) will hold, otherwise \( U_{i1} - U_{i2} < 0 \) will be true. Let \( Y_i^* \) be this difference, and define it as:

\[
Y_i^* = U_{i1} - U_{i2} = (\alpha_{01} - \alpha_{02}) + (\alpha_{11} - \alpha_{12})X_i + (v_{i1} - v_{i2})
\]

This can be simplified to:

\[
Y_i^* = \beta_0 + \beta_1X_i - u_i
\]

where:

\[
\beta_0 = \alpha_{01} - \alpha_{02}
\]

\[
\beta_1 = \alpha_{11} - \alpha_{12}
\]

\[
u_i = v_{i1} - v_{i2} \]

As mentioned above, the rational choice perspective asserts that household \( i \) will choose alternative one over alternative two if \( U_{i1} > U_{i2} \), or if \( Y_i^* > 0 \). Using (16), this means that alternative one is chosen if:

\[
\beta_0 + \beta_1X_i - u_i > 0 \quad \text{or} \quad \beta_0 + \beta_1X_i > u_i.
\]

The observed choice made by household \( i \), \( Y_i \), is one when \( Y_i^* > 0 \) \(^{42}\), and is equal to zero when \( Y_i^* < 0 \) \(^{43}\). This leads to a probabilistic statement:

\[
P(Y_i = 1) = P(Y_i^* > 0) = P(\beta_0 + \beta_1X_i > u_i).
\]

\(^{41}\)\( u_i \) is defined as \( v_{i2} - v_{i1} \) to simplify the algebra, and to follow convention. This makes the negative of \( u_i \) appear in Equation 16. Since this disturbance is not observable, the definition is somewhat arbitrary.

\(^{42}\)That is, household \( i \) will adopt a vegetable cash crop.

\(^{43}\)That is, household \( i \) will not adopt a vegetable cash crop.
Thus, in order to estimate $P(Y_i = 1)$, the total, or cumulative, probability that $u_i$ is less than $\beta_0 + \beta_1 X_i$ must be known. This requires knowledge of the probability distribution of $u_i$. If $u_i$ is a continuous random variable, which is a reasonable assumption, (17) can be re-written as:

$$P(\beta_0 + \beta_1 X_i > u_i) = P(Z_i > u_i) = F(Z_i) = \int_{-\infty}^{Z_i} f(u) \, du$$ \hspace{1cm} (18)

where:

- $Z_i = \beta_0 + \beta_1 X_i$

- $F(\cdot)$ = the cumulative distribution function

- $f(\cdot)$ = the probability density function of the random variable $u_i$.

If the probability density function of $u_i$ is assumed to follow a logistic distribution function, the logistic curve is obtained (recall Equation 7).

The logit model is based on a linear relationship between the unobserved $Y^*_i$ and the explanatory variable $X_i$. The unobserved variable $Y^*_i$ cannot be measured. As shown in (17), the dichotomous dependent variable $Y_i$ is a function of $Y^*_i$, and is related to the exogenous variable $X_i$ by the probability $P_i$. The latter is itself a transformation of $\beta_0 + \beta_1 X_i$. It is possible then, to derive a logistic function from a choice-based rationale for the dichotomous dependent variable, $Y_i$.

4.2.5 Estimation of the Logit Model

Most logit parameters are typically estimated using maximum likelihood methods. A "likelihood function" expresses the probability of obtaining the given sample as a function of the model's parameters. In order for maximum likelihood estimates to result in unbiased and efficient logit parameters, the following assumptions must hold:

a) The model is correctly specified. No important variables are omitted, and no extraneous variables are included. The independent variables are measured without error.
b) The cases are independent; that is, there is no autocorrelation.

c) None of the independent variables are linear functions of the others. Strong multicollinearity makes estimates imprecise; perfect multicollinearity makes estimation impossible.

In order to compute maximum likelihood estimates, consider the following: let $X_i$ be the $i$th combination of $X$ values. Based on a logit model, recall from (10) that the conditional probability that $Y_i = 1$ is:

$$P_i = \frac{1}{1 + e^{-L_i}}$$

where:

$$L_i = \beta_0 + \sum_{k=1}^{K-1} \beta_k X_{ik}.$$ 

The contribution of the $i$th case to the likelihood function equals $P_i$ if $Y_i = 1$, otherwise, it equals $1 - P_i$. This can be re-written as:

$$P_i^{Y_i} (1 - P_i)^{1-Y_i}.$$ 

Assuming the cases are independent, the likelihood function is the product of the contribution of each case $i$:

$$\mathcal{L} = \prod \left\{ P_i^{Y_i} (1 - P_i)^{1-Y_i} \right\} \quad (19)$$

The estimated $\beta$ parameters that are sought are those that result in the highest possible values for the likelihood function (11).

By taking natural logs of (18), the equation is easier to work with, since the multiplication is turned into addition:

$$\ln \mathcal{L} = \sum \left\{ Y_i \ln P_i + (1 - Y_i) \ln (1 - P_i) \right\}. \quad (19a)$$
This logarithm, called the "log likelihood", is maximised. To find maximum likelihood estimates, first derivatives of the log likelihood with respect to each of the estimated parameters is taken. These derivatives are then set to zero. This results in simultaneous equations:

\[
\sum (Y_i - P_i) = 0 \quad \text{and} \quad \sum (Y_i - P_i) X_k = 0 \quad \text{for } k=1,2,3,...,K-1.
\]

These equations are non-linear in the parameters; thus, they can not be solved directly. An iterative procedure is used instead, where successively better approximations of \( \beta_k \) values are computed that satisfy (20) and (21).

4.2.6 Interpretation of Logit Model Results

Estimated parameters in these linear logit models can be interpreted in a straightforward manner. For instance, given the following logit model with two explanatory variables, \( X_1 \) and \( X_2 \):

\[
L_i = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2}
\]

where:

- \( L_i \) is the logit for household \( i \)
- \( \beta_0, \beta_1, \beta_2 \) = estimated parameters
- \( X_{i1} \) = the \( X_1 \) variable for household \( i \)
- \( X_{i2} \) = the \( X_2 \) variable for household \( i \).

The parameters can be interpreted as follows:

- \( \beta_0 \): when \( X_1 = X_2 = 0 \), the odds favouring \( Y = 1 \) are \( e^{\beta_0} \). The probability that \( Y = 1 \) is

\[
P = \frac{1}{1 + e^{-\beta_0}}
\]

- \( \beta_1 \): each one-unit increase in \( X_1 \) multiplies the odds favouring \( Y = 1 \) by \( e^{\beta_1} \), if \( X_2 \) stays the same.
\( \beta_2 \): each one-unit increase in \( X_2 \) multiplies the odds favouring \( Y = 1 \) by \( e^{\beta_2} \), if \( X_1 \) stays the same.

In other words, the odds favouring \( Y = 1 \) change by \( 100 \left( e^{\beta_2} - 1 \right) \) per cent with each one-unit increase in \( X_1 \); similarly for each one-unit increase in \( X_2 \), the odds change by \( 100 \left( e^{\beta_2} - 1 \right) \). The probability that \( Y = 1 \) changes by an amount depends upon all the terms in the equation, namely \( \beta_0, \beta_1, X_i, \beta_2, \) and \( X_2 \).

In a logit model, the impact of a change in an independent variable \( X_k \) on \( P_i \) is not as straightforward as in a linear regression model.\(^{44}\) This is due to the non-linear relationship between \( P_i \) and each explanatory \( X \) variable. The behaviour of the logit functional form is best illustrated by Table 2. This table contains values for a logit model with two exogenous variables and a constant term.

The first three columns contain the constant term and various values of the two independent variables, \( X_1 \) and \( X_2 \). The values of the estimated coefficients (\( \beta \) s) are indicated at the bottom of the table. Column four displays the computed logit value (\( \hat{L}_i \)). The logit model is given at the foot of the table. The value for \( P_i \) appears in column five. It has been computed using (7). Notice that \( P_i \) is exactly one-half when \( \hat{L}_i \) is zero and that the model is symmetric around that point.

\(^{44}\)Recall that \( X_k \) is variable \( X_k \) for household i, and that \( P_i \) is the probability that \( Y_i = 1 \).
Table 2. Illustrative Values of a Dichotomous Logit Model

<table>
<thead>
<tr>
<th>Constant (1)</th>
<th>(X_1) (2)</th>
<th>(X_2) (3)</th>
<th>(\hat{L}_i) (4)</th>
<th>(P_i) (5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>0</td>
<td>-3.60</td>
<td>0.02660</td>
</tr>
<tr>
<td>1</td>
<td>3</td>
<td>0</td>
<td>-1.80</td>
<td>0.14185</td>
</tr>
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<td>5</td>
<td>0</td>
<td>-0.00</td>
<td>0.50000</td>
</tr>
<tr>
<td>1</td>
<td>7</td>
<td>0</td>
<td>1.80</td>
<td>0.85815</td>
</tr>
<tr>
<td>1</td>
<td>9</td>
<td>0</td>
<td>3.60</td>
<td>0.97340</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>1</td>
<td>-1.80</td>
<td>0.14185</td>
</tr>
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<td></td>
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<td>2</td>
<td>7.20</td>
<td>0.99925</td>
</tr>
</tbody>
</table>

Note: This is adapted from Table 2.1, Aldrich and Nelson (1984), p.42.

Logit Model: \(L = -4.50 + 0.90X_1 + 1.80X_2\)

The logit values \((\hat{L}_i)\) are linear functions of the exogenous variables; thus, they change with each \(X\) according to the sign and magnitude of the corresponding coefficient. As defined by (7), \(P_i\) varies directly with \(\hat{L}_i\). This can be seen in the above table. \(P_i\) ranges from near zero at large negative values of \(\hat{L}_i\), to near one at large positive values; nevertheless, notice that the rate of change is not constant.

\(P_i\) values increase slowly when \(\hat{L}_i\) is large, regardless of whether \(\hat{L}_i\) is positive or negative; at values near zero, on the other hand, the rate of change in \(P_i\) is high. Clearly the estimated coefficients determine the direction of the effect, but the magnitude of the effect depends on the magnitude of \(\hat{L}_i\). The latter, in turn, depends upon the magnitude of all the exogenous variables.

Assessing the impact of an independent variable \(X_{k}\) on \(P_i\) is not straightforward since the effect of \(X_{k}\) on \(P_i\) is not constant. Aldrich and Nelson (1984) recommend using simple calculus to determine such an impact. By selecting "interesting" values for the
exogenous variables, the corresponding $P_i$ can be computed. The $X$ variable of interest can be changed by some arbitrarily small amount, and then the $P_i$ can be re-computed. The rate of change can be measured as:

$$\frac{\partial P_i}{\partial X_{ik}}$$

where $\partial P_i$ indicates the difference in the two computed values of $P_i$; similarly $\partial X_{ik}$ is the difference in the chosen $X$ variable. When $\partial X_{ik}$ is very small, this rate of change is the derivative of $P_i$ with respect to $X_{ik}$. The formulae for continuous and dummy variables respectively are:

$$\frac{\partial P_i}{\partial X_{ik}} = \frac{1}{1 + e^{-l_i}} \times \frac{1}{1 + e^{l_i}} \times \beta_k$$  \hspace{1cm} (22)

$$\frac{\partial P_i}{\partial X_{ik}} = P(Y_i = 1|X_i, X_{ik} = 1) - P(Y_i = 1|X_i, X_{ik} = 0).$$  \hspace{1cm} (23)

These derivatives are known as "quasi-elasticities". They indicate the percentage point of change in the probability upon a one per cent increase in $X_{ik}$ (Cramer 1991). In the case of continuous variables, the $p_k$ appears as a multiplicative factor. In fact, the $p_k$ term determines the sign of the effect since the other factor in (22) is positive.

It is therefore apparent that the effect of a change in $X_{ik}$ upon $P_i$, the probability that the response variable is one, is related to the estimated coefficient $\beta_k$. The sign of $\beta_k$ determines the direction of the effect. Also, the larger the $\beta_k$, the larger the effect. The effect of a change in the exogenous variable is not, however, completely determined by $\beta_k$. The magnitude of the effect also varies with the values of the other exogenous variables.
4.2.7 Hypothesis Tests

A "nested-models" strategy is often employed to test hypotheses in logit regressions.\textsuperscript{45} Let $\ln L_k$ represent the log likelihood (11a) of a logit model with $K$ parameters.\textsuperscript{46} To test whether this model significantly improves upon a simpler model with $H$ ($0 < H < K$) fewer exogenous variables, compare $\ln L_k$ with $\ln L_{k-H}$, where the latter is the log likelihood of the simpler model.

The null hypothesis that the $H$ omitted variables have no effect,

$$H_0: \beta_1 = \beta_2 = \ldots = \beta_H = 0$$

is tested by:

$$\chi^2_H = -2(\ln L_{k-H} - \ln L_k).$$

This quantity follows a theoretical $\chi^2$ (chi-squared) distribution with $H$ degrees of freedom. If this test rejects $H_0$, the null hypothesis that the specified coefficients are zero is rejected. In this case, the more complex model is the preferred model, as it fits significantly better. The null hypothesis that all $X$ variables' coefficients are zero can also be tested in this manner.

Another method to test whether a coefficient is zero uses the t-statistic. The t-statistic is given by:

$$t = \frac{b_k}{SE_{b_k}}$$

where:

$b_k$ = the sample estimate of the model coefficient $\beta$

$SE_{b_k}$ = the coefficient standard error of the exogenous variable $X_k$.

As explained in earlier (2a and 2b), the error term in a logit regression follows a binomial distribution, and the homoscedasticity assumption does not hold. As a result, the

\textsuperscript{45}This section is adapted from Hamilton (1992).
\textsuperscript{46}That is, there are $K-1$ $X$ variables, and one constant term.
standard error and t-statistic are not computed as they are in an OLS regression; rather, they are approximated. The coefficients standard error, SE, are calculated as part of the maximum likelihood estimation process. These standard errors are the square roots of the diagonal elements of the inverse of the "information matrix". This information matrix is a matrix of the negatives of the second partial derivatives of the log likelihood function.47

In large samples, both the $\chi^2$ test and the t-test should give similar results. In small samples, however, the results from the two tests may diverge since the t-statistic is only an approximation.

A widely accepted overall measure of "goodness-of-fit"48 does not exist for logit regressions. The $R^2$ coefficient of determination, or $R^2$-adjusted, which measure overall fit, are inappropriate for the logit regression. The dichotomous nature of the dependent variable in a logit model results in calculations much lower than one. Indeed, Aldrich and Nelson (1984) contend that "use of the coefficient of determination as a summary statistic should be avoided with qualitative dependent variables" (Aldrich and Nelson 1984, 15).

Nevertheless, a number of "pseudo-$R^2$" measures have been proposed. Aldrich and Nelson (1984) suggest:

$$pseudo-R^2 = \frac{\chi^2}{\chi^2 + n}$$

where:

$\chi^2$ = the test statistic for the null hypothesis that all coefficients but the intercept are zero

$n$ = the sample size.

A well-fitting logit model is one whose pseudo-$R^2$ value is between 0.2 and 0.4. This pseudo-$R^2$ measure has two advantages. First, it is easily computed from readily available values; and second, it ranges between zero and one. It approaches zero as the

47 Variances and covariances of logit coefficients are also estimated from the inverse of this matrix.
48 Goodness-of-fit measures how effective the model is in describing the outcome variable.
quality of fit diminishes, and approaches one as the fit improves. This measure also has a few disadvantages. First, no adjustment in measurement is made to account for the number of explanatory variables; and second, it is neither universally accepted, nor used. Third, these pseudo-$R^2$ do not truly measure the proportion of variance in the dependent variable "explained" by the exogenous variables.

Aldrich and Nelson (1984), and Hosmer and Lemeshow (1989) propose other analogous measures. Each has its own advantages, but there is no general agreement about which is best.

4.3 Structure of the Empirical Model

The estimated logit model is designed primarily to test the determinants of vegetable cash crop adoption by households in the Jhikhu Khola Watershed. Identification of the relevant factors will foster a better understanding of the process undertaken by these households as they decide whether or not to incorporate a vegetable cash crop into their production cycle. A better understanding of this decision-making process, in turn, can assist policy-makers to develop and implement appropriate programmes that will benefit households that either do engage, or want to engage, in the production of vegetable cash crops.

The determining factors under consideration are household characteristics. Households that were interviewed highlighted household characteristics such as access to irrigation water as the main factors taken into consideration in the decision-making process. Hence, an analysis of vegetable cash crop adoption in the Jhikhu Khola Watershed must necessarily include household characteristics.

As previously mentioned, a statistical model of the determinants of vegetable cash crop adoption is employed. It is hypothesised that the choice to become a vegetable cash crop grower is determined by socio-economic factors and resource endowments of the
farm household. The following adoption factors were identified through a combination of observations from the field, farmers’ responses, and similar models used in other studies.

4.3.1 Socio-economic Determinants

Socio-economic factors, such as household caste/ethnic group, expected gross margins of the vegetable cash crop(s) and the most important staple crop, and access to inorganic commercial fertiliser are all factors in adoption. In order to measure the importance of socio-economic factors, the caste to which each household belongs is quantified. Although the Nepali caste system is not as rigid as in India, class or socio-economic privileges have been successfully consolidated along caste delineations (Bista 1992). Households that belong to higher castes generally have better access to financial resources, political power, and market linkages than do lower caste farm households. As a result, these higher caste households may be more able, and thus more willing, to bear the risk of growing a vegetable cash crop than their lower caste counterparts.

There is much debate amongst Nepalis regarding caste order; nevertheless, for the purposes of this study, all households were grouped into two categories. All castes that were highly positively correlated with political power, financial resources, and market linkages were categorised as high castes, while the others were not. It is hypothesised that since high caste households generally have more resources available to them, they are more likely to grow a vegetable cash crop.

Economic factors such as expected gross margins of the vegetable cash crop(s) and the most important staple crop are believed to affect adoption. Farm households that are interested in producing a vegetable cash crop are obviously concerned about the returns to those crops. They are also concerned about the returns from other crops, specifically their staple crops. Gross margins are used as a measure of profitability of the

49 For a thought-provoking look at the role of the caste system and its negative impact on development in Nepal, see Bista (1992).
cash crops, potato and tomato, and the main staple crops, maize and rice. Gross margins are the value of the output minus the direct, or variable, costs.

The statistical model in fact incorporates expected gross margins, not actual gross margins. Expected gross margins are used due to problems that are caused by the timing of the survey and developments beyond the control of the study, and the expectations of the farmers. As mentioned, the surveys were undertaken from February 1993 to April 1993. The first of these developments was the removal of government subsidies from inorganic fertilisers in late 1992. The removal of these subsidies caused the prices to more than double from just under Rs. 300 to well over Rs. 600. The real price is probably higher since bribery is a problem in some input stores. The supply of inorganic fertiliser can be unpredictable; store owners exploit these shortages by demanding a price higher than the official rate. Potato is a relatively high input crop, in that farmers apply a significant quantity of fertiliser onto their potato crop; as a result, the increase in fertiliser prices has adversely affected these growers.

The second development in 1992-1993 was the unavailability of the right type of inorganic fertiliser. The farmers in the watershed previously used a Korean fertiliser called Complex (20-20-0). This fertiliser is now difficult to buy in the watershed. Another fertiliser, Diammonium Phosphate (18-46-0), or DAP, is being recommended and used in its place. This has resulted in decreased potato yields of about 30 to 40 per cent. These two events have caused most households that chose to grow potatoes to lose money on this important cash crop.

Since most households that grew potatoes lost money, their actual gross margins, which are negative, in the statistical model would not correlate very highly with the

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50 Prices are for 50 kg bags.
51 During the early of the part of the field work, the interview team discovered that the farmers in the watershed refer to both Complex and DAP as "geda", even though they know that the real names of the fertilisers, and that they are different from one another. Consequently, The interview team always clarified what kind of inorganic fertiliser the farmers were referring to by cross-checking with the English names.
dependent variable being one. That is, a loss, reflected by negative gross margins, would not appear to be correlated with the adoption of a cash crop. If a farm household suffers a loss from this cash crop, it is not likely to grow the crop. This is the first reason that expected gross margins were used as opposed to actual gross margins.

Nepali farmers appear to have naive expectations. Many of their production decisions are based upon events or outcomes from the previous year or season. For example, potato growers had made a reasonable profit, and in some cases a significant profit, from their potato crops in previous seasons. They had expected this pattern to continue in the 1992-1993 year. Their expectations, however, were not met due to the removal of the fertiliser subsidies and the unavailability of the correct fertiliser. As a result of these two factors, expected gross margins are used in the model instead of actual gross margins.

Expected gross margins are calculated using information provided by the interviewed farmers. They are estimated for both vegetable cash crops under study, potato and tomato, and the most important staple crops, rice and maize. Most households grow one or the other vegetable crop on a significant scale; some households, however, grow both. In the latter case, the expected gross margin variable for the vegetable cash crops is a weighted sum of the expected gross margins of the potato and tomato crops. The expected gross margin is weighted by the land area allocated to the particular vegetable crop over the total land area allocated to both vegetable cash crops.

If a household does not grow a vegetable cash crop, an average expected gross margin is calculated for that household. The value is the average of the expected gross margin of the other households that belong to the same caste in the same VDC in which the non-growing household is located. For instance, suppose household i does not include a vegetable cash crop in its production cycle. If it belongs to the Tamang caste, and is located in Rabi-Opi, then its expected vegetable gross margin is the average of the expected vegetable cash crop gross margin for all Tamang households in Rabi-Opi.
This method is used as households of the same caste within a VDC generally have similar access to resources, and thus may have similar expectations regarding profits earned from their cash crops. Given these facts, it is hypothesised that a positive expected gross margin for vegetable cash crops will have a positive impact on the adoption of these crops. The higher the expected profits, the more likely a household will adopt the cash crop.

An expected gross margin for staple crops is also included. One staple crop, either maize or rice, has been recorded for all interviewed households. This variable is included in the model since the cash crops compete to some extent with the staple crop for farm resources. It is hypothesised that this variable is negatively correlated with cash crop adoption; that is, the higher the expected gross margin for the recorded staple crop, the less likely the household will grow a vegetable cash crop.

The last socio-economic variable in the model quantifies the access to inorganic commercial fertiliser. Many households experienced problems acquiring fertilisers, such as high prices, shortages, and bribery. These problems adversely affected the production of some households, while other households were able to overcome them. It is hypothesised, then, that extensive problems associated with inorganic commercial fertiliser that adversely affect a household's production will have a negative effect on vegetable cash crop adoption.

4.3.2 Resource Endowment Determinants

The resource endowments of the households are also hypothesised to be instrumental in its decision-making process. Resource endowments such as availability of irrigation water, education level of the household head, and soil quality are also factors in adoption. Availability of irrigation water was highlighted by the surveyed households as being the most important factor in the adoption of vegetable cash crops. Most farmers claimed that they could grow any vegetable crop if they had sufficient water for irrigation
purposes. A number of the households interviewed had stopped growing a variety of crops, both vegetables and herbs, due to the lack of water. Water has been diverted from the watershed to meet the needs of the growing urban centres in the Kathmandu Valley; therefore, adequate access to this important resource is diminishing in the Jhikhu Khola Watershed.\textsuperscript{52}

Households without irrigation water prefer to grow sturdy crops that do not require much water, such as maize. In this manner, households that must rely solely on the monsoon rains are able to reduce their production risk. For these reasons it is hypothesised that access to water, either seasonal or permanent sources, for irrigation purposes will positively affect a household's decision to adopt a vegetable cash crop.

The decision of what crop to plant is either made exclusively by the male household head, or jointly by men and women, but dominated by men. Since the male household head is the primary decision-maker, it is hypothesised that his education level will have a positive effect on the adoption decision. That is, the higher his education-level, the more non-traditional he will be, and thus the more willing he will be to engage in cash crop production. This variable is assumed to represent the level of human capital endowment of the household.

Finally, the quality of the soil has been included as the remaining hypothetical factor to affect the adoption decision. Soils in the watershed are categorised by a complex indigenous system (Tamang 1992). In order to simplify the classification of soils for this study, they are divided into two categories, red and non-red soils. Red soils are lower in organic content than non-red soils. Farmers claim that non-red soils are relatively more productive. Thus, non-red soils should have a positive impact on the adoption of vegetable cash crops.

\textsuperscript{52}A number of farmers reported that water from the watershed was being diverted to the Kathmandu Valley. This information was validated at the District Office in Dhulikhel.
4.3.3 Caveats

A few cautionary notes regarding these variables should be mentioned. It can be argued that the expected gross margin variables are a function of the other independent variables. Including these endogenous variables can lead to multicollinearity. In most regressions, however, the hypothesised exogenous variables do tend to be correlated with one another to some degree. The issue is not that this correlation exists, but rather the degree to which multicollinearity is a problem in the regression.

Inclusion or exclusion of endogenous variables such as the expected gross margin variables is a matter of judgement and involves a trade-off between inefficient and biased estimates. By including them in the model, the estimates will be unbiased, but they will be inefficient; the standard errors will be high. On the other hand, by dropping them, any contribution they make towards explaining the dependent variable will be attributed to the remaining exogenous variables; this will result in biased estimates.

The expected gross margins were included despite these apparent problems of endogeneity for two reasons. First, they are not highly correlated with the other exogenous variables; and second, it is expected that they will account more directly for influences, such as market signals, which are not captured by the other variables.

The issue of other variables that could have been included, but were not, should also be addressed. Potential variables such as land holdings, distance to roads, the proportion of female household labour, and life-cycle stage of the household were not included in the regression. These variables were dropped mainly for a couple of reasons. Some of these were highly correlated with other variables, while others were not significant. Once the problems with multicollinearity were corrected, the variables that remained insignificant, regardless of which other variables were included, were dropped from the regression.
4.3.4 Specification of the Empirical Model

The logit model is specified such that the dependent variable equals one if the household grows a vegetable cash crop, and zero otherwise. The general form is as follows:

\[ Y_i' = \beta 'X_i + u_i \]

where:

\[ Y_i' = 1 \quad \text{if} \quad Y_i > 0 \]

otherwise:

\[ Y_i' = 0 \]

and

\[ \text{Probability}(Y_i' = 1) = \text{Probability}(\beta 'X_i > u_i) = F(\beta 'X_i) \]

where:

- \( Y_i' \) = the dependent variable
- \( \beta ' \) = the maximum likelihood estimates
- \( X_i \) = the explanatory, or independent variables
- \( F(*) \) = cumulative distribution function for \( u_i \); it is assumed to follow a logistic distribution.

Specifically, given the hypotheses outlined in the previous section, the adoption model is as follows:

\[ \text{VegGrow} = f(\text{HiCaste}, \text{VegMrg}, \text{StplMrg}, \text{Fert}, \text{Water}, \text{School}, \text{RedSoil}) \]

where:

- \( \text{HiCaste} \) = household belongs to a high caste; it is one if it does, else it is zero
- \( \text{VegMrg} \) = the estimated expected gross margin of the vegetable cash crop(s)
- \( \text{StplMrg} \) = the estimated expected gross margin of the main staple crop grown
In this chapter the theoretical background and justification for using the logistic regression was outlined. For models with dichotomous dependent variables, the logistic regression can provide valuable insights into the relationships between the exogenous variables and the dependent adoption variable. The socio-economic and resource endowment determinants of the empirical model were specified, and the reasons for their inclusion in the model. The independent variables are HiCaste, VegMrg, StplMrg, Fert, Water, School, and RedSoil.
5.1 Model Results

The logit model estimates are reported in Table 3. The statistically significant variables are denoted by an asterisk. The estimation results indicate that the decision made by households to adopt a vegetable cash crop is indeed related to household characteristics. As expected, the fertiliser problems have a negative impact on a households decision to grow a vegetable cash crop. The inorganic fertiliser variable is statistically significant. Although the absolute t-value is normally 2.0 at the 95 per cent level for significant variables, the t-value is less than 2.0 for the Fert variable. Recall that in small samples, the t-test and the $\chi^2$ test can diverge. According to the $\chi^2$ test, Fert is statistically significant.

Table 3. Logit Estimates of Vegetable Cash Crop Adoption

<table>
<thead>
<tr>
<th>Indep. Variable</th>
<th>Estimated Coefficient</th>
<th>Absolute t-Value</th>
<th>Standard Error</th>
<th>Mean Value of Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>HiCaste</td>
<td>-0.1925</td>
<td>0.2201</td>
<td>0.8746</td>
<td>0.4375</td>
</tr>
<tr>
<td>VegMrg</td>
<td>-0.0003</td>
<td>0.8838</td>
<td>0.0003</td>
<td>2419.6000</td>
</tr>
<tr>
<td>StplMrg</td>
<td>0.0005</td>
<td>0.6099</td>
<td>0.0008</td>
<td>562.8000</td>
</tr>
<tr>
<td>Fert*</td>
<td>-1.5275</td>
<td>1.6632</td>
<td>0.9184</td>
<td>0.3594</td>
</tr>
<tr>
<td>Water*</td>
<td>3.2482</td>
<td>2.7634</td>
<td>1.1754</td>
<td>0.6719</td>
</tr>
<tr>
<td>School*</td>
<td>0.3468</td>
<td>2.2040</td>
<td>0.1574</td>
<td>3.0313</td>
</tr>
<tr>
<td>RedSoil*</td>
<td>-3.4740</td>
<td>3.0350</td>
<td>1.1447</td>
<td>0.4063</td>
</tr>
<tr>
<td>Constant</td>
<td>0.4057</td>
<td>0.4126</td>
<td>0.9833</td>
<td>-</td>
</tr>
</tbody>
</table>

Notes: Number of observations: 64
Chi-squared = 33.77
pseudo-$R^2 = 0.35$
Percentage of correct predictions: 80%
t-Values computed at 95% level*
* - denotes statistically significant variables

Households that experienced extensive problems with inorganic commercial fertiliser such that their production was adversely affected, were less likely to adopt
vegetable cash crops than those households that did not have such problems. Access to irrigation water has the correct sign as well, and is significant at the 0.05 level.\textsuperscript{53} There is a positive relationship between access to irrigation water and adoption of a vegetable cash crop by the surveyed households. The level of formal education of the male household head, which was assumed to indicate the human capital endowment of the household, also positively affects vegetable cash crop adoption. The presence of predominantly red soils does significantly affect the choice of whether or not to grow a cash crop. Remember that red soils are relatively lower quality soils. The sign of the red soil variable is negative, as expected, indicating a negative impact on the decision to grow a vegetable cash crop.

The statistically non-significant variables in the logit regression are also interesting to note. The variable HiCaste, which represents households that belong to relatively higher social and economic castes or ethnic groups, does not significantly affect the choice of becoming a vegetable cash crop grower. This outcome may be explained by religious and social customs. Some of the higher caste/ethnic groups, for instance the Brahmans, the priestly caste, have several dietary restrictions. Traditionally, Brahmans in the watershed have not been able to grow tomatoes because tomatoes were believed to be an “unclean” and hence a “polluting” vegetable. Tomatoes were seen growing “wild” in cow dung heaps, and other similar unsanitary areas; consequently, they were considered to be an inedible vegetable. Previously Brahmans did not even touch tomatoes, due to its ritual polluting properties. Nevertheless, this attitude of Brahman households has begun to change as tomatoes have proven to be quite profitable for other peasant households.\textsuperscript{54}

Another possible reason why the HiCaste variable is not statistically significant is that higher caste/ethnic households may not be as motivated to grow the more profitable crops. With greater endowments of wealth, they may feel that using their household

\textsuperscript{53}All independent variables were tested at the 0.05 level.
\textsuperscript{54}In order to justify their own adoption of tomatoes, some Brahman households claim that they had seen the tomato plant growing out of the potato plant. They reasoned that since potatoes were suitable vegetables to grow and eat for Brahmans, tomatoes must be as well.
resources to maintain their high social standing is more important than growing cash crops. For instance, some surveyed higher caste/ethnic households stated that growing rice was preferred to growing vegetable cash crops since rice is regarded as a "high status" crop; that is, the social importance of rice makes it the preferred crop of these households, even if it is not as profitable as some vegetable cash crops. These factors would indicate that higher caste/ethnic households are slow, and therefore less likely, to adopt new cash crops since their need for cash is less important than lower caste/ethnic households.

Expected gross margins of the vegetable and the staple crops do not significantly affect the adoption probability. The variables $VegMrg$ and $StplMrg$, which respectively represent the expected gross margin of the vegetable cash crop(s) and the staple crop grown by the household, are not statistically significant. The market infrastructure is still in the developmental stages in the watershed, and though it is improving with each year, relatively poor market infrastructure and cohesiveness, delayed market signals, and consequential concerns with risk may explain this model outcome.

The overall fit of the model is quite good. The pseudo-$R^2$ is 0.35. Recall for logit regressions a model with a pseudo-$R^2$ value between 0.2 and 0.4 is considered to be a well-fitting model. The percentage of correct predictions is 80 per cent.

In summary, it may be concluded from these results that households in the watershed with access to irrigation water, that did not encounter extensive problems using inorganic commercial fertiliser, that have an educated male household head and relatively good quality soils, are more likely to adopt vegetable cash crops.

5.2 Interpretation of Estimated Coefficients

The logit equation from Table 3 is approximately:

$$\hat{L}_i = 0.41 - 0.19 X_{i1} - 0.0003 X_{i2} + 0.0005 X_{i3} - 1.53 X_{i4} + 3.25 X_{i5} + 0.35 X_{i6} - 3.47 X_{i7}$$

$\hat{L}$ represents the log odds of adopting a vegetable cash crop. The coefficients can be interpreted with reference to odds or probabilities. In addition, quasi-elasticities of the
coefficients can be calculated and their effects interpreted. Odds allow an intuitive interpretation, especially with dichotomous dependent variables. The coefficient on Water, a dummy variable that indicates the availability of irrigation water, is $b_4 = 3.25$. Having irrigation water therefore multiplies the odds by $e^{3.25} = 25.79$. If all other dependent variables equal their means, the predicted odds that households with irrigation water will grow a vegetable cash crop are about 9.17 to 1. Predicted odds for a household without irrigation water are about 1/25th as high (0.36 to 1). The odds of households growing a vegetable cash crop without access to irrigation water are slim indeed.

The odds for all the coefficients are given in Table 4. As can be seen from the Odds Ratio column in this table, of all the adoption factors, access to irrigation water has the greatest impact on growing vegetable cash crops.

<table>
<thead>
<tr>
<th>Indep. Variable</th>
<th>Odds Ratio</th>
<th>Probabilities (%)</th>
<th>Quasi-Elasticity</th>
</tr>
</thead>
<tbody>
<tr>
<td>HiCaste</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>VegMrg</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>StplMrg</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Fert*</td>
<td>0.22</td>
<td>54%</td>
<td>-0.31</td>
</tr>
<tr>
<td>Water*</td>
<td>25.79</td>
<td>90%</td>
<td>0.64</td>
</tr>
<tr>
<td>School*</td>
<td>1.41</td>
<td>76%</td>
<td>0.06</td>
</tr>
<tr>
<td>RedSoil*</td>
<td>0.03</td>
<td>29%</td>
<td>-0.64</td>
</tr>
</tbody>
</table>

Note: * - denotes statistically significant variables

The odds ratio for School variable is 1.41. This describes the effect of a one-unit change; that is, with each additional year of formal education attained by the male household head, the odds of the household growing a vegetable cash crop are multiplied by 1.41.

Alternatively, the effects of the factors of adoption can be described in terms of probabilities instead of odds. Table 4 also lists these probabilities. Recall (10) where probabilities are predicted using the estimated logit. The probability of a household
growing a vegetable cash crop is 54 per cent, if it has serious problems using fertiliser. Similarly, the chance that a household with access to irrigation water, or lower quality soils, will adopt a cash crop is 90 and 29 per cent, respectively. As shown by the School variable, if all factors are at their means, the probability that the household will adopt a cash crop is 76 per cent.

Although the probabilities of counter values are not listed in the table, they can also be computed using (10). Thus, the chance that a household without serious fertiliser problems will adopt a vegetable cash crop is 85 per cent. The probability of a household with good quality soils adopting a cash crop is 93 per cent.

The quasi-elasticities of the estimated coefficients are also given in Table 4. Equations (22) and (23) specify how quasi-elasticities are computed. Quasi-elasticities indicate the effect on the probability of adoption given a one per cent increase in a given explanatory variable. Since the quasi-elasticity is different for every observation, the elasticities have been calculated at the mean values of the exogenous variables. Referring to Table 4, the quasi-elasticity of the School variable is 0.06; thus, a one per cent increase in the education of the male household head results in a 0.06 increase in the probability that the household will grow a vegetable cash crop.

The above explanation of quasi-elasticities makes sense only when referring to continuous variables. The quasi-elasticity for dummy variables is calculated using (23) since the notion of a percentage change does not hold when dealing with dummy variables. Equation (23) defines quasi-elasticities of dummy variables to be the difference between the probability that the household will grow a cash crop, and the probability that it will not. The quasi-elasticity of Water is 0.64. In other words, the probability that a household with access to irrigation water will adopt a vegetable cash crop is 64 percentage points greater than if it does not have irrigation water.

The quasi-elasticity of Fert and RedSoil are negative. This means for these variables, the probability that a household will grow a vegetable cash crop is greater if the
value of the dummy variable is zero. For instance, the probability that a household will adopt a vegetable cash crop if it does not have serious problems with fertilisers is 31 per cent higher than if it does have serious problems. Similarly, the quasi-elasticity for RedSoil is -0.64; that is, the probability that a household will grow a vegetable cash crop is 64 percentage points higher if it has good quality soils as opposed to relatively poor quality soils. This is true for all variables that have a negative impact on adoption; or in other words, those variables that have a negative sign on their estimated coefficient.

The logit model has been a useful tool in analysing the given data and examining household behaviour regarding cash crop adoption. By employing this model, the statistically significant and insignificant variables have been identified; thereby, indicating which of the hypotheses regarding household adoption behaviour are true, and which are not. These causal relationships would have been difficult to discern from simple examination of the data, or from observations in the field. For instance, in the field, it appeared that there was a definitive causal relationship between castes/ethnic background and adoption. The model, however, revealed that this is not true. As mentioned earlier (Chapter 4), this logit model also was able to provide information about the magnitude of the relationship between different variables and the adoption decision. For example, from the results of the model, one can conclude that access to irrigation water is the most important factor in the decision-making process.
CHAPTER SIX

IMPLICATIONS OF VEGETABLE CASH CROP PRODUCTION

6.1 Overview

This chapter will fulfill the second objective of the study at hand; that is, in this chapter the implications of cash crop adoption will be reviewed. The effects of adoption will be assessed by comparing the vegetable cash crops, potato and tomato, with the staple food crops, maize and rice. The data used in this chapter are from the household surveys. The following evaluation of the effects, both positive and negative, consists of an assessment in the following areas: a) the profitability and costs of all four crops; b) the returns of those households that do, and those that do not, adopt a cash crop; c) the risks and uncertainties involved in the production of all four crops; d) the perceived constraints to vegetable cash crop expansion; e) and finally, the effect of cash crop adoption on food security.

6.2 Profitability and Costs of all Crops

The first assessment of the cash crop adoption is an examination of the profitability and costs of the four crops being studied, maize and rice, and potatoes and tomatoes. A measurement and comparison of the profitability of these staple and cash crops is required because for those households that choose to adopt vegetable cash crops, the returns of those crops to land and labour is important since allocation of these vital household resources is central in any decision that the household makes when choosing what crop to grow. Gross margins are used to measure the profitability of the two staple crops, maize and rice, and the two vegetable crops, potato and tomato.

As already mentioned, gross margins are the value of the output minus the direct, or variable, costs. Specifically, they have been calculated by subtracting the costs of the
following items from the value of the output: labour, material inputs, and an interest charge.

These values have been estimated from the household surveys. As already mentioned, the information covers recall periods specific to the nature of the data. The households do not keep any written records, so the responses are from memory. Despite this drawback, many households were able to answer the questions quite well; this is probably because since they do not have any written records, they are forced to rely on their memory of production practices and other information from previous years. In addition, the information provided was validated by the methods mentioned in Chapter 3.

The gross margins have been estimated for the four crops under study on a per unit of land basis, and are reported in Tables 5-8. The gross margins are based upon the 1992-1993 cropping season as expressed in the cropping calendar illustrated in Figure 18. The production cycle is based on the Nepali calendar, which consists of twelve months; however, the Nepali months do not completely coincide with the months in the Gregorian calendar. For example, the first month of the Nepali year, Baisak, begins in the middle of April and ends in mid-May. The cropping calendar in Figure 18 reflects this, as the crop cycles begin and end in the middle of the respective months. The cash crops are mainly grown outside the period when the staple crops are produced. Tomato is the only crop that is grown virtually all year round, either on khet or bari land.

A comparison of the profitability of these staple and cash crops reveals mixed results. While tomatoes have proven to be a very profitable cash crop, recently potatoes have been a failure. Tomatoes yield a gross margin per unit of land almost twelve times higher than that of the principal staple crop, maize. It is about five times higher than rice, the second most important staple crop in the watershed. The average gross margin earned by tomato growers is about Rs. 4,143 per ropani, compared to about Rs. 357 for maize.

Material inputs include seed, inorganic fertiliser, pesticides, and compost.
Table 5. Production Costs and Gross Margin Estimates of Maize

<table>
<thead>
<tr>
<th>Constant Values</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Monthly Interest Rate:</td>
<td>0.01</td>
</tr>
<tr>
<td>Maize Land Area (ropani):</td>
<td>9.88</td>
</tr>
<tr>
<td>Maize Farmgate Price (kg):</td>
<td>5.74</td>
</tr>
</tbody>
</table>

**MAIZE: PRODUCTION COSTS PER ROPANI**

| Total Production (kg): | 166.01 |

<table>
<thead>
<tr>
<th>Unit</th>
<th>Quantity</th>
<th>Price</th>
<th>Value</th>
<th>Total Cost</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CULTIVATION ACTIVITIES:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male Adult Labour</td>
<td>day</td>
<td>3.91</td>
<td>39.00</td>
<td>152.49</td>
<td>14.42%</td>
</tr>
<tr>
<td>Female Adult Labour</td>
<td>day</td>
<td>6.13</td>
<td>32.00</td>
<td>196.16</td>
<td>18.55%</td>
</tr>
<tr>
<td>Male Child Labour</td>
<td>day</td>
<td>0.40</td>
<td>19.50</td>
<td>7.80</td>
<td>0.74%</td>
</tr>
<tr>
<td>Female Child Labour</td>
<td>day</td>
<td>0.81</td>
<td>16.00</td>
<td>12.96</td>
<td>1.23%</td>
</tr>
<tr>
<td>Bullock</td>
<td>day</td>
<td>1.06</td>
<td>115.00</td>
<td>121.90</td>
<td>11.53%</td>
</tr>
<tr>
<td><strong>MATERIAL INPUTS:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compost</td>
<td>kg</td>
<td>627.44</td>
<td>0.55</td>
<td>345.09</td>
<td>32.64%</td>
</tr>
<tr>
<td>Ammonium Sulphate</td>
<td>kg</td>
<td>0.94</td>
<td>4.61</td>
<td>4.33</td>
<td>0.41%</td>
</tr>
<tr>
<td>DAP</td>
<td>kg</td>
<td>13.62</td>
<td>11.75</td>
<td>160.04</td>
<td>15.14%</td>
</tr>
<tr>
<td>Urea</td>
<td>kg</td>
<td>5.52</td>
<td>5.55</td>
<td>30.64</td>
<td>2.90%</td>
</tr>
<tr>
<td>Seed</td>
<td>kg</td>
<td>1.67</td>
<td>0.11</td>
<td>0.18</td>
<td>0.02%</td>
</tr>
</tbody>
</table>

**TOTAL VARIABLE COST:** 1,031.59 (97.56%)

**OTHER COSTS:**
- Interest on Variable Cost: 25.79 (2.44%)

**TOTAL COST:** 1,057.38 (100.00%)

**COST PER HECTARE:** 21,147.60
**COST PER KG:** 6.37
**VALUE OF JOINT PRODUCTS:** 461.57

**RE-turns:** 952.90
**GROSS MARGINS:** 357.09

Source: Household surveys.
Table 6. Production Costs and Gross Margin Estimates of Rice

<table>
<thead>
<tr>
<th>Constant Values</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Monthly Interest Rate:</td>
<td>0.01</td>
</tr>
<tr>
<td>Rice Land Area (ropani):</td>
<td>10.13</td>
</tr>
<tr>
<td>Rice Farmgate Price (kg):</td>
<td>6.27</td>
</tr>
</tbody>
</table>

**RICE: PRODUCTION COSTS PERROPANI**

| Total Production (kg): | 317.82 |

<table>
<thead>
<tr>
<th>Unit</th>
<th>Quantity</th>
<th>Price</th>
<th>Value</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CULTIVATION ACTIVITIES:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male Labour</td>
<td>day</td>
<td>10.37</td>
<td>39.00</td>
<td>404.43</td>
</tr>
<tr>
<td>Female Labour</td>
<td>day</td>
<td>8.56</td>
<td>32.00</td>
<td>273.92</td>
</tr>
<tr>
<td>Male Child Labour</td>
<td>day</td>
<td>0.03</td>
<td>19.50</td>
<td>0.59</td>
</tr>
<tr>
<td>Female Child Labour</td>
<td>day</td>
<td>0.12</td>
<td>16.00</td>
<td>1.92</td>
</tr>
<tr>
<td>Bullock</td>
<td>day</td>
<td>1.44</td>
<td>119.00</td>
<td>171.36</td>
</tr>
<tr>
<td>Tractor</td>
<td>hours</td>
<td>0.19</td>
<td>120.00</td>
<td>22.80</td>
</tr>
</tbody>
</table>

| **MATERIAL INPUTS:** | | | | |
| Compost | kg | 222.91 | 0.32 | 71.33 | 5.89% |
| Ammonium Sulphate | kg | 0.28 | 4.61 | 1.29 | 0.11% |
| DAP | kg | 13.27 | 11.75 | 155.92 | 12.87% |
| Urea | kg | 6.94 | 5.55 | 38.52 | 3.18% |
| FenFen | ml | 5.77 | 0.26 | 1.50 | 0.12% |
| Metacid | ml | 12.53 | 0.69 | 8.65 | 0.71% |
| Nuvan | ml | 7.89 | 0.53 | 4.18 | 0.34% |
| Seed | kg | 4.49 | 6.27 | 28.15 | 2.32% |

**TOTAL VARIABLE COST:**

1,184.56 98.00%

**OTHER COSTS:**

| Interest on Variable Cost: | 27.24 | 2.25% |

**TOTAL COST:**

1,211.80 100.00%

**COST PER HECTARE:**

24,236.00

**COST PER KG:**

3.81

**RETURNS:**

1,992.73

**GROSS MARGINS:**

780.93

Source: Household surveys.
Table 7. Production Costs and Gross Margin Estimates of Potato

<table>
<thead>
<tr>
<th>Constant Values</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Monthly Interest Rate:</td>
<td>0.01</td>
</tr>
<tr>
<td>Potato Land Area (ropani):</td>
<td>4.65</td>
</tr>
<tr>
<td>Potato Farmgate Price (kg):</td>
<td>4.18</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>POTATO: PRODUCTION COSTS PER ROPANI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Production (kg):</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unit</th>
<th>Quantity</th>
<th>Price</th>
<th>Value</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male Labour</td>
<td>day</td>
<td>8.26</td>
<td>39.00</td>
<td>322.14</td>
</tr>
<tr>
<td>Female Labour</td>
<td>day</td>
<td>6.07</td>
<td>32.00</td>
<td>194.24</td>
</tr>
<tr>
<td>Male Child Labour</td>
<td>day</td>
<td>0.07</td>
<td>19.50</td>
<td>1.37</td>
</tr>
<tr>
<td>Female Child Labour</td>
<td>day</td>
<td>0.43</td>
<td>16.00</td>
<td>6.88</td>
</tr>
<tr>
<td>Bullock</td>
<td>day</td>
<td>0.46</td>
<td>114.00</td>
<td>52.44</td>
</tr>
<tr>
<td>Tractor</td>
<td>hours</td>
<td>0.39</td>
<td>116.00</td>
<td>45.24</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MATERIAL INPUTS:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Compost</td>
<td>625.42 kg  0.45</td>
</tr>
<tr>
<td>Ammonium Sulphate</td>
<td>6.21 kg  4.61</td>
</tr>
<tr>
<td>DAP</td>
<td>30.55 kg  11.75</td>
</tr>
<tr>
<td>Potash</td>
<td>1.15 kg  4.60</td>
</tr>
<tr>
<td>Urea</td>
<td>5.63 kg  5.55</td>
</tr>
<tr>
<td>DM45</td>
<td>1.06 kg  257.22</td>
</tr>
<tr>
<td>FenFen</td>
<td>2.31 ml  0.82</td>
</tr>
<tr>
<td>Metacid</td>
<td>2.50 ml  0.69</td>
</tr>
<tr>
<td>Multiplex</td>
<td>13.87 ml  0.30</td>
</tr>
<tr>
<td>Nuvan</td>
<td>13.78 ml  0.53</td>
</tr>
<tr>
<td>Seed</td>
<td>39.52 kg  8.46</td>
</tr>
</tbody>
</table>

TOTAL VARIABLE COST: 1,949.95 98.33%

<table>
<thead>
<tr>
<th>OTHER COSTS:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Interest on Variable Cost:</td>
<td>33.15</td>
</tr>
</tbody>
</table>

TOTAL COST: 1,983.10 100.00%

COST PER HECTARE: 39,662.00
COST PER KG: 4.49

<table>
<thead>
<tr>
<th>RETURNS:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1,844.17</td>
</tr>
</tbody>
</table>

| GROSS MARGINS:               | -138.93 |

Source: Household surveys.
Table 8. Production Costs and Gross Margin Estimates of Tomato

<table>
<thead>
<tr>
<th>Constant Values</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Monthly Interest Rate:</td>
<td>0.01</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tomato Land Area (ropani):</td>
<td>2.76</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tomato Farmgate Price (kg):</td>
<td>7.20</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TOMATO: PRODUCTION COSTS PER ROPANI

| Total Production (kg):          | 865.37|

<table>
<thead>
<tr>
<th>Unit</th>
<th>Quantity</th>
<th>Price</th>
<th>Value</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>CULTIVATION ACTIVITIES:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male Labour</td>
<td>day</td>
<td>14.92</td>
<td>39.00</td>
<td>581.88</td>
</tr>
<tr>
<td>Female Labour</td>
<td>day</td>
<td>12.27</td>
<td>32.00</td>
<td>392.64</td>
</tr>
<tr>
<td>Male Child Labour</td>
<td>day</td>
<td>0.68</td>
<td>19.50</td>
<td>13.26</td>
</tr>
<tr>
<td>Female Child Labour</td>
<td>day</td>
<td>1.18</td>
<td>16.00</td>
<td>18.88</td>
</tr>
<tr>
<td>Bullock</td>
<td>day</td>
<td>1.02</td>
<td>113.00</td>
<td>115.26</td>
</tr>
<tr>
<td>Tractor</td>
<td>hours</td>
<td>0.13</td>
<td>112.00</td>
<td>14.56</td>
</tr>
<tr>
<td>Water Pump</td>
<td>hours</td>
<td>0.47</td>
<td>75.00</td>
<td>35.25</td>
</tr>
</tbody>
</table>

MATERIAL INPUTS:

<table>
<thead>
<tr>
<th>Unit</th>
<th>Quantity</th>
<th>Price</th>
<th>Value</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compost</td>
<td>kg</td>
<td>447.49</td>
<td>0.47</td>
<td>210.32</td>
</tr>
<tr>
<td>Ammonium Sulphate</td>
<td>kg</td>
<td>1.20</td>
<td>4.61</td>
<td>5.53</td>
</tr>
<tr>
<td>DAP</td>
<td>kg</td>
<td>14.66</td>
<td>11.75</td>
<td>172.26</td>
</tr>
<tr>
<td>Potash</td>
<td>kg</td>
<td>0.11</td>
<td>4.60</td>
<td>0.51</td>
</tr>
<tr>
<td>Urea</td>
<td>kg</td>
<td>1.61</td>
<td>5.55</td>
<td>8.94</td>
</tr>
<tr>
<td>DM45</td>
<td>kg</td>
<td>0.97</td>
<td>257.22</td>
<td>249.50</td>
</tr>
<tr>
<td>FenFen</td>
<td>ml</td>
<td>86.13</td>
<td>0.54</td>
<td>46.51</td>
</tr>
<tr>
<td>Metacid</td>
<td>ml</td>
<td>13.43</td>
<td>0.69</td>
<td>9.27</td>
</tr>
<tr>
<td>Multiplex</td>
<td>ml</td>
<td>99.94</td>
<td>0.30</td>
<td>29.98</td>
</tr>
<tr>
<td>Nuvan</td>
<td>ml</td>
<td>96.30</td>
<td>0.53</td>
<td>51.04</td>
</tr>
<tr>
<td>Seed</td>
<td>kg</td>
<td>0.17</td>
<td>583.08</td>
<td>99.12</td>
</tr>
</tbody>
</table>

TOTAL VARIABLE COST: 2,054.71 98.42%

OTHER COSTS:

| Interest on Variable Cost:       | 32.88  | 1.58% |

TOTAL COST: 2,087.59 100.00%

COST PER HECTARE: 4,175.18

COST PER KG: 2.41

RETURNS: 6,230.66

GROSS MARGINS: 4,143.07

Source: Household surveys.
The interest charge is used to calculate an "opportunity cost on capital invested in variable crops." It is charged for the "time period between expenditure of the capital and harvest when income is or can be received" (Kay 1986, 67). An opportunity cost rate of 12 per cent is used. This was the average annual interest rate at the bank in the district headquarters, Dhulikhel. Rent for land is not included. Gross margins are expressed per unit of land (ropani) and per adult labour day in order to assess the competitiveness of the crops at the farm level. All calculations are based on estimated average costs for the surveyed households.

Kennedy and Dunlop (1989) also estimate gross margins of various vegetable and staple crops. Their gross margin estimates of maize, potato, and tomato differ from the estimates listed in Tables 5, 7, and 8. These differences can be attributed to the changes in the operational environment during the intervening 5.5 years, and differences in methodologies. Some of the more notable changes that have occurred that have already been noted in this study are the changes in input and output prices, closure of the Panchkhal Horticulture Farm, and the end of the Japanese Overseas Aid Project. Kennedy and Dunlop also used a different methodology in their estimations. For example, their estimates are only from Panchkhal, not any other VDC. Consequently, differences in access to resources may not be as pronounced across their sample. In the case of water, for instance, as mentioned earlier, households in Rabi-Opi must rely on seasonal rains more since irrigation water is quite limited as compared to households in Panchkhal. Second, due to data limitations, Kennedy and Dunlop did not estimate gross margins from their household surveys. Rather, they consulted one key informant and some local farmers; in the study on hand, on the other hand, the gross margins have been estimated from data from 64 households and includes a variety of household farming practices and costs, such as compost costs, that are not included in Kennedy and Dunlop's estimates. Finally,

56 The following gross margin estimates are from Table 30 (Kennedy and Dunlop 1989).
57 They did not estimate gross margins for rice.
Kennedy and Dunlop disaggregated their estimates by both season and type of land; thereby, providing an interesting dimension to their estimates.

Despite these differences, a comparison of the two sets of gross margin estimates (both computed on a per ropani basis) is useful for illustrative purposes. Kennedy and Dunlop estimated the gross margin for maize grown on khet land in the spring (before the monsoons) to be Rs. 558 per ropani. Maize grown during the monsoons on bari land have an estimated gross margin of Rs. 414 per ropani. Both these are slightly higher than Rs. 357, shown in Table 5. It would be expected that the maize grown on khet land would be higher since it is better quality land, thus the yields are higher. As mentioned, the estimates in this study include a variety of farming practices in three different VDCs, on khet and bari land, of both efficient and inefficient farmers. This may well account for the lower gross margin estimate in this study.

The estimated gross margins of potato crops cultivated on khet and bari land are Rs. 221 and Rs. 485 per ropani, respectively. These are obviously higher than the negative gross margin estimate in this study. The reasons for the current loss in potatoes has already been discussed.

Kennedy and Dunlop estimated gross margins for both traditional and improved varieties of tomatoes. Tomatoes were not differentiated in this study because many households did not know what tomato variety they were cultivating. Kennedy and Dunlop give gross margins estimates only for tomatoes grown on khet land. The traditional tomatoes, grown during the spring, yield a gross margin of Rs. 2,108 per ropani, while improved tomatoes grown at the same time have a gross margin of Rs. 2,207. On the other hand, improved tomatoes cultivated on khet land, but during the winter, yield a gross margin of Rs. 482 per ropani. These estimates are substantially lower than the one listed in Table 8. A significant difference between the estimates from Kennedy and Dunlop and this study is the farmgate price. They use a per kilogram farmgate price of Rs. 4 for improved tomatoes and Rs. 6 for traditional tomatoes; for improved tomatoes grown
during the winter, the farmgate price is Rs. 2.50. As shown in Table 8, the average farmgate price of tomatoes is Rs. 7.20 per kg. This accounts for a significant portion of the difference in the two sets of estimates. Changes in the operational environment over time may account for the remaining difference.

The estimates of the gross margins between the two studies are different. The question arises as to which estimate is the “right” estimate. In fact, neither is right nor wrong. Each is valid for the method used; consequently, neither of the these estimates are definitive in themselves. More importantly, they serve to give an idea of the relative profitability and the range of earnings from these different crops.

A disaggregation of the variable costs for all the crops under study is given in Table 9. Animal costs account for over 14 per cent of the variable costs for rice. This means that on a per ropani basis, bullock costs account for over 14 per cent of the total variable costs for rice, the highest animal labour costs of all crops. The relative costs of compost are highest for maize, and lowest for rice. Maize has the greatest application of compost amongst all the crops, rice the least. Chemical input costs include the costs of inorganic fertilisers and pesticides. The cash crops have the highest chemical input costs.
Figure 6. Cropping Calendar of All Crops.

<table>
<thead>
<tr>
<th>Crop</th>
<th>J</th>
<th>F</th>
<th>M</th>
<th>A</th>
<th>M</th>
<th>J</th>
<th>J</th>
<th>A</th>
<th>S</th>
<th>O</th>
<th>N</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spring Rice</td>
<td>&lt;=</td>
<td>=</td>
<td>=</td>
<td>=</td>
<td>=</td>
<td>=</td>
<td>=</td>
<td>=</td>
<td>=</td>
<td>=</td>
<td>=</td>
<td>=</td>
</tr>
<tr>
<td>Rice</td>
<td>&lt;=</td>
<td>=</td>
<td>=</td>
<td>=</td>
<td>=</td>
<td>=</td>
<td>=</td>
<td>=</td>
<td>=</td>
<td>=</td>
<td>=</td>
<td>=</td>
</tr>
<tr>
<td>Potato¹</td>
<td>=</td>
<td>=</td>
<td>=&gt;</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<td>-</td>
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<td>Potato²</td>
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<td>=</td>
<td>=&gt;</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Tomato¹</td>
<td>&lt;=</td>
<td>-</td>
<td>-</td>
<td>=</td>
<td>=</td>
<td>=</td>
<td>=</td>
<td>=</td>
<td>=</td>
<td>=</td>
<td>=</td>
<td>=</td>
</tr>
<tr>
<td>Tomato²</td>
<td>&lt;=</td>
<td>-</td>
<td>-</td>
<td>=</td>
<td>=</td>
<td>=</td>
<td>=</td>
<td>=</td>
<td>=</td>
<td>=</td>
<td>=</td>
<td>=</td>
</tr>
</tbody>
</table>

Source: Household surveys.

Note: The double lines show the main periods of planting, growing, and harvesting; the single lines show extended periods during which a minority of farmers engage in these activities.

1 - grown on bari, or rain-fed, land
2 - grown on khet, or irrigated, land

Table 9. Variable Cost Disaggregation of All Crops

<table>
<thead>
<tr>
<th>Crop</th>
<th>Animal Costs</th>
<th>Compost Costs</th>
<th>Chemical Input Costs</th>
<th>Material Input Costs</th>
<th>Machinery Cost</th>
<th>Labour Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize</td>
<td>12.00%</td>
<td>33.00%</td>
<td>19.00%</td>
<td>52.00%</td>
<td>0.00%</td>
<td>36.00%</td>
</tr>
<tr>
<td>Rice</td>
<td>14.47%</td>
<td>6.02%</td>
<td>17.73%</td>
<td>26.13%</td>
<td>1.92%</td>
<td>57.48%</td>
</tr>
<tr>
<td>Potato</td>
<td>2.69%</td>
<td>14.43%</td>
<td>36.51%</td>
<td>68.09%</td>
<td>2.32%</td>
<td>26.90%</td>
</tr>
<tr>
<td>Tomato</td>
<td>5.61%</td>
<td>10.24%</td>
<td>27.91%</td>
<td>42.97%</td>
<td>2.42%</td>
<td>48.99%</td>
</tr>
</tbody>
</table>

Source: Tables 5-8.
Although the chemical input costs for the potato crop is only about 9 per cent higher than that of tomatoes, pesticides, and not fertilisers, account for the majority of the chemical input costs for the tomato costs. Pesticides are not used to any significant extent on the potato crop. Material input costs aggregate compost, inorganic fertilisers and pesticides, and seed costs. Material input costs contribute to about 68 per cent of the variable costs for potato. It is interesting to note that though maize is considered to be a low-input crop, 52 per cent of its variable costs is due to the costs of material inputs. As can be seen from the table, machinery costs are quite low for all crops. Labour costs are highest for rice, and lowest for potato. It accounts for over 57 per cent of the variable costs for rice, and for about 27 per cent of the variable costs for the potato crop.

As reported in Table 10, per unit of labour, the gross margin of tomatoes is almost three times the margin reported for maize. Tomatoes absorb 2.5 times more total labour per ropani, in terms of labour days, than maize. Compared to rice, a high status crop, the returns to labour are three times greater for tomatoes, and tomatoes require 1.6 times more labour per ropani than rice. The gross margin (net return) per day of labour indicates the level of opportunity cost of labour in agriculture. The gross margins per labour day exceed the range of local wage rates, which are Rs. 35-44 a day for men. The reported wage for women is lower than the men's rate, ranging from Rs. 27 to Rs. 38. Returns to labour from tomatoes exceed these male and female rates by a substantial margin. The net return to labour from the potato crop, however, is negative.

Referring to Table 7, the gross margin for potato is negative, an indication that the households are on average losing about Rs. 139 per ropani. The negative gross margin is primarily the result of the dramatic increase in the price of inorganic commercial fertiliser caused by the removal of government subsidises, and the unavailability of the right type of fertiliser. These developments were fully explained earlier.

58Men's, women's, and children's labour days are weighted by 1.0, 1.0, and 0.5, respectively.
There is a third possible reason why farmers incurred a loss from their potato crop. Apparently, the productive capacity of the soil is decreasing in the study area. A number of farmers interviewed reported a general decline in the yields of all their crops due to a decline in the productivity of the soils. This can be due to such factors as increased cropping intensity,\(^5\) and the increased application of inorganic fertiliser. Cropping patterns have become more intensive in general all over Nepal as the population has grown (Riley 1991); this is true of the Jhikhu Khola Watershed as well. Households in the watershed now normally grow at least two, and in some cases three, successive crops a year. This is higher than the national average range of 1.30 to 1.59 harvests per year (Hagen 1980; Panth and Gautam 1990). Nutrient depletion and increased soil acidification are some of the possible harmful consequences of this increased cropping intensity (Tamang 1992). This intensification of cropping patterns has led to a higher need for inorganic fertilisers to sustain the soil fertility on these intensively used fields (Wymann 1991).

Table 10. Returns to Labour and Labour Requirements of All Crops

<table>
<thead>
<tr>
<th>Crop</th>
<th>Gross Margin/Labour (Rs.)</th>
<th>Labour/Ropani (Rs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize</td>
<td>56.97</td>
<td>9.53</td>
</tr>
<tr>
<td>Rice</td>
<td>51.54</td>
<td>14.91</td>
</tr>
<tr>
<td>Potato</td>
<td>-14.23</td>
<td>12.98</td>
</tr>
<tr>
<td>Tomato</td>
<td>154.74</td>
<td>23.56</td>
</tr>
</tbody>
</table>

Source: Household surveys.

Farmers in the study areas have increasingly been relying on inorganic fertilisers to maintain their yields. Application rates are higher than those recommended by government farm stations. Households are trying to stabilise production by substituting inorganic fertiliser for biological diversity and organic materials such as compost. This may not be sustainable as several households interviewed claim that yields recently have actually been

\(^5\)Cropping intensity is defined as the number of harvests per year from the same field.
declining. Experiments carried out at research stations around Nepal have also reached this conclusion (Riley 1991). In addition, the soil to which inorganic fertiliser has been applied becomes dry and difficult to plough; more time is needed to break up clods and work with the soil, thus increasing labour requirements. Other disadvantages of inorganic fertilisers include increased soil acidification, reduced moisture retention of the soil, and perhaps most importantly, the productivity of the soil is reduced as inorganic fertilisers absorb the organic material from the soil and make it available to the plant in a short time (Tamang 1992; Wymann 1991).

The increase in fertiliser prices may facilitate a reduction in the use of these inorganic fertilisers, which may be beneficial to the soil productivity in the long term. In the short term, however, high prices are causing distressing problems for many households. Half the households that grew potatoes lost money on this crop; the losses range from Rs. 136 to almost Rs. 4,000 per ropani. Needless to say, these losses are having an impact on potato-growing households. One third of the households reported that they are planning to either reduce the amount of land allocated to the potato crop, or they simply will not plant another potato crop at all. Farmers complained that potatoes need relatively too much expensive inorganic fertiliser to be profitable. Farmers also commented on the relatively high water requirements of the potato crop compared to other crops such as tomato and maize.60

These developments are recent; the subsidy removal and lack of Complex occurred within the year prior to the surveys (1992-1993). Thus, farmers had planted their potato crop expecting to earn a profit, as they have for the last few years. Prior to these changes, farmers reported an average gross margin of about Rs. 1,240 per ropani. The impact of

60It is reported that subsequent to this study, farmers in the watershed continue to grow potatoes despite losses. This may be explained by a number of factors; the relatively low average losses; half the surveyed households did earn a profit from their potato crop; only one third of the farmers in the sample planned to reduce land allocations to potato crops, while the majority planned to continue cultivating this crop; finally, households may feel that the losses are only temporary.
these changes is obviously significant. The negative gross margin is evidence that the first major vegetable cash crop in the study area, potato, is no longer a profitable crop because of increased inorganic fertiliser prices, decreased yields due to the unavailability of the proper fertiliser (Complex), and decreased soil fertility. Conversely, tomatoes are by far the most profitable crop of all the four crops under examination. The returns to land and labour from the tomato crop far exceed the returns of either maize or rice.

6.3 Returns of Growers and Non-Growers

Those households that grow a vegetable cash crop on average have higher returns than non-growers to both land and labour for the main comparable crop, maize (see Table 11). It may be that the more efficient farmers decided to grow vegetable cash crops. These households may also have better access to yield improving technologies such as inputs and technical information. It is worthwhile to note that vegetable cash crops producers achieve higher returns to land and labour from the main staple crop, maize, than do other farmers, despite the greater inputs devoted to the vegetable cash crops.

Table 11. Grower and Non-Grower Returns to Land and Labour for Maize

<table>
<thead>
<tr>
<th></th>
<th>Gross Margin/Ropani (Rs.)</th>
<th>Gross Margin/Labour (Rs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash Crop Adopters</td>
<td>384.92</td>
<td>69.08</td>
</tr>
<tr>
<td>Non-Adopters</td>
<td>312.39</td>
<td>41.02</td>
</tr>
</tbody>
</table>

Source: Household surveys.

6.4 Comparative Uncertainty and Risks

Inseparable from the assessment of profitability of vegetable cash crops versus traditional staple crops is their comparative risk. Uncertainty regarding the vegetable cash crops’ input and output price fluctuations are a concern for these farmers. The risks of allocating household resources, such as labour, fertilisers, and compost from uncertain, but traditional crops such as maize and rice to uncertain and unfamiliar vegetable cash crops, can be an important obstacle for some households. Risk is usually thought of as
price variability over time for a particular household, but data limitations prevent an analysis of this type of risk. Although long-term longitudinal study would be required to properly address this issue of risk, a limited assessment can be made of the risks associated with these crops.

Two methods are used to evaluate the degree of risk associated with each crop. The first indication of the risk of vegetable cash crops versus traditional staple crops is given by a comparison of the variation of their respective gross margins (Rs.) and yields (kg) per ropani. The sample variance of the gross margins and yields of all crops are reported in Table 12. The results are somewhat mixed. The gross margin variance of tomato is the lowest of all the crops, while the potato variance is the highest. It is clear that the gross margins of tomatoes tend to be less variable across the sample than those of the staple crops, though potato is the highest. Variability in production is greatest for maize, the main staple food crop, and lowest for rice, the second most important food crop. Yields for the vegetable cash crops are clearly lower across the sample than maize.

Table 12. Gross Margin and Yield Variances of All Crops

<table>
<thead>
<tr>
<th>Crop Name</th>
<th>Gross Margin Variance</th>
<th>Yield Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize</td>
<td>306,221.71</td>
<td>2,132,301.93</td>
</tr>
<tr>
<td>Rice</td>
<td>1,713,180.18</td>
<td>12,731.71</td>
</tr>
<tr>
<td>Potato</td>
<td>3,950,267.26</td>
<td>95,362.53</td>
</tr>
<tr>
<td>Tomato</td>
<td>242,247.26</td>
<td>82,302.92</td>
</tr>
</tbody>
</table>

Source: Household surveys.

Assessing potential losses is the second method used to make between-crop risk comparisons. The level of potential losses as a proportion of the land, or asset, base is also important for determining household risk. Given the relatively high input costs for some cash crops (see Table 9)\(^6\), the potential for loss from crop failure, output-price

\(^6\)The material input cost for potato is the highest of all the crops, though tomato is the second lowest. The material input cost for maize is higher than for tomato.
depression, or input-price increases, may constitute a much higher probability of substantial income loss. This is illustrated by the relative losses from the crops under study.

In order to evaluate this aspect of risk, the frequencies and levels of losses from staple crops and vegetable cash crops are ascertained. In this assessment, losses are represented by negative gross margins; that is, net returns to land and labour are negative since variable costs exceed the gross value of the output, or production. A combination of factors may lead to this outcome; examples are unfavourable input-output ratios, high input prices, low farmgate prices, low yields, or all of these. Both rice and tomato proved to be profitable for every household that grew these two crops; in other words, rice and tomato gross margins were positive for all households.

Only the relative losses from potato and maize can be used to evaluate the potential losses as a proportion of the land base. As previously mentioned, the losses from potato range from a low of Rs. 136 to almost Rs. 4,000 per ropani. The comparable figures for maize are Rs. 109 to Rs. 467. In 14 per cent of the sample fields, gross returns of maize do not cover the variable costs; whereas, in 50 per cent of the fields, gross returns of potato do not cover these costs.

This comparison of the uncertainty and risks of vegetable cash crops and traditional staple crops has revealed some interesting results. Within the limits of the survey data and the method used, vegetable cash crops do not appear to necessarily be less risky than the staple crops. Rather, it appears from the sample that within the new environment of higher input prices, unavailability of fertilisers, and lower yields, price uncertainty is more of an issue with potatoes than with staple crops. The gross margin variance of potato is the highest of all the crops under study. Also, the potential losses from potato are higher than that of maize. Variability in production, however, is greatest

As in the case for potatoes.
for maize. The variability in vegetable cash crop yields is lower across the sample compared to that of maize. Tomatoes appear to be the least risky crop under study. Its gross margin variance is the lowest of all the crops, and on average, since tomatoes are the most profitable of all the crops, both in terms of land and labour, the potential losses from this crop is a rather mute point. It would appear that low-input vegetable cash crops are less risky than traditional staple crops.

6.5 Vegetable Cash Crop Expansion

The evaluation above reveals mixed results in terms of returns to factors of production. Tomatoes yield higher returns per unit of land and labour than do staple crops. Potatoes, on the other hand, had negative returns. Despite the potentially high returns, vegetable cash crop growers still plant just over one-third (34 per cent) of their land with the main staple crop, maize. This is substantially less than non-vegetable cash crop growers, who devote about 78 per cent of their land area to maize. Yet, one-third is still a significant proportion. In fact, of all the households that are growing a vegetable cash crop, only 17 per cent reported that they plan to expand their vegetable cash crop area.

No obvious technical reason exists as to why households do not further expand their vegetable cash crop area. Expansion of vegetable cash crops does not necessarily have to be at the expense of staple crops such as rice or maize. Due to the prevailing climatic conditions, crops can be grown all year round, provided water is available. Thus, vegetable cash crops can be grown during the off-season of the staple crops.

Many households that produce rice grow it twice a year; in the spring and during the monsoons, without a fallow period between these two plantings (see Figure 18). Not only do these successive rice plantings deplete the same nutrients from the soil, but they require substantial amounts of water. As a consequence of this practice, these households have reported a decline in their rice yields.
In addition to the decrease in yields, another problem is created as a result of planting spring rice. Farm households with land in the upper part of the valley use the water from the river to irrigate their spring rice crop. This severely reduces the river flow as it continues downstream. This reduction in flow adversely affects households with land situated downstream since they must contend with an extremely limited water supply to meet their own needs. Their only option is to plant drought-resistant crops that have low net returns (Kennedy and Adhikari 1989).

Considering the importance of water to households in the watershed (see logit model results), these households could reduce both their water consumption and water requirements by planting a vegetable cash crop in the spring instead of rice. They can still grow a rice crop during the monsoon season. Planting a vegetable cash crop with relatively low inorganic fertiliser and low water requirements, such as tomato, could well increase the overall net returns of these households, and may improve the yields of other crops, such as monsoon rice, by increasing the diversity of the crops that are planted. In a similar manner, households that grow maize as their staple crop can continue to grow it during the monsoons, and they can also produce a low-input vegetable cash crop at another time during the production year.

Labour is not a serious constraint since hired labour is available in the regions under examination to meet increased labour demands. For those households with limited financial resources, under-employed family labour or family labour seeking off-farm employment can be drawn into the vegetable cash crop. After all, average returns from tomatoes is higher than the prevailing market wage rate (see Table 9). This may have positive effects for labour in the area in general.

The reluctance to expand vegetable cash crop production can be hypothesised to be motivated by the concern of households regarding the risk involved with the vegetable cash crop, and the households desire for food security. The risks are potentially high
absolute losses per ropani. Losses with respect to vegetable cash crops have already been discussed. The issue of food security is a rather complicated matter.

6.6 Food Security

A household is capable of ensuring food security through a number of mechanisms. The three main alternatives available to a household are: 1) own food production and related stockholding; 2) open-market trading of food and non-food production to generate income; and 3) secure off-farm employment. The combination of these alternatives depends upon a household’s resource endowments, mainly human capital, integration of food and labour markets, and public institutions or community-level institutions, such as the village or the extended family.

These resource endowments play an important role in providing food security during unforeseen circumstances. Public institutions are limited in their ability to ensure an effective response to local situations. The food and agricultural markets are still in the developmental stages, hence they are not entirely reliable. Though casual agricultural work is available, formal employment opportunities with relatively high, steady wages are rare. Due to the instabilities of these markets, especially the food and agricultural markets, the food security burden shifts towards own production and stockholding. According to the households interviewed, these forces are the main causes for the relatively high levels of staple food production. This food production is primarily used to meet household consumption needs. If households are reluctant to expand their vegetable cash crop production because they believe that this may adversely affect their staple food production, thereby reducing their secure food position, the effects of vegetable cash crop production on staple food production must be examined.

In order to determine the effect of vegetable cash crop production on staple food production, household responses to pertinent questions, yield and production data are assessed. All households grew at least one staple crop, rice or maize. Those households
with access to irrigation generally grow both these crops. Nevertheless, maize has been identified by the households interviewed as the most important staple crop in the study area.

Although most farmers would not completely replace their maize crop with a vegetable cash crop, the attitude of vegetable growers towards maize and its importance in the production cycle is different from that of non-growers. The introduction of the vegetable cash crops plays a role in this context, and at the same time, the adoption of new crops is affected by these attitudes. Farm households were asked what the three most important reasons are for them to grow maize. The responses are quantified in Table 13.

Table 13. Farmers’ Reasons for Growing Maize

<table>
<thead>
<tr>
<th>Stated Reason</th>
<th>Vegetable Growers</th>
<th>Non-Growers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ranking of Reasons</td>
<td>Ranking of Reasons</td>
</tr>
<tr>
<td></td>
<td>First</td>
<td>Second</td>
</tr>
<tr>
<td>(per cent of responses)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Most productive crop on bari land</td>
<td>57%</td>
<td>29%</td>
</tr>
<tr>
<td>To always have food</td>
<td>39%</td>
<td>71%</td>
</tr>
<tr>
<td>Can be sold easily</td>
<td>4%</td>
<td>-</td>
</tr>
<tr>
<td>Other crops are risky</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Source: Household surveys.
Note: ‘-’ denotes zero responses.

The difference in attitudes between growers and non-growers is revealed by examining the reasons stated for growing maize. The most important reason reported by households that grow a vegetable cash crop is “maize is the most productive crop on bari land”; the second most important “to always have food” is followed by “maize is profitable”. The ordering for non-growers is different. For those households that have chosen not to adopt a vegetable cash crop, the most important reason to grow maize is ensuring food security (“to always have food”). Their second concern is the productivity of maize on bari land; and the third reason stated is that “other crops are risky”. Non-growers are more concerned about a stable supply of own-produced maize than vegetable
cash crop growers. Also, non-growers view other crops as being more risky than do vegetable growers.

These attitudes are linked to the households' ability to be self-sufficient in maize. A significant proportion of the surveyed households are not self-sufficient in maize. About one-third (34 per cent) of the households surveyed that grow maize must buy additional maize to meet their annual consumption needs. If this figure is disaggregated by vegetable cash crop growers and non-growers, the above attitudes are understandable. About 76 per cent of vegetable cash crop growers are self-sufficient in maize; the comparable figure for non-growers is 45 per cent. It is clear, then, why non-growers are more concerned with food security than vegetable cash crop growers. The former group are more concerned with food security because they are less secure in their maize supply than are vegetable cash crop growers. Since the majority of growers are self-sufficient in maize, it is understandable that crop efficiency is their primary concern, not food security.

It is clear that this change in attitude does not lead to a reduction in the availability of maize. As further evidence, consider Table 14. When corrected for land size, the majority of vegetable growers tend to have higher amounts of maize available for consumption from own-production compared to non-growers. Table 14 disaggregates maize land, labour, and yields by growers and non-growers. Despite reductions in labour inputs to maize, household-level production is maintained by higher maize yields and greater land allocations to maize. Growers average 201 kg of maize on a per ropani basis, compared to 158 kg for non-growers. On average, households that have adopted a vegetable cash crop are able to, and do, allocate a slightly larger area to maize than do households that do not grow a vegetable cash crop (about 10 ropani vs. 9.71 ropani).
Table 14. Average Resource Allocations to Maize and Maize Yields

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Vegetable Growers</th>
<th>Non-Growers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land allocated to maize (ropani)</td>
<td>10.02</td>
<td>9.71</td>
</tr>
<tr>
<td>Labour allocated to maize</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adult labour (days)</td>
<td>64.29</td>
<td>90.84</td>
</tr>
<tr>
<td>Child labour (days)</td>
<td>2.15</td>
<td>5.18</td>
</tr>
<tr>
<td>Total labour (days)</td>
<td>65.37</td>
<td>93.43</td>
</tr>
<tr>
<td>Yields (kg/ropani)</td>
<td>201.00</td>
<td>158.00</td>
</tr>
</tbody>
</table>

Source: Household surveys.

It appears that households that choose to include a vegetable cash crop in their production cycle are in a more secure position with respect to their staple food crop, maize, than are non-adopters. The attitude of farmers towards maize and other crop production reflects this difference in food security. Households that do not grow a vegetable cash crop are concerned with food security issues and view other crops as risky. Households that have adopted a vegetable cash crop, on the other hand, grow maize primarily because they believe that it is the most productive food crop that can be grown on bari land. Although they are also concerned with food availability, it is not as important as efficiency. It is understandable why non-growers view food security as being their main concern, since more than half of these households (55 per cent) are unable to meet their own household maize consumption needs from their own production. Conversely, more than three-quarters (76 per cent) of adopters are self-sufficient in maize. Finally, despite lower labour inputs to maize and growing vegetable cash crop(s), growers have higher yields and allocate more land to maize than do non-growers. It can be concluded from this analysis, that vegetable cash crop production does not adversely affect staple food production.

In this chapter, the implications of cash crop adoption were reviewed. The effects of adoption were assessed by comparing the vegetable cash crops with the staple food crops. In terms of profitability, although tomatoes are the most profitable crop of the four,
it is not true that these cash crops are definitely more profitable than the staple food crops. Due to changes in the operational environment, many farmers lost money from their potato crop. In terms of costs, the cash crops do have the highest chemical input costs. Nevertheless, when other material inputs, namely compost, are accounted for, maize has significant input costs as well. Although rice has the relatively lowest material input costs, it does have the highest labour costs of all the crops under consideration. In terms of returns from maize, households that adopt cash crops have higher returns than households that choose not to adopt cash crops. Uncertainty and risk are associated with all crops, but from the limited analysis undertaken in this study, it would appear that cash crops are not necessarily more uncertain a proposition than staple crops. Finally, in terms of food security, cash crops do not appear to adversely affect a household's staple food production.
CHAPTER SEVEN

SUMMARY AND CONCLUSION

7.1 Summary

Peasant households in the Middle Mountains of Nepal are faced with a myriad of problems and challenges as they attempt to improve their living conditions. Vegetable cash crop production is regarded as a possible solution to alleviating rural poverty by many households and policymakers. This study deals with the case of vegetable cash crop adoption by peasant households in a peri-urban area near Kathmandu. There were two objectives of this study, the first was to identify the determinants of vegetable cash crop adoption by Nepali peasants, and the second was to examine the implications of this adoption.

This research was based on a detailed household-level survey of peasants in the Jhikhu Khola Watershed that was undertaken in early 1993. The watershed is located about 40 km east of Kathmandu. The sample is divided into two groups of households, those that produce vegetable cash crops and those that do not. Peasant households, 64 in total, from three different VDCs in the watershed were included in the sample. Semi-structured interviews with both open-ended and close-ended questions were successfully employed in gathering the household-level data. Both the male and female household heads were interviewed as they made the decisions for the household. Separate, but simultaneous interviews were undertaken of both men and women household heads.

In order to meet the first objective, a dichotomous logistic model was used to determine the significant factors for the adoption of vegetable cash crops. The choice made by households to produce a vegetable cash crop is related to characteristics of the household. For the second objective, the survey data was analysed to understand the implications of vegetable cash crop adoption. The effects of adoption were assessed by comparing two vegetable cash crops, potato and tomato, with two staple food crops,
maize and rice. The evaluation of the effects, both positive and negative, consisted of an assessment in the following five areas: a) the profitability and costs of both cash and staple crops; b) the returns of those households that do, and those that do not, adopt a vegetable cash crop; c) the risks and uncertainties involved in the production of these four crops; d) the perceived constraints to cash crop expansion; e) and finally, the effect of vegetable cash crop adoption on food security.

7.2 Conclusions

The commercialisation of agricultural production can contribute to economic development in Nepal. This success depends upon the prevailing economic and social conditions. Peasant households adapt differently to the process of cash crop adoption, depending upon the resources available to them, economic and social conditions, and government policies; while some households may benefit, others may not. The case of vegetable cash crop production in the Jhikhu Khola Watershed is an illustrative example, where peasant households have begun to produce vegetable cash crops for nearby towns and Kathmandu.

In order to identify the determinants of adoption, a logistic regression was used. The results of the adoption/non-adoption model indicate that access to irrigation water has the greatest impact on growing vegetable cash crops. The probability that a household will choose to adopt a vegetable cash crop is 90 per cent, if it has water for irrigation purposes. There is a positive relationship between access to irrigation water and adoption of vegetable cash crops by the surveyed households. The level of formal education attained by the male household head also increases adoption rates. Difficulty with inorganic commercial fertilisers and predominantly red soils both have an negative impact on the choice to produce vegetable cash crops. In summary, it may be concluded from these results that adoption rates are highest for households in the watershed that have access to irrigation water, that do not encounter extensive problems using inorganic...
commercial fertiliser, that have an educated male household head and relatively good quality soils.

A review of the implications of cash crop adoption reveals some interesting results; the experience has been mixed. The effects of adoption were assessed by comparing the vegetable cash crops with the staple food crops. Tomatoes have been a very successful cash crop. In terms of labour requirements, tomatoes are the most labour-intensive of all the crops under investigation; they require about 24 adult-days of labour per ropani. Potatoes require about 13 days. Labour requirements for rice average about 15 days, slightly more than potatoes, while maize requires only about 9.5 days of adult-days of labour per ropani.

Tomatoes are by far the most profitable crops; net returns (gross margins) per ropani show that tomatoes are on average about 12 times higher than maize, the principal staple food crop, and about 5 times higher than rice, the second most important staple crop. Returns of tomatoes per unit of labour are almost three times that of both maize and rice.

The input costs per ropani for vegetable cash crops, however, are much higher than for the staple crops, thus the potential loss relative to household income is higher than for traditional staple crops. This is the case for potato. Due to dramatic increases in the price of inorganic commercial fertilisers, the unavailability of the right type of fertiliser at the right time, and declining soil productivity, potatoes have become unprofitable for the first time. Farmers who grew potatoes lost about Rs. 139 per ropani; they lost about Rs. 14 per day of labour. The losses suffered by peasant households that produced potatoes ranged from Rs. 136 to Rs. 4,000 per ropani, whereas previously profits averaged about Rs. 1,240 per ropani. These losses have been quite serious for some households.

In terms of returns from maize, households that adopt cash crops have higher returns than households that choose not to adopt cash crops. A limited comparison of the
uncertainty and risks of vegetable cash crops and traditional staple crops does not clearly reveal that staple crops are less risky than vegetable crops. Within the new environment of higher input prices, unavailability of fertilisers, and lower yields, price uncertainty is more of an issue with potatoes than with staple crops. Variability in production, however, is greatest for maize. It would appear that low-input vegetable cash crops are less risky than traditional staple crops.

Peasant households that cultivate vegetable cash crops have higher amounts of maize available for consumption from own production than do households that choose not to grow a vegetable cash crop. Despite lower labour-inputs to maize, household-level production is maintained by higher maize yields and greater land allocations to maize. Growers average about 201 kg per ropani compared to 158 kg for non-growers.

It appears that households that choose to grow a vegetable cash crop are in a more secure food position with respect to the main staple food crop, maize, than non-growers. Vegetable cash crop adoption does not appear to adversely affect food production.

7.3 Recommendations and Future Research

This study has examined the determinants of adoption of vegetable cash crops to understand the decision-making process of peasant households. A number of recommendations can be made based upon the results and conclusions of this study. In order to facilitate the production of vegetable cash crops, irrigation water must be made available to households in the watershed. Water availability is declining due to the divergence of water to the Kathmandu Valley, increased cropping intensity, and populations pressures. Despite these trends, more water can still be made available by encouraging such agricultural practices as the production of crops with low water requirements and improved water management methods.

These agricultural practices can be made known through extension services. Extension services must be made available that is both meaningful and useful. With the
closure of the Panchkhal Horticulture Farm, little or no services are available in the watershed. Farmers need and want to know more about such production issues as pesticide management, fertiliser use, frost recovery, improved seeds, planting and cultivation practices. This will build upon the positive education findings of the adoption model, and help to minimise some of the uncertainty surrounding the production of vegetable cash crops. Through extension services, households can be shown the benefits of and encouraged to grow vegetable cash crops that have low water and inorganic commercial fertiliser requirements. This will also help minimise the risk of potential losses and limit the use of scarce household resources.

The results of the adoption model reveal that the probability that a household with good quality soils will choose to adopt a vegetable cash crop is 93 per cent. Farmers must be provided with information on how to increase the productivity of their soils, and to increase the use of compost where possible. Appropriate use of inorganic commercial fertilisers must be demonstrated as well. This will both improve the productivity of the soil and decrease a household’s input costs. Peasant households that earn a good return on the labour and land investment will be encouraged to manage their soils and to maintain the soil’s productivity. A number of farmers commented on this issue, but were unsure how to improve the soil’s productivity. Peasant households have a clear motivation for sustaining their yields and enhancing the fertility of their soils, but need information on how to do so. Appropriate extension services can provide farmers with this much needed information.

Markets, especially input markets, must be better integrated to facilitate the production of vegetable cash crops. For example, the logit model showed that households that experienced extensive problems with inorganic commercial fertilisers were less likely to cultivate cash crops. On the other hand, the probability of adoption by a household that did not have such problems is 85 per cent.

This study did not cover the impact of vegetable cash crop production on nutrition and employment. The nutritional benefits, if any, economic growth, food expenditures,
and detailed consumption patterns are not known. Future research efforts should investigate the effects of vegetable cash crop adoption on the nutrition and food consumption level of household members, especially the effects on pre-school children in the watershed.

Although the production of vegetable cash crops is labour-intensive, the direct and indirect employment benefits were not measured. The labour market should be analysed to determine if the effects are positive; that is, have wages actually increased and is more work available for such people as landless labourers.

This research does show, however, that with appropriate access to resources, peasant households in the Middle Mountains of Nepal can improve their well-being through the cultivation of vegetable cash crops.
NOMENCLATURE

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bari</td>
<td>Non-irrigated land on which irrigated rice can not be grown.</td>
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<tr>
<td>Cash Crop</td>
<td>A crop grown specifically for the market.</td>
</tr>
<tr>
<td>Cropping Intensity</td>
<td>The number of harvests per year from the same field.</td>
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<tr>
<td>Gross Margin</td>
<td>The value of the output minus the direct, or variable, costs</td>
</tr>
<tr>
<td>Khet</td>
<td>Irrigated land on which rice can be grown.</td>
</tr>
<tr>
<td>Land Holding</td>
<td>Land from which the household receives some return, either through ownership or cultivation of the land.</td>
</tr>
<tr>
<td>Literacy Rate</td>
<td>The percentage of persons aged 15 and over who can, with understanding, both read and write a short simple statement on their everyday life.</td>
</tr>
<tr>
<td>Material Inputs</td>
<td>Factor inputs that include seed, inorganic fertiliser, pesticides, and compost.</td>
</tr>
<tr>
<td>Newar</td>
<td>A Nepali ethnic group of who are considered to be the original inhabitants of the Kathmandu Valley.</td>
</tr>
<tr>
<td>Peasant</td>
<td>Farm households, with access to their means of livelihood in land, utilising mainly family labour in farm production, always located in a larger economic system, but fundamentally characterised by partial engagement in markets which tend to function with imperfection.</td>
</tr>
<tr>
<td>Peasant Production</td>
<td>A type of agricultural production where the peasant farm household is neither fully integrated into the wider economy, nor is it wholly insulated from the pressures of that wider economy.</td>
</tr>
<tr>
<td>Risk</td>
<td>The subjective probabilities attached by household decision-makers to the likelihood of the occurrence of different events.</td>
</tr>
<tr>
<td>Ropani</td>
<td>Nepali land unit of measurement. One ropani is approximately 500m².</td>
</tr>
<tr>
<td>Uncertainty</td>
<td>The character of the economic environment confronting peasant farm households.</td>
</tr>
</tbody>
</table>
WORKS CITED


APPENDIX 1

VILLAGES INCLUDED IN THE SAMPLE
Villages in Rabi-Opi:

1. Sarkigaun
2. Banepa-Opi
3. Chapleti
4. Rabi
5. Chapatol
6. Karkipati
7. Makai Sahukopati

Villages in Panckhal:

1. Bhamarkot
2. Keraghari
3. Sallenigairo
4. Rampur
5. Thumka
6. Aadhabato Thumka
7. Tallo Thumka
8. Baniyadihi
9. Tamaghat
10. Kamidanda
11. Jagatapati, Bhamarkot
12. Pandelthok, Tinpiple
13. Jhinganpur
14. Kafledihi
15. Panchkhal
Villages in Baluwa:

1. Ojetar
2. Sera
3. Jaretar
4. Tallo Thumka
5. Thakurigaun
6. Bakultar (or Tallo Bakultar)
7. Khampur
8. Ranipani
9. Neupanegaun (or Neupanetol)
10. Luitelgaun
11. Baluwa
12. Ampghari
13. Bhainselitol
14. Ramche (or Ramche Palanchowk)
15. Bhimsenthan Thulagaun
16. Tinghare
17. Bhotetar
18. Devabhumi
19. Sathighar
20. Bikramtar
21. Srirampati

Total villages: 43
MRM: VEGETABLE PRODUCTION QUESTIONNAIRE
MEN FARMERS

Date __________
Area ________________________ Village ________________________
Ward No. ____________ Household No. ____________
Farmer's Name ________________________ Yrs. Lived Here ____________
Age ____________ Caste/Ethnic Group ________________________
Position in Household ____________ Distance from fields to closest road ____________

A. PRODUCTION

1. Land holdings
   1a. How many ropani of khet land do you farm in total ______
   1b. How many ropani of bari land do you farm in total ______

2. Main staple crop
   Provide the following information for your main staple crop:
   Staple Crop Name ____________
   Why do you grow this staple crop? (at most 3 reasons-do not prompt)
   a) ________________________
   b) ________________________
   c) ________________________

2a. Production cycle:
   Note: use ranges for the following questions if they are unable to answer exact amounts.

   Month Planted: ________________________
   Month Harvested: ________________________
   Total Land Grown on (ropani): ________________________
   Type of Land Grown on (bari or Khet): ________________________
   Seed or Seedlings (quantity): ________________________
   Total production: ________________________
2b. Input Requirements:

<table>
<thead>
<tr>
<th>Fertiliser Type</th>
<th>Fertiliser Quantity</th>
<th>Pesticide Type</th>
<th>Pesticide Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

2c. Plot characteristics

Record the following information about the plots of land on which the main staple crop is grown:

<table>
<thead>
<tr>
<th>Plot No.</th>
<th>Land &amp; Soil Type</th>
<th>Slope</th>
<th>Aspect</th>
<th>Elevation (m)</th>
<th>No. of Ropani</th>
</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>

3. Most important vegetable crop

Provide the following information for your most important vegetable crop:

Most Important Vegetable Crop Name ________________

Why do you grow this vegetable crop? (at most 3 reasons-do not prompt)

a) ____________________________________________

b) ____________________________________________

c) ____________________________________________
3a. Production cycle:
Note: use ranges for the following questions if they are unable to answer exact amounts.

<table>
<thead>
<tr>
<th>Month Planted:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Month Harvested:</td>
<td></td>
</tr>
<tr>
<td>Total Land Grown on (ropani):</td>
<td></td>
</tr>
<tr>
<td>Type of Land Grown on (bari or Khet):</td>
<td></td>
</tr>
<tr>
<td>Seed or Seedlings (quantity):</td>
<td></td>
</tr>
<tr>
<td>Total production:</td>
<td></td>
</tr>
</tbody>
</table>

3b. Input Requirements:

<table>
<thead>
<tr>
<th>Fertiliser Type</th>
<th>Fertiliser Quantity</th>
<th>Pesticide Type</th>
<th>Pesticide Quantity</th>
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</thead>
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</tbody>
</table>

3c. Plot characteristics

Record the following information about the plots of land on which the most important vegetable crop is grown:

<table>
<thead>
<tr>
<th>Plot No.</th>
<th>Land &amp; Soil Type</th>
<th>Slope</th>
<th>Aspect</th>
<th>Elevation (m)</th>
<th>No. of Ropani</th>
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</tbody>
</table>
4. **Alternative vegetable crop (if applicable):**

Provide the following information for your alternative vegetable crop:

Alternative Vegetable Crop Name __________________

Why do you grow this vegetable crop? (at most 3 reasons-do not prompt)

a) ____________________________________________

b) ____________________________________________

c) ____________________________________________

4a. **Production cycle:**

*Note: use ranges for the following questions if they are unable to answer exact amounts.*

<table>
<thead>
<tr>
<th>Month Planted:</th>
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<tbody>
<tr>
<td>Month Harvested:</td>
<td></td>
</tr>
<tr>
<td>Total Land Grown on (ropani):</td>
<td></td>
</tr>
<tr>
<td>Type of Land Grown on (bari or Khet):</td>
<td></td>
</tr>
<tr>
<td>Seed or Seedlings (quantity):</td>
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<tr>
<td>Total production:</td>
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</tbody>
</table>

4b. **Input Requirements:**

<table>
<thead>
<tr>
<th>Fertiliser Type</th>
<th>Fertiliser Quantity</th>
<th>Pesticide Type</th>
<th>Pesticide Quantity</th>
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</table>

4c. **Plot characteristics**

Record the following information about the plots of land on which the alternative vegetable crop is grown:

<table>
<thead>
<tr>
<th>Plot No.</th>
<th>Land &amp; Soil Type</th>
<th>Slope</th>
<th>Aspect</th>
<th>Elevation (m)</th>
<th>No. of Ropani</th>
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</table>
5. Sharecropped land

Of the above plots, which are sharecropped? Indicate if sharecropped in or out, and the arrangements. Specify how much of the inputs the farmer buys, and the number of years sharecropped.

The information should be able to indicate the costs and returns to the farmer for the sharecropped land.

<table>
<thead>
<tr>
<th>Plot No.</th>
<th>In/Out</th>
<th>Output Farmer Keeps (%)</th>
<th>Inputs Farmer Buys</th>
<th>Associated Costs</th>
</tr>
</thead>
<tbody>
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</table>

Comments:

6. Alternative vegetables not grown

If do not grow alternative vegetables:

6a. Why not grown:

Why do you not grow these vegetables? (do not prompt - if he can not answer, note that down, and then prompt him with the following list)

- inadequate land
- inadequate fertiliser
- inadequate water
- inadequate pesticide
- inadequate credit
- inadequate seed
- inadequate knowledge
- other, explain:
6b. Tried before?
Have you tried to grow any of these vegetables before?

no ___ yes ___ --> When (no. of years ago)?

Which one(s) and what happened?

6c. Try again?
Would you try again? (Explain):

7. Input procurement
7a. Fertiliser
Where do you buy your fertiliser from, and at what price?

*Note: Fertiliser type includes organic fertiliser such as compost.*

<table>
<thead>
<tr>
<th>Fertiliser Type</th>
<th>Bought from</th>
<th>Price</th>
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<tbody>
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</tbody>
</table>

7b. Pesticide
Where do you buy your pesticide from, and at what price?

<table>
<thead>
<tr>
<th>Pesticide Type</th>
<th>Bought from</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>
7c. Seed/Seedling
How much seed/seedling of your own do you use, how much do you buy, where do you buy it from, and at what price?

<table>
<thead>
<tr>
<th>Crop</th>
<th>Own (%)</th>
<th>Buy (%)</th>
<th>Where</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
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</table>

8. Land use changes
The following question applies to all crops that are being recorded:
Do you plan to change the amount of land that you allocate to these crops in the future? Explain.

________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________

________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________

________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________

________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________

9. Production constraints
What are your 3 major constraints to production (for all crops):
Note: List most important constraint as a).
If the farmer can not supply 3 reasons, cross out the remaining letters(s).
a)________________________________________________________________________________________________________________________________________________________________________________________________________________________________________
b)_________________________________________________________________________________________________________________________________________________________________________________________________________________________________________
c)_________________________________________________________________________________________________________________________________________________________________________________________________________________________________________

10. Food consumption
How much of each crop do you consume, and why?

<table>
<thead>
<tr>
<th>Crop</th>
<th>Consume (%)</th>
<th>Why?</th>
</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>
11. Labour allocation to main staple crop

For your main staple crop, how much time do you spend on each activity, and how much time do children spend on their activities:

*Note: indicate children, women, and men as - Child: C, Women - W, Men - M
Indicate hired labour with *, perma labour with a 'P'.
If both men and women do an activity, are there more men or women?*

Wage and capital equipment rates:

<table>
<thead>
<tr>
<th>Item</th>
<th>Daily/hourly cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male wage rate (daily):</td>
<td></td>
</tr>
<tr>
<td>Female wage rate (daily):</td>
<td></td>
</tr>
<tr>
<td>Bullock rate (daily):</td>
<td></td>
</tr>
<tr>
<td>Tractor rate (hourly):</td>
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</tr>
<tr>
<td>Water pump rate (hourly):</td>
<td></td>
</tr>
</tbody>
</table>

Crop Name: ____________________
Time required to walk to the field(s) __________________

Nursery:

What month is the nursery made?
What month is it transplanted?
prepare land and sow seed
applying compost
applying commercial fertiliser
applying pesticide
frost protection
watering, weeding
nursery transplanting

Field Land Preparation:

first ploughing (bullock labour or hand)
second ploughing (bullock labour or hand)
first soil pulverising and levelling
second soil pulverising and levelling
seed sowing (if no nursery)
make raised beds

Irrigation:

canal repair and maintenance
irrigation

Fertilisation:
applying compost/organic fertiliser
applying commercial fertiliser

Cultural Operation:
first weeding and hoeing
second weeding and hoeing
spraying
pesticide application

Harvesting:
picking
cutting
threshing
sorting and grading

Storage:
storage of harvested crop
packing one doko/bag

12. Labour allocation to main vegetable crop
For your main vegetable crop, how much time do you spend on each activity, and how much time do children spend on their activities:

Note: indicate children, women, and men as - Child: C, Women - W, Men - M

Indicate hired labour with ‘*’, perma labour with a ‘P’.

If both men and women do an activity, are there more men or women?

Wage and capital equipment rates:

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<td>Water pump rate (hourly):</td>
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Crop Name: ___________________

Time required to walk to the field(s) ___________________

Nursery:
What month is the nursery made?
What month is it transplanted?
prepare land and sow seed
applying compost
applying commercial fertiliser
applying pesticide
frost protection
watering, weeding
nursery transplanting

Field Land Preparation:
first ploughing (bullock labour or hand)
second ploughing (bullock labour or hand)
first soil pulverising and levelling
second soil pulverising and levelling
seed sowing (if no nursery)
make raised beds

Irrigation:
canal repair and maintenance
irrigation

Fertilisation:
applying compost/organic fertiliser
applying commercial fertiliser

Cultural Operation:
first weeding and hoeing
second weeding and hoeing
spraying
pesticide application

Harvesting:
picking
cutting
threshing
sorting and grading

Storage:
storage of harvested crop
packing one doko/bag

13. Labour allocation to alternative vegetable crop
For your alternative vegetable crop, how much time do you spend on each activity, and how much time do children spend on their activities:

Note: indicate children, women, and men as - Child: C, Women - W, Men - M

Indicate hired labour with *; perma labour with a 'P'.

If both men and women do an activity, are there more men or women?

Wage and capital equipment rates:

<table>
<thead>
<tr>
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</tr>
<tr>
<td>Water pump rate (hourly):</td>
<td></td>
</tr>
</tbody>
</table>

Crop Name: ____________________________

Time required to walk to the field(s) ____________________________

Nursery:
- What month is the nursery made?
- What month is it transplanted?
- prepare land and sow seed
- applying compost
- applying commercial fertiliser
- applying pesticide
- frost protection
- watering, weeding
- nursery transplanting

Field Land Preparation:
- first ploughing (bullock labour or hand)
- second ploughing (bullock labour or hand)
- first soil pulverising and levelling
- second soil pulverising and levelling
- seed sowing (if no nursery)
- make raised beds

Irrigation:
- canal repair and maintenance
irrigation

Fertilisation:
- applying compost/organic fertiliser
- applying commercial fertiliser

Cultural Operation:
- first weeding and hoeing
- second weeding and hoeing
- spraying
- pesticide application

Harvesting:
- picking
- cutting
- threshing
- sorting and grading

Storage:
- storage of harvested crop
- packing one doko/bag

14. Land use changes for alternative vegetable crop

Are you growing more of your alternative vegetable than 5 years ago?

No --> why?

Yes --> are you growing more on newly purchased or leased land?

Yes --> what crop(s) are you growing less of?
B. MARKETING

15. Marketing costs

The following instructions apply to all crops being recorded:

If the farmer sells the commodity at more than one market, determine costs for the one at which he sells most of his production. Example: if he sells at Banepa and Kathmandu, but he sells most of this crop at Banepa, determine costs at Banepa. If he sells about the same amount at both markets, select the one at which he prefers to sell.

15a. Main staple crop

Main Staple Crop Name ________________________________

a. how much does one bag or doko cost if you were to buy one in the market?
b. do you take the crop by your own labour to the market, or use a bus/minivan?
c. if he uses own labour:
   how long does it take to go to the market?
   how many people (specify no. of adults and children): 
   do you hire porters? If so, what is the cost?
d. if he uses bus or minivan:
   does the minivan come to the field?
   how do you take your dokos/bags to the bus stop or minivan pick-up point?
   porter - cost per doko/bag: Rs.
   own labour: how many people (specify number of adults and children):
   how long does it take? (hours or minutes)
e. how much does it cost to load one doko/bag onto the vehicle (if applicable): Rs.
f. how long does it take to reach the market (ie. how long is the bus ride)?:
g. what is the charge for each doko/bag on the bus or minivan? Rs.
h. what is your bus fare or minivan fare? Rs.
i. how much do you pay porter(s) at the market to unload each doko/bag?: Rs.
j. how much do you spend on food at the market?: Rs.
k. how much do you spend on lodging at the market?: Rs.
l. tax:
m. other charges (specify):
15b. Main vegetable crop

Main Vegetable Crop Name

a. how much does one bag or doko cost if you were to buy one in the market?
b. do you take the crop by your own labour to the market, or use a bus/minivan?
c. if he uses own labour:
   how long does it take to go to the market?
   how many people (specify no. of adults and children):
   do you hire porters? If so, what is the cost?
d. if he uses bus or minivan:
   does the minivan come to the field?
   how do you take your dokos/bags to the bus stop or minivan pick-up point?
   porter - cost per doko/bag: Rs.
   own labour: how many people (specify number of adults and children):
   how long does it take? (hours or minutes)
e. how much does it cost to load one doko/bag onto the vehicle (if applicable): Rs.
f. how long does it take to reach the market (ie. how long is the bus ride)?:
g. what is the charge for each doko/bag on the bus or minivan? Rs.
h. what is your bus fare or minivan fare? Rs.
i. how much do you pay porter(s) at the market to unload each doko/bag?: Rs.
j. how much do you spend on food at the market?: Rs.
k. how much do you spend on lodging at the market?: Rs.
l. tax:
m. other charges (specify):
15c. Alternative vegetable crop

Alternative Vegetable Crop Name

a. how much does one bag or doko cost if you were to buy one in the market?
b. do you take the crop by your own labour to the market, or use a bus/minivan?
c. if he uses own labour:
   how long does it take to go to the market?
   how many people (specify no. of adults and children):
   do you hire porters? If so, what is the cost?
d. if he uses bus or minivan:
   does the minivan come to the field?
   how do you take your dokos/bags to the bus stop or minivan pick-up point?
      porter - cost per doko/bag: Rs.
      own labour: how many people (specify number of adults and children):
         how long does it take? (hours or minutes)
e. how much does it cost to load one doko/bag onto the vehicle (if applicable): Rs.
f. how long does it take to reach the market (ie. how long is the bus ride)?
g. what is the charge for each doko/bag on the bus or minivan? Rs.
h. what is your bus fare or minivan fare? Rs.
i. how much do you pay porter(s) at the market to unload each doko/bag?: Rs.
j. how much do you spend on food at the market?: Rs.
k. how much do you spend on lodging at the market?: Rs.
l. tax:
m. other charges (specify):
16. Selling vegetables

16a. Reasons for selling
When and why did you start to sell these vegetables (his most important and the alternative vegetable)?
  
  most important vegetable -
  alternative vegetable -

16b. Interest in others
Are there other vegetables which you would like to sell?
  no ____ yes ____ --> which ones?

17. Farmgate Price

17a. Price
What price do you receive for each crop, regardless of whether you sell it or not, and which market is this price from?

*Note: the prices of all crops, regardless of whether they are actually sold or not.*

*For each crop, indicate price and the applicable quantity. Example: if he sells tomatoes for Rs. 15 per dharni, record it as Rs. 15/dharni.*

<table>
<thead>
<tr>
<th>Crop</th>
<th>Farmgate Price</th>
<th>Where Sell</th>
<th>Month Sold</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

17b. Market information
How do you find out the farmgate price for these crops?

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

18. Do not participate in output market
*Note: as these questions only if he grows the alternative vegetable crop, but does not sell it.*

18a. Reason does not sell
Why do you not sell these vegetables? (do not prompt - if he cannot answer, then record that fact, and then prompt him with the following list)
too difficult to get to a market (circle): slope too steep or elevation too high or both
poor road
too far from a market
don't know how to sell, to whom
lack of adequate credit
sharecropping arrangement (do not have enough produce left to sell)
do not produce enough to sell
transportation too expensive (specify transportation facilities)
other (explain)

18b. Interest in selling
Would you like to sell any of these alternative vegetables?
   no ___ yes ___ -> Which ones and why?

C. GENERAL
19. Training
Do you or anyone in your family need any agricultural training?
   no ___ yes ___ -> what type?

20. Tax
How much land tax do you pay annually?
21. Farm equipment
What farm implements do you own (Example: sprayer), and how much do you spend annually on maintenance?

<table>
<thead>
<tr>
<th>Implement</th>
<th>Maintenance Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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</tbody>
</table>

22. Household loans
Does anyone in your household have any loans?
no _____ yes _____ --> Who (M or F)?
Amount of loan?
Interest rate? per month _____ % per year _____ %
Source of loan?
Use of loan?

23. Non-farm income
Do any members of your family work for wages or outside income?

Note: This includes the household head and any members of the family who send some or all of their wages to this household. If the farmer sells dairy products or animals for regular income, record this as well.

<table>
<thead>
<tr>
<th>Gender</th>
<th>Age</th>
<th>Hrs/day</th>
<th>Where</th>
<th>Work Type</th>
<th>Wage</th>
<th>Since</th>
<th>Remittance</th>
</tr>
</thead>
<tbody>
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</table>

Farmer quotes and remarks:
APPENDIX 3

FEMALE QUESTIONNAIRE
MRM: VEGETABLE PRODUCTION QUESTIONNAIRE  
WOMEN FARMERS

Date __________
Area ____________________________ Village ____________________________
Ward No. ____________ Household No. ____________
Farmer's Name ____________________________ Yrs. Lived Here ____________
Age ____________ Caste/Ethnic Group ____________________________
Position in Household ____________ Distance from fields to closest road ____________
Type of roof ____________

A. FAMILY PROFILE

1. Describe your family: the number of people, their age, if they go to school etc. Start with the household head:

   NOTE: the household head makes the major decisions such as what to plant, and his spouse is the female household head. This does not necessarily mean the oldest member in the household.

<table>
<thead>
<tr>
<th>Member</th>
<th>Married?</th>
<th>Gender</th>
<th>Age</th>
<th>In School?</th>
<th>Lives in HH?</th>
<th>Educ. Level</th>
</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>
B. PRODUCTION

2. Cropping patterns
2a. What is your cropping pattern?
Khet Land:
1 2 3 4 5 6 7 8 9 10 11 12

Bari Land:
1 2 3 4 5 6 7 8 9 10 11 12

2b. Do you grow different varieties of these crops every year?

2c. Do you grow the crops on the same land every year?

_________________________________________________________

_________________________________________________________

3. Irrigation water
3a. What type of irrigation facilities do you have? (circle)
seasonal permanent other (specify)

Comments:

_________________________________________________________

_________________________________________________________

3b. How do you get water to your lands?

_________________________________________________________

_________________________________________________________

4. Inorganic commercial fertiliser
4a. Are there any problems associated with using commercial fertiliser? (do not prompt)
no ___ yes ___ -> wrong type ___
wrong time ___
lack of money __

4b. Does it adversely affect your production? no _____ yes _____

Comments:


5. Compost production and consumption
5a. Tell us how long it takes you to make compost:
   - gathering forest litter
   - animal bedding and manure
   - compost maintenance

5b. In one year, how many dokos of compost do you use for each crop?
   main staple crop (number of ropanis grown on?) -
   main vegetable crop (number of ropanis grown on?) -
   alternative vegetable crop (number of ropanis grown on?) -

6. Production of main staple crop
For your main staple crop, how much time do you spend on each activity, and how much time do children spend on their activities:

Note: indicate children, women, and men as - Child: C, Women - W, Men - M

Indicate hired labour with '*' perma labour with a 'P'.

If both men and women do an activity, are there more men or women?
Wage and capital equipment rates:

<table>
<thead>
<tr>
<th>Item</th>
<th>Daily/hourly cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male wage rate (daily):</td>
<td></td>
</tr>
<tr>
<td>Female wage rate (daily):</td>
<td></td>
</tr>
<tr>
<td>Bullock rate (daily):</td>
<td></td>
</tr>
<tr>
<td>Tractor rate (hourly):</td>
<td></td>
</tr>
<tr>
<td>Water pump rate (hourly):</td>
<td></td>
</tr>
</tbody>
</table>

Crop Name: ____________________________

Time required to walk to the field(s) ____________________________

Nursery:
  What month is the nursery made?
  What month is it transplanted?
  prepare land and sow seed
  applying compost
  applying commercial fertiliser
  applying pesticide
  frost protection
  watering, weeding
  nursery transplanting

Field Land Preparation:
  first ploughing (bullock labour or hand)
  second ploughing (bullock labour or hand)
  first soil pulverising and levelling
  second soil pulverising and levelling
  seed sowing (if no nursery)
  make raised beds

Irrigation:
  canal repair and maintenance
  irrigation

Fertilisation:
  applying compost/organic fertiliser
  applying commercial fertiliser

Cultural Operation:
  first weeding and hoeing
second weeding and hoeing
spraying
pesticide application

Harvesting:
picking
cutting
threshing
sorting and grading

Storage:
storage of harvested crop
packing one doko/bag

7. Production of main vegetable crop

7a. For your main vegetable crop, how much time do you spend on each activity, and how much time do children spend on their activities:

Note: indicate children, women, and men as - Child: C, Women - W, Men - M

Indicate hired labour with '*', per ma labour with a 'P'.

If both men and women do an activity, are there more men or women?

Wage and capital equipment rates:

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</tr>
<tr>
<td>Water pump rate (hourly):</td>
<td></td>
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</table>

Crop Name: ______________________

Time required to walk to the field(s) __________________

Nursery:

What month is the nursery made?
What month is it transplanted?
prepare land and sow seed
applying compost
applying commercial fertiliser
applying pesticide
frost protection
watering, weeding
nursery transplanting

Field Land Preparation:
  first ploughing (bullock labour or hand)
  second ploughing (bullock labour or hand)
  first soil pulverising and levelling
  second soil pulverising and levelling
  seed sowing (if no nursery)
  make raised beds

Irrigation:
  canal repair and maintenance
  irrigation

Fertilisation:
  applying compost/organic fertiliser
  applying commercial fertiliser

Cultural Operation:
  first weeding and hoeing
  second weeding and hoeing
  spraying
  pesticide application

Harvesting:
  picking
  cutting
  threshing
  sorting and grading

Storage:
  storage of harvested crop
  packing one doko/bag

7b. When did you begin growing this vegetable?

7c. Why did you begin growing this vegetable?
7d. How has it progressed since you first started?

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

8. Production of alternative vegetable crop

8a. For your alternative vegetable crop, how much time do you spend on each activity, and how much time do children spend on their activities:

*Note: indicate children, women, and men as - Child: C, Women - W, Men - M
*Indicate hired labour with '*', perma labour with a 'P'.
*If both men and women do an activity, are there more men or women?

Wage and capital equipment rates:

<table>
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<tr>
<th>Item</th>
<th>Daily/hourly cost</th>
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<td></td>
</tr>
<tr>
<td>Water pump rate (hourly):</td>
<td></td>
</tr>
</tbody>
</table>

Crop Name: __________________________

Time required to walk to the field(s) __________________________

Nursery:

- What month is the nursery made?
- What month is it transplanted?
- prepare land and sow seed
- applying compost
- applying commercial fertiliser
- applying pesticide
- frost protection
- watering, weeding
- nursery transplanting

Field Land Preparation:

- first ploughing (bullock labour or hand)
- second ploughing (bullock labour or hand)
first soil pulverising and levelling
second soil pulverising and levelling
seed sowing (if no nursery)
make raised beds

Irrigation:
canal repair and maintenance
irrigation

Fertilisation:
applying compost/organic fertiliser
applying commercial fertiliser

Cultural Operation:
first weeding and hoeing
second weeding and hoeing
spraying
pesticide application

Harvesting:
picking
cutting
threshing
sorting and grading

Storage:
storage of harvested crop
packing one doko/bag

8b. Why do you grow this vegetable? (at most 3 reasons, do not prompt)
1. 
2. 
3. 

8c. When did you begin growing this vegetable?

8d. Why did you begin growing this vegetable?
8e. How has it progressed since you first started?

9. IF DO NOT GROW ALTERNATIVE VEGETABLES:

9a. Why do you not grow these alternative vegetables? (do not prompt)

If she can not answer, then record that fact, and prompt her with the choices below:

- inadequate land
- inadequate fertiliser
- inadequate water
- inadequate pesticide
- inadequate credit
- inadequate seed (poor quality insufficient amount: circle one or both)
- inadequate knowledge
- other

9b. Have you tried to grow any of these alternative vegetables before?

yes___ --> Which one(s)?
When?
What problems did you have?

Comments:

10. Marketing costs

The following instructions apply to all crops being recorded:

If the farmer sells the commodity at more than one market, determine costs for the one at which he sells most of his production. Example: if he sells at Banepa and Kathmandu, but he sells most of this crop at Banepa, determine costs at Banepa. If he sells about the same amount at both markets, select the one at which he prefers to sell.
10a. Main staple crop

Main Staple Crop Name ________________________________

a. how much does one bag or doko cost if you were to buy one in the market?
b. do you take the crop by your own labour to the market, or use a bus/minivan?
c. if he uses own labour:
   how long does it take to go to the market?
   how many people (specify no. of adults and children):
   do you hire porters? If so, what is the cost?
d. if he uses bus or minivan:
   does the minivan come to the field?
   how do you take your dokos/bags to the bus stop or minivan pick-up point?
   porter - cost per doko/bag: Rs.
   own labour: how many people (specify number of adults and children):
   how long does it take? (hours or minutes)
e. how much does it cost to load one doko/bag onto the vehicle (if applicable): Rs.
f. how long does it take to reach the market (ie. how long is the bus ride)?:
g. what is the charge for each doko/bag on the bus or minivan? Rs.
h. what is your bus fare or minivan fare? Rs.
i. how much do you pay porter(s) at the market to unload each doko/bag?: Rs.
j. how much do you spend on food at the market?: Rs.
k. how much do you spend on lodging at the market?: Rs.
l. tax:
m. other charges (specify):
10b. Main vegetable crop

Main Vegetable Crop Name

a. how much does one bag or doko cost if you were to buy one in the market?
b. do you take the crop by your own labour to the market, or use a bus/minivan?
c. if he uses own labour:
   how long does it take to go to the market?
   how many people (specify no. of adults and children):
   do you hire porters? If so, what is the cost?
d. if he uses bus or minivan:
   does the minivan come to the field?
   how do you take your dokos/bags to the bus stop or minivan pick-up point?
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   own labour: how many people (specify number of adults and children):
   how long does it take? (hours or minutes)
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g. what is the charge for each doko/bag on the bus or minivan? Rs.
h. what is your bus fare or minivan fare? Rs.
i. how much do you pay porter(s) at the market to unload each doko/bag?: Rs.
j. how much do you spend on food at the market?: Rs.
k. how much do you spend on lodging at the market?: Rs.
l. tax:
m. other charges (specify):
10c. Alternative vegetable crop

Alternative Vegetable Crop Name ______________________________

a. how much does one bag or doko cost if you were to buy one in the market?

b. do you take the crop by your own labour to the market, or use a bus/minivan?

c. if he uses own labour:
   - how long does it take to go to the market?
   - how many people (specify no. of adults and children):
   - do you hire porters? If so, what is the cost?

d. if he uses bus or minivan:
   - does the minivan come to the field?
   - how do you take your dokos/bags to the bus stop or minivan pick-up point?
     - porter - cost per doko/bag: Rs.
     - own labour: how many people (specify number of adults and children):
     - how long does it take? (hours or minutes)

e. how much does it cost to load one doko/bag onto the vehicle (if applicable): Rs.

f. how long does it take to reach the market (ie. how long is the bus ride)?:

g. what is the charge for each doko/bag on the bus or minivan? Rs.

h. what is your bus fare or minivan fare? Rs.

i. how much do you pay porter(s) at the market to unload each doko/bag?: Rs.

j. how much do you spend on food at the market?: Rs.

k. how much do you spend on lodging at the market?: Rs.

l. tax:

m. other charges (specify):
11. Livestock

11a. What animals are kept by this household? How many?

Note: If any of these not owned by the household, indicate these with a "*".

<table>
<thead>
<tr>
<th>Animals</th>
<th>Quantity</th>
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<tbody>
<tr>
<td>Bulls</td>
<td></td>
</tr>
<tr>
<td>Cows</td>
<td></td>
</tr>
<tr>
<td>Cows (young)</td>
<td></td>
</tr>
<tr>
<td>Bullocks (adult)</td>
<td></td>
</tr>
<tr>
<td>Bullocks (young)</td>
<td></td>
</tr>
<tr>
<td>Buffalo (M)</td>
<td></td>
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<td>Buffalo (F)</td>
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<td>Buffalo (Y)</td>
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<td>Goats (M)</td>
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<td>Goats (F)</td>
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<td>Goats (young)</td>
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<tr>
<td>Sheep</td>
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<tr>
<td>Pigs</td>
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<tr>
<td>Chickens</td>
<td></td>
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<tr>
<td>Others</td>
<td></td>
</tr>
<tr>
<td>Young</td>
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</tbody>
</table>

11b. How much fodder do you feed your livestock (per day) in the different seasons?

_________________________________________________________________________________

_________________________________________________________________________________

_________________________________________________________________________________

11c. From where do you collect the fodder? (If collect forest litter for feed, how much time spent?)

_________________________________________________________________________________

_________________________________________________________________________________

_________________________________________________________________________________

11d. Do you buy any concentrates, straw, etc.? If so, from where?

<table>
<thead>
<tr>
<th>Type of feed</th>
<th>Price</th>
<th>From Where?</th>
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<tbody>
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</tbody>
</table>

C. GENERAL

12. Forest use

12a. What uses do you make of forest litter?

- compost organic matter
- fuel
- animal bedding
- timber
- other
12b. What kind of trees do you prefer, for forest litter, firewood etc.?

<table>
<thead>
<tr>
<th>Tree</th>
<th>Use</th>
</tr>
</thead>
<tbody>
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</table>

13. Staple food consumption
How much of your staple crop do you need to feed your family for one month?

14. Self-sufficiency
Are you self-sufficient in the following items?

<table>
<thead>
<tr>
<th>Item</th>
<th>No/Yes</th>
<th>When have shortage?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feed</td>
<td></td>
<td></td>
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<tr>
<td>Firewood</td>
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</tbody>
</table>

15. Household loans
Does anyone in your household have any loans?

no _____ yes _____ --> Who (M or F)?
Amount of loan?
Interest rate? per month _____% per year _____%
Source of loan? ____________________________
Use of loan? ____________________________

16. Training
16a. Do you or anyone in your family need any agricultural training?

no ____ yes ____ -> what type?
16b. Have you had any agricultural training before?
    yes -> what type and was it useful?

    ____________________________________________________________
    ____________________________________________________________
    ____________________________________________________________
    ____________________________________________________________

    no -> why not?

    ____________________________________________________________
    ____________________________________________________________
    ____________________________________________________________
    ____________________________________________________________

Farmer quotes and remarks:

    ____________________________________________________________
    ____________________________________________________________
    ____________________________________________________________
    ____________________________________________________________
    ____________________________________________________________
    ____________________________________________________________