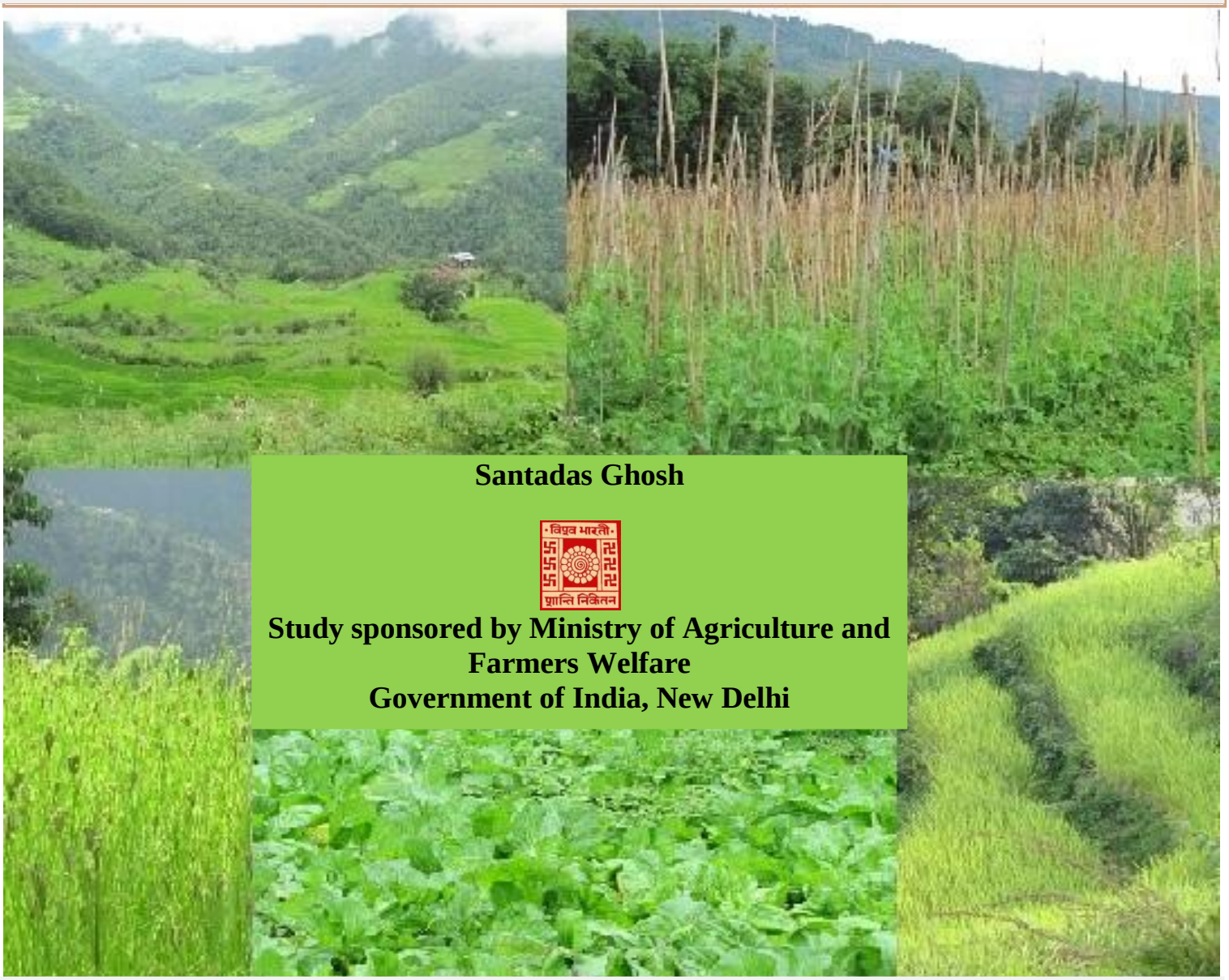
Study No. 181

A STUDY ON PRODUCTIVITY AND PROFITABILITY IN AGRICULTURE AND HORTICULTURE IN EASTERN HIMALAYAN REGION



Santadas Ghosh

Study sponsored by Ministry of Agriculture and Farmers Welfare
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Agro-Economic Research Centre
(For the States of West Bengal, Sikkim and Andaman & Nicobar Islands)
Visva-Bharati, Santiniketan
West Bengal

September - 2016

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A STUDY ON PRODUCTIVITY AND PROFITABILITY IN AGRICULTURE AND HORTICULTURE IN EASTERN HIMALAYAN REGION

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PREFACE

The present report titled *'A Study on Productivity and Profitability in Agriculture and Horticulture in Eastern Himalayan Region'* is the outcome of a study initiated by Agro-Economic Research Centre (Santiniketan) during 2014-15. In spirit, the study is a continuation of another report produced by the Centre, *Baseline Data on Area, Production and Productivity of Horticulture Crops in Sikkim*, prepared by the Centre in 2013. Agriculture in eastern Himalayan hill area is a very important source of livelihood in absence of major industrial activity in that region. However, available agricultural statistics lacks micro level details of productivity and profitability of major crops in the area. Aggregated data at block level often miss out the factors that might affect household level decision making on crop choices. Further, altitude and climate have major impacts on agricultural productivity and crop choice. Unlike in plains of India, such parameters vary widely within a small administrative unit in eastern Himalayan hills.

This study is a step further towards informed policy making for agricultural development of the hill region. It provided new insight into genetic diversity of different crops and use of chemical fertilizers in hills which has implication for environmental sustainability. The study finds out that some crops cannot be associated with a specific season as defined by calendar months in hill area. Productivity and profitability of some crops are found to be significantly variable across altitudes.

The study was proposed by Dr. Santadas Ghosh (Associate Professor in the Department of Economics & Politics, Visva-Bharati) to the Centre and was later approved by the MOA (GOI). Dr. Ghosh and his research team members from AERC (Santiniketan) have accomplished a challenging job in remote hill villages in Noorth Bengal and Sikkim and often faced language barriers between respondents and researchers. The researchers had lived up to such challenges with the help of field workers and officials of Gorkha Territorial Administration (GTA) and Department of Agriculture and Horticulture (Govt. of Sikkim) along with various NGO workers. All these have been done within a small budgetary allocation. This is a study peeping into hill agriculture from new angles which might be extended in its scope in future. On behalf of AERC (Santiniketan), I thank the Ministry of Agriculture and Farmers Welfare (GoI) for kind approval of the study and congratulate the Principal Investigator and his research team for bringing out this report.

Place: Santiniketan
Date:

Professor Swapan Dutta
Vice-Chancellor (Acting), Visva-Bharati
&
Honorary Director ,
AERC, Santiniketan

Executive Summary

In plains of India, the temperature, rainfall pattern, ground water resources and soil conditions show little variation within a CD Block. All of these factors together decide agricultural productivities in that area. Again infrastructural provisions, irrigation options, location *vis-a-vis* urban centres, local prices of agricultural inputs and outputs and transport and storage facilities are generally fairly comparable within such a Block. These factors are assumed to shape the choice of crops and their varieties by the farmers. The same is true for horticulture as well. There is negligible variation in agriculture and horticulture related activities within a Block located on plains. So, various statistics that are available at block level provide a reasonable idea of the state of agro-horticultural situation within it.

The situation is much different in the Eastern Himalayan hilly regions. The climate, water availability, top-soil quality and rainfall pattern changes drastically within small distances. Also, one can find large variation in transport and infrastructural facilities within a CD Block and consequently in local prices of inputs and farm outputs. Unfortunately, data available at block level collapse the whole spectrum of variations within it into an aggregate number. It can hardly give an idea of the real state of the block's agriculture and horticultural situation. In this backdrop, this study was aimed at estimating agro-horticultural productivity and its returns in the hilly regions of North Bengal and Sikkim through a carefully designed primary survey. Also, the role of the state-sponsored support programmes for local farmers can be crucial in determining the agricultural performance. This study accounts for such differences as Sikkim provides significant support to its farmers and Darjeeling lacks such support.

Objective

In the background stated above, this study had set out the following three objectives:

- *To gain a micro level understanding of major agricultural and horticultural practices and its variation across different agro-climatic zones within eastern Himalayan hills.*
- *To generate a baseline understanding of seasonality, productivity and returns from some major agricultural and horticultural crops in the region*
- *To examine whether state sponsored support programmes have any significant role in determining the returns from agro-horticultural activities in the region*
- *To provide relevant policy inputs for improvement in agricultural and horticultural profile of the hill farmers on the basis of study findings*

Data and Sampling

The study was entirely based on primary survey of farm households. Data were collected from 314 farming households in Sikkim and Darjeeling district of West Bengal between December, 2014 to January, 2015. Choice of households was made ensuring enough variation in altitude within each state, but maintaining comparability at similar altitude across Sikkim and Darjeeling. The finding from primary survey throws up some important characteristics of agriculture and horticulture in the hill area.

Depending on the elevation, the hill region can be categorized into five agro-ecological zones. These are:

(i) Tropical (below 610 metres)
(ii) Sub-tropical (610 – 1524 metres)
(iii) Temperate (1524 – 2743 metres)
(iv) Sub-temperate (2743 – 3962 metres)
(v) Alpine (3962 – 8153 metres)

All these agro-climatic zones are present in both Sikkim and Darjeeling. Almost all of the agricultural households are confined within the first three zones. Accordingly, this study remained confined within *Tropical*, *Sub-tropical* and *Temperate* zones of Sikkim and Darjeeling.

Findings

One important difference with plain-land agriculture is that, in hills, often a crop cannot be associated with a unique season. Largest variation in cultivars of crops is seen in the *sub-tropical* zone. Crop cycles vary significantly with altitude in terms of its sowing and harvesting time. This phenomenon is more pronounced in case of crops like radish and carrot which is more sensitive to temperature than rainfall. For crops which are more dependent on rainfall, like rice, seasonality is somewhat maintained. In such cases, altitude difference results in more local cultivar.

The hill terrain doesn't allow large land parcels and hence farm mechanization is almost absent in hills. There is no canal or groundwater irrigation facility. In absence of large fields and with little control on irrigation by individual farmers, application of chemical fertilisers is naturally not viable. Modern HYV seeds for staple food crops like rice are also not suitable in hills.

Though there is a large variety of agricultural and horticultural crops produced by the farming households, farmers are increasingly shifting to high value commercial crops such as large cardamom and ginger. There is a severe shortage of agricultural labour in hills area because youth is increasingly moving out to other parts of India and even abroad. In absence of a vibrant market of agricultural labourers in these sparsely populated isolated villages, crop choices are being influenced by the available assured labour supply from within farming households. Food crops like rice and maize require more labour and also more prone to wild animal raids. So, farmers are moving away from these food crops, compromising with local food security.

In spite of better state support to Sikkim farmers, productivity and profitability of most of the crops is better in Darjeeling compared to Sikkim. This might be the result of better rainfall in Darjeeling and its proximity to the city of Siliguri, nearest trading point in plains. State support in Sikkim is being directed towards high value commercial crops like large cardamom and ginger, and hence there is a declining interest in cultivation of staple food crops like rice and maize.

The Govt. of Sikkim is providing reasonable support to its farmers for training, inputs like seeds and saplings and facilitating the marketing of their produce. However, in the process, it

might have reduced the diversity of crop varieties. Darjeeling has shown more cultivar varieties of major crops compared to Sikkim across comparable agro-ecological zones. Profitability of large cardamom is seen to be consistently rising with altitude. For this crop, effective marketing and other state support has resulted in higher profitability of cardamom in Sikkim compared to Darjeeling.

Given the nature of very small plots of cultivation and lack of control over irrigation water, crop varieties are almost entirely local. With substantial livestock holding and using livestock waste, home-made bio-fertilizers are invariably used for all types of crops both in Sikkim and Darjeeling hills. The stated objective of Sikkim to make itself hundred percent organic, and the lack of such state efforts in Darjeeling, does not show up in any significant difference in fertilizer use pattern across the two regions.

State support is lacking to control the virus attacks that are plaguing farmers for high value crops like large cardamom and ginger. In certain parts of Darjeeling and Sikkim, these profitable horticultural crops had been wiped out in recent times due to virus attacks though it was previously produced and was very remunerative.

This study by AERC (Santiniketan) has tried to cover the information gap and bring to light certain aspects of hill agriculture that cannot be obtained from an aggregative study. Farm level data collected from 314 farmers highlights the following points:

- Agricultural and horticultural crops are found to be mostly confined within 2000 metre altitude. Largest variation in cultivars of crops is seen in the *Sub-tropical* zone (610-1524 Metres).

- For many crops, it is hard to classify them by their seasonality according to calendar months.

- This phenomenon is more pronounced in case of crops like radish and carrot which are more sensitive to temperature than rainfall. For crops which are more dependent on rainfall, like rice, seasonality is somewhat maintained. In such cases, altitude difference results in more local cultivars.

- The terrain doesn't allow large land parcels and hence farm mechanization is almost absent in hills.

- Application of chemical fertilisers is naturally not viable. Modern HYV seeds for staple food crops like rice are also not suitable in hills.

- Farmers are increasingly shifting to high value commercial crops such as large cardamom and ginger.

- There is a severe shortage of agricultural labour in hills area because young generation is increasingly moving out to other parts of India and even abroad.

- In absence of a vibrant market of agricultural labourers, crop choices are being influenced by the availability of own labour supply of farming households.

- Food crops like rice and maize require more labour and they are also more prone to wild animal raids. So, farmers are moving away from these food crops, compromising with local food security.

- In spite of better state support to Sikkim farmers, productivity and profitability of most of the crops is better in Darjeeling compared to Sikkim. This might be the result of better rainfall in Darjeeling and its proximity to the city of Siliguri, nearest trading point in plains.

- State support in Sikkim is being directed towards high value commercial crops like large cardamom and ginger, and hence there is a decline in farmers' interest on staple food crops like rice and maize.

- Darjeeling has shown more cultivar varieties of major crops compared to Sikkim. The Govt. of Sikkim is providing reasonable support to its farmers by training, providing inputs like seeds and saplings and facilitating the marketing of their produce. However, in the process, it might have reduced the diversity of crop cultivars.

- Profitability of large cardamom is seen to be consistently rising with altitude. For this crop, effective marketing and other state support has resulted in higher profitability of cardamom in Sikkim compared to Darjeeling.

- Given the nature of very small plots of cultivation and lack of control over irrigation water, crop varieties are almost entirely local. With substantial livestock holding and using livestock waste, home-made bio-fertilizers are invariably used for all types of crops both in Sikkim and Darjeeling hills.

Policy Implications

This study is a recent and unique one that generates farm level understanding of agricultural practices in Eastern Himalayan Hills. In doing so, it comes up with the following points that might be relevant to the policy authority:

- State support to farmers in Sikkim is being primarily directed towards high value commercial crops like large cardamom and ginger, and hence there is a decline in cultivation of rice and maize. Such supports may be extended to staple food crops like rice and maize to enhance local food security in Eastern Himalayan Hills.

- The stated objective of Sikkim to make itself hundred percent organic, and the lack of such state efforts in Darjeeling, does not show up in any significant difference in fertilizer use pattern across the two regions. Local geographical constraints in hill area do not support adaptation of modern agricultural inputs and HYV seeds. So, it might be wasteful expenditure to promote organic farming when it is already in practice by default. Money spent on awareness building on organic farming might be better used by providing the farmers with tangible agricultural inputs like free distribution of seeds.

- State support is lacking to control the virus attacks that are plaguing farmers for high value crops like large cardamom and ginger. In certain parts of Darjeeling and Sikkim, these profitable horticultural crops had been wiped out due to virus attacks though it was previously produced and was very remunerative. More state sponsored research and technology development for curing this specific crop disease is required.

- Large cardamom is the most remunerative crops among all the crops produced in the hill area of Sikkim and Darjeeling. Since large cardamom takes at least two years after plantation to yield profit, poor farmers cannot devote their land to it as they cannot afford such a long gestation period. To promote this crop to enhance farmers' income, specialized credit facilities should be devised. Special provisions for medium term agricultural credits to poor farmers should be made for large cardamom promotion.

- Crop insurance practice is almost totally absent in hill agriculture. This is primarily due to non-availability of specialized insurance schemes for hill agriculture. Such schemes should be developed through further studies and farmers need to get expert consultancy on crop insurance to promote profitable crops like large cardamom and ginger.

Way Forward

The study admits that it has faced huge challenges in dealing with unconventional measurement units of land as reported by the respondents. The diversity in hill agriculture has sometimes resulted in a small respondent size for a specific crop in a specific zone and in a particular state. This might cast some doubt about the robustness of productivity and profitability estimates that this survey has reported.

However, the study has thrown open the possibility of a detailed study in similar line incorporating a much larger set of crops and farmers. Also, the dynamics of hill agriculture in recent times could not be captured in such a one-shot study. There is good scope of revisiting these same farm households at regular intervals so that relatively more 'successful' farming practices and the factors enabling them can be filtered out. This is specially important in light of the recently announced resolve by the Government of India of "Doubling Farmers' Income by 2022". So, more detailed farm-level studies at regular intervals in Eastern Himalayan Hills remain open as a future research agenda - both for AERC (Santiniketan) and for any other interested agency.

CONTENTS

1. INTRODUCTION

In plains of India, the temperature, rainfall pattern, ground water resources and soil conditions show little variation within a Community Development Block. All of these factors together decide agricultural productivities in that area. Again characteristics of villages (and households therein) in terms of infrastructural provisions, irrigation options, location vis-a-vis urban centres, local prices of agricultural inputs and outputs and transport and storage facilities are generally fairly comparable within a block. These factors are assumed to shape the choice of crops and their varieties at household level. The same is true for the practice of horticulture as well. One can reasonably assume that there is negligible variation in agriculture and horticulture related activities within a block located on plain land. So, various statistics that are available at block level provide a reasonable idea of the state of agro-horticultural situation within it.

The situation is much different when one moves to the hilly regions, especially in eastern Himalayas. The climate, water availability, top-soil quality and rainfall pattern changes drastically within small distances. Even within an administrative block, enough of these differences can be easily noticed. The vegetation can considerably differ within a few kilometres in a hilly terrain. Also, one can find large variation in transport and infrastructural facilities within an administrative block and consequently in local prices of inputs and agricultural and horticulture products. Villages within a hill block can be very heterogeneous in their agro-economic situation. There is little scope to obtain a 'representative agricultural village' in hilly region unless it is estimated for each agro-ecological zone. The zones should be categorized ideally by their characteristics such as elevation, land gradient and remoteness.

Unfortunately, administrative blocks are not demarcated along these characteristics and data available at block level collapse the whole spectrum of variations within it into an aggregate number. It can hardly give an idea of the real state of the block's agriculture and horticulture. In this backdrop, this study builds up some estimates of agro-horticultural productivity and its returns in the hilly regions of North Bengal and Sikkim through a carefully designed primary survey.

In eastern Himalayan hill area, horticulture is a dominant primary production activity apart from traditional crop-based agriculture. In recognition to its importance, a flagship

programme for development of horticulture (Horticulture Mission for North East Himalayan States: HMNEH) has already been undertaken in this region. In its Operational Guideline (April, 2014), the Mission explicitly talks about the need to "organize base-line survey and feasibility studies for distinct areas/clusters (District, sub-District, or a group of Districts) to determine status of horticultural production, potential and demand....". This study includes some major horticultural crops like ginger, cardamom and broom grass which are commercially very successful in the region in recent times.

Also, agro-horticultural activities depend on state sponsored promotional programmes. The North Bengal district of Darjeeling and the adjacent state of Sikkim provide a unique opportunity to examine the role of such provisions in determining the productivity and profitability in agriculture. There are villages in hills of these two politically different regions that are very similar in terms of their elevation, climate and soil quality. A significant difference in their agricultural productivity and returns, if exists, should be indicating the benefits derived from different institutional provisions created by different political regimes.

2. STUDY OBJECTIVE

In the background stated above, this study has set out the following three objectives:

- *To gain a micro level understanding of major agricultural and horticultural practices and its variation across different agro-climatic zones within eastern Himalayan hills.*
- *To generate a baseline understanding of seasonality, productivity and returns from some major agricultural and horticultural crops in the region*
- *To examine whether state sponsored support programmes have any significant role in determining the returns from agro-horticultural activities in the region.*

3. BACKGROUND AND STUDY AREA

Eastern Himalyan Hill area is considered as a biodiversity hotspot for a varied existence of flora and fauna - some of which are unique in this area. Human settlements were there for long historical time and utilized the varied agro-climatic conditions to fulfil their food need locally. It can be concluded that the region was self-sufficient in food production as it sustained its population without significant trade with plain lands in historical times.

However, with advent of road-links, under the British colonial rule, both the local population and trade with plains of India has started increasing. After independence of India, and accession of Sikkim as a state of India, the hill economy is considerably integrated with the larger Indian economy and trade in all sorts of goods and services takes place. This naturally resulted in a qualitative change in local agricultural practices. Specialized agricultural productions with comparative climatic advantages are taking place in hill area. While this can be justified for faster economic development, it also brings in the question of food security of the region.

A local or regional food security requires that the local population is self-reliant in producing their own staple food so that disturbances in the larger economy have minimum implication for their basic food need. Towards this end, Government (both Central and State) are increasingly providing knowledge and input support to induce local agriculture that are directed to produce local food crops. Such support programmes are to be backed by a scientific understanding of the productivity and seasonality of local food-crops, which include both field crops and horticultural crops.

Throughout plain lands of India, a detailed understanding of seasonality and productivity of different agricultural and horticultural crops are available from various sources. These are available from both government sources and published micro level studies by private agencies. However, from an extensive search of the literature, it seems that there is a large gap in this respect when one tries to understand the state of hill agriculture.

Secondary data on hill-agriculture, available from various studies and reports, almost always provide the information at regional and at most block level[1]. So, we have time series data of 'total area devoted under different crops' and 'total estimated production of different crops' across different administrative units (lowest is a Community Block). Also, following the tradition of agricultural record-keeping in plains of India, the crops are classified across three main agricultural seasons (*Rabi, Kharif and Aman*).

[1] 1. (2011-12) *Annual Report* of Horticulture and Cash Crops Development Department, Govt. of Sikkim
2.(2013) *Baseline Data on Area, Production and Productivity of Horticulture Crops in Sikkim* (AERC, Visva-Bharati, Santiniketan)

However a close look at the agricultural practices in hills immediately tells us that the agro-climatic condition in hill slopes are grossly different than that in the plains. In plains of India, seasons are clearly demarcated by calendar months and within a particular block or district, the soil and climatic conditions are almost invariant. But in Hill area, when within a Community block there can be an altitude difference of more than thousand metres, this is certainly not true. So, the record keeping practice in agricultural production needs to be modified for hill area. Crops which are generally grown in winter in lower altitude, might be seen to be growing in summer in upper altitudes. So a 'Rabi' crop in plains might be a 'Kharif' crop in higher altitude. Hence, classification of crops with 'season' gets blurred in hill area.

Also, within a district or block in plains, the cultivars of a certain crop are usually very less in number. As the soil and climate is homogeneous within it, the specific cultivar that is most profitable, is generally produced. So, productivity of a certain crop within a block or district refers to the productivity of that specific cultivar.

But within a hill CD block, there can be vast differences in soil condition and temperature and rainfall pattern. So, the number of cultivars of a crop in a particular block might be large. Accordingly, the productivity also varies. Again, the productivity of the same cultivar varies across altitude. When agricultural statistics (area and total production) are provided at block level for hills, it completely obscures the cultivar-specific productivity and seasonality scenario. Unless clearer understanding of these details is developed, government intervention programmes to develop agriculture and food security will be based on incomplete information. In light of such gaps in understanding, the primary outcome of this study is aimed at shedding light on this unexplored area.

This detailed micro-level information can be obtained only with farm level data and that calls for primary survey. With the limitation of time and resources, this study is understandably a first attempt in this line to generate some preliminary numbers and show the way to build a larger database. The study findings are concluded in the last section with the acknowledgement of its limitations and ways to go forward.

The study area is spread over Darjeeling district in West Bengal and in the state of Sikkim. Following official practice, the hill region can be categorized into three agro-ecological zones. This is done depending on the elevation as follows:

Table 1: Agro-Climatic Zones in Hill Area[2]

Sl. No.	Range	Altitude (Metres)	Zone
1	TROPICAL	Below 610	I
2	SUB-TROPICAL	610 – 1524	II
3	TEMPERATE	1524 – 2743	III
4	SUB-TEMPERATE	2743 – 3962	IV
5	ALPINE	3962 – 8153	V

All these agro-climatic zones are present in both Sikkim and Darjeeling. Most of the agricultural households are confined within the first three zones. Accordingly, this study remained confined within Tropical, Sub-tropical and Temperate Zones of Sikkim and Darjeeling.

Local agriculture is influenced by the various state sponsored support programmes that are intended to help the farmers. Within the same state, these supports are similar. It is generally understood that such programmes sponsored by Sikkim government is more due to a relatively better financial resource allocation to agriculture in that state. This study aimed to shed light on the effect of such programmes as well. The choice of inclusion of Darjeeling (under the state of West Bengal), is to facilitate the comparison of agricultural practices in similar agro-climatic zones but belonging to different states. The details of sample selection are described in Section 5 of this study report.

4. STUDY DESIGN

The study primarily aims at a very specific target of generating good quality household level data. This is achieved by a purposive selection of sample area and sample units (households) and is detailed in Section 5.

[2] (2011-12) *Annual Report* of Horticulture and Cash Crops Development Department, Govt. of Sikkim

The number of crops and their varieties are found to be too large to be covered in a small study like the present one. So, some major crops that are included in the study. The following section provides the justification of the crops included.

4.1 Crops covered in the study

Before the actual survey, a focus group discussion was carried out with field workers of the Department of agriculture (Sikkim and West Bengal), some local NGO workers active in agricultural sector and few farmers. It was understood that, unlike their plain land counterparts, farming households in hill area usually produce a large number of agricultural and horticultural crops at a time. Since one household has many plots or land parcels (often steps on a hill slope), it allows them to diversify easily in their crop choice. They produce little bit of many items on different plots within a year. Most of them are for self consumption, but often there is surplus over self consumption and the excess production is sold to the local markets. So, it is difficult to identify some crops uniquely by their production motive (self-consumption or commercial).

It turns out to be very difficult to gather detailed information on every crop that a respondent household produced over one year. This calls for narrowing down the number of crops for which primary data collection and estimation can be feasible and meaningful. This has been done objectively. Firstly, secondary information on major crops is obtained for Sikkim and Darjeeling. Secondly, opinion from Field workers and NGO activists were sought after explaining them the purpose of this study. This resulted in the identification of eight major crops that are covered under this study.

The detailed justification of this crop choice for the study objectives is based on secondary information and is provided in Appendix A1. Information on household characteristics and agricultural/horticultural practices are collected by carefully designed close-ended and pre-coded survey instruments.

Table 2: Major crops that are covered in the study

Crop Type	Scientific Name	Common Name
Field Crops	*Oryza sativa*	Rice
	Zea mays	Maize
	Vigna mungo	Urad (Kalo Dal)
Horticulture Crops	*Raphanus sativus*	Radish
	Daucus carota sativus	Carrot
	Zingeber officinale	Ginger
	Amomum subulatum	Large Cardamom
Forage Crops	*Thysanolaena maxima*	Broom Grass (Amrisho)

4.2 Types of Information collected

Due to language difficulties[3] and limited resources, the survey questionnaire has been kept as short as possible with only necessary information as is required to address the research questions. Only the education, age and sex of the household head, household size, caste and religion are recorded in 'household profile' section. Rest of the information recorded are all relating to the agricultural practices of the household over last one year. The survey has been carried out during the months of December 2014 to March, 2015. So, the reference period of the data collected relates to Summer and Monsoon of 2014 and Winter of 2014-2015.

The questionnaire is divided in further two modules - one for short duration crops (rice, maize, gram, radish, carrot and ginger) and one for horticulture crops which need not be planted every year (Cardamom and Broom Grass). For the second set of crops the information that was collected relates to:

- costs for annual maintenance,
- fertilisers use,
- water use,
- production,

[3] Farmers mostly speak *Nepali*, which none of the AERC (Santiniketan) Field Stuff could understand. So, the interviews were mostly carried out through some local Hindi-speaking volunteer interpreters.

- area devoted,
- quantity sold,
- price realized

For the first set of crops, in addition to the above aspects, following information is also collected:

- cost of land preparation
- cost of procurement of seed/saplings
- sowing time (month and week)
- harvesting time (month and week)
- transplanting cost (for rice)

The important information on altitude could not be recorded at household level. It was recorded at village level after obtaining some secondary information and FGD. So, every household in one village was assigned the same recorded altitude.

The collected data has been entered electronically in a spreadsheet (Excel) and has been checked for consistency. Quite a few outliers have been found in the preliminary results, which were later replaced by the respective mean values. The findings are described in Section-6.

5. SAMPLE SELECTION

Sample selection for this study was crucial and challenging. The selection of Sikkim and Darjeeling as study locations are for obvious reasons that has been explained before. But within Sikkim and Darjeeling, selection of respondent households was done carefully in two stages. In the first stage a number of Gram Panchayet (GP) areas and villages therein have been selected. In the second stage, respondent households within such villages were selected.

5.1 Village Selection

Available information on climate, rainfall and vegetation was used to narrow down the study area into two comparable sets of Gram Panchayets – one set in Darjeeling and the other set in Sikkim. This was done purposively and in consultation with agriculture-related NGO workers

in Darjeeling district and field workers in a state sponsored agricultural marketing federation in Sikkim (SIMFED).

It was understood that among the four districts of Sikkim (East, North, West and South), the most agriculturally diversified district is the West, followed by South and East. The North district in Sikkim mostly comprises of high altitude locations. It is sparsely populated and with very little agriculture. So, North district of Sikkim was kept out of our sample locations.

In Darjeeling, the locations in close proximity of Sikkim's West and South districts were chosen to minimize climatic variations across comparable zones. The Bijanbari CD Block of Darjeeling has been chosen for this purpose.

Within the selected districts and blocks, Gram Panchayet (GP) areas have been chosen purposively so that all the three agro-climatic zones are represented in the sample. Also GPs with maximum agro-diversity and easier to commute has been chosen to minimize the logistical challenge of survey. Since Sikkim is comparatively sparsely populated, GPs are smaller in terms of their population size. So, a larger number of GP has been chosen from Sikkim. Altogether 16 GPs from Sikkim and 6 GPs from Darjeeling have been selected for primary survey (Appendix: A2).

Within each GP, villages have been chosen depending upon the proximity to road links and availability of local interpreters as the enumerators were outsiders. Altogether 23 villages from Sikkim and 28 villages from Bijanbari (Darjeeling) have been covered in this survey (Appendix: A2).

5.2 Household selection

There was no ready sampling frame of farming households in the selected villages. So, selection of sample households has been done within a village following '*snowball sampling*' method. The local interpreter was first asked to lead to that household in the village which is most diversified in its agricultural practices. After completion of survey in that household, the respondent was asked to identify another farming household among his neighbours who preferably produces a different set of crops. That household was approached next. In this way, the next respondent from the same village was identified after completion of each

survey. Since the villages are small in size and farming profile within a village is similar, a target set of 5-7 households per village has been interviewed.

GPs and villages were selected after ensuring variation in altitude. So, the households also showed varied altitude in their location. Maximum number of villages and households has been selected from Sub-tropical zone, as it contains the most diversified agriculture. The following table shows the distribution of survey households across such agro-climatic zones.

Table 3: Distribution of sample households across Agro-Climatic zones

Agro-Climatic Zone	Altitude (Metres)	Number of Sample Households
TROPICAL	Below 610	24
SUB-TROPICAL	610 – 1524	207
TEMPERATE	1524 – 2743	83
Total Number of Sample Households=		314

It is to be noted that the zones *Sub-temperate* and *Alpine* (described in Section 3) has been excluded from sample as agriculture is not a primary occupation in these zones. In high altitudes, people mainly depend on livestock rearing and cultivation of exotic species which cannot be classified as major crops in the region.

6. STUDY FINDINGS

After collection of data from field and its cleaning, quite a few challenges were thrown up for this study. *Firstly,* it was found that there is not enough number of farmers reporting certain crops in all altitudes (zones) and in both the states. This was realized to be unavoidable for a small scale study with such a wide variation in its subjects. Secondly, there was difficulty with units of measurement as different non-standard units were reported for measurements, especially for land area. The difficulties were solved objectively to the extent possible. The findings are described in the following sections.

6.1 Cultivars for crops under study

One main finding is the existence of a large number of cultivars of the same crop within a small area. A wide number of local cultivars for different crops have evolved in Eastern Himalayan hills over ages and is sustaining even today. Laboratory-based HYV crops might be more productive and profitable, but they were developed for plain lands where the variety can be extended over a vast area. But those are not suitable for specific climatic conditions in the hill region. The cultivar names are often also local. Such diversity in cultivars is most prevalent in case of rice, which had traditionally been the main food crop in the region. Among the 314 households in the sample, 83 plots were devoted to rice cultivation over the last one year. Within these 83 plots, as many as 16 cultivar names have been recorded. A distribution of these cultivars across agro-climatic zones is provided in Table-4.

Table 4: Local names of cultivars of rice and their distribution across climatic zones

Tropical (below 610 Metres)		**Sub-Tropical** (610-1524 Metres)		**Temperate** (1524- 2743 Metres)	
Sikkim	**Darjeeling**	**Sikkim**	**Darjeeling**	**Sikkim**	**Darjeeling**
Seino Attey	*Choti*	*Basmati*	*Basmati*	*Basmati*	*(Not cultivar found)*
	Kalo Jeera	*Doodh Kanti*	*Bhangeri*	*Jhapaka*	
	Kati	*Juari*	*Kalo Jeera*	*Seino Attey*	
		Lamo	*Marsi*		
		Seino Attey	*Masino*		
		Thulo Attey	*Ram Tulsi*		
			Phulpata		

With such a range of cultivars, each of them is produced by only a few of the sample households and any estimate based on such a small sample might be statistically challenged. So, productivity and profitability calculations for rice production, as is described in subsequent sections, have been carried out with all the cultivars taken together. The take home messages from Table-4 are:

- *Cultivar varieties are most diverse in Sub-tropical zone*
- *Darjeeling shows more cultivar varieties of rice compared to the similar agro-climatic zones of Sikkim*

The other major field crop considered in this study, Maize, however, fails to show such variation in its cultivars. There are only two cultivars that have been found in this study and they are locally called *Paheli* and *Seti*. Both of them are in existence in all climatic zones in Sikkim as well as in Darjeeling.

Pulses (beans) have a large number of varieties in eastern Himalayan hills. The variation is so wide that an attempt to estimate productivity of each variety across all climatic zones is impossible for a small scale survey. So, only one variety of it, Black Gram (*Urad*), is considered in this study as it is the most prevalent across different climatic zones. However, farmers didn't report any cultivar name for it and it is invariably referred to as *Kalo Dal*. Horticultural crops like *Broom Grass* and *Carrot* also didn't come up with different cultivar names. *Radish* has got three cultivar names across survey sample. These are named by the colours with which the crop is identified – *White*, *Pink* and *Blue*.

Ginger, a very important cash crop for hill farmers, has shown four cultivar names across 196 plots on which it is grown over last one year by the survey households. The distribution of them across climatic zones and states is described in Table 5.

Table 5: Local names of cultivars of ginger and its distribution across climate zones

Tropical (below 610 Metres)		**Sub-Tropical** (610-1524 Metres)		**Temperate** (1524-2743 Metres)	
Sikkim	Darjeeling (WB)	Sikkim	Darjeeling (WB)	Sikkim	Darjeeling (WB)
Patla	*Medium*	*Bathanly*	*Medium*	*Patla*	*Mota*
	Patla	*Patla*	*Mota*		*Patla*
			Patla		

Table-5 also shows that

- *Sub-tropical zone contains most of the cultivar varieties.*
- *Darjeeling has more variety than Sikkim in corresponding agro-climatic zone*

Large Cardamom, the most profitable cash crop in eastern Himalayan hills in present days, shows a larger number of cultivars. Table 6 describes the cultivar names and their distribution across agro-climatic zones and states. It is seen that unlike rice and ginger, large cardamom has greater diversity at higher altitudes. But the most interesting aspect that comes out from this table is a much greater concentration of cultivars in West Bengal (Darjeeling) compared to Sikkim. Darjeeling was cultivating this crop from quite some time and experimented with various cultivars. Field discussions suggest that in Sikkim, most of the seeds are supplied by government agencies and hence they generally concentrate on few most profitable cultivars.

Table 6: Local names of cultivars of ginger and its distribution across climate zones

Tropical (below 610 Metres)		**Sub-Tropical** (610-1524 Metres)		**Temperate** (1524-2743 Metres)	
Sikkim	Darjeeling (WB)	Sikkim	Darjeeling (WB)	Sikkim	Darjeeling (WB)
Ramsai	*Baralang*	*Golsai*	*Baralang*	*Golsai*	*Baralang*
		Ramsai	*Chebeysai*	*Ramsai*	*Chebeysai*
			Golsai		*Chiteysai*
			Ramsai		*Golsai*
			Resemna		*Muserey*
			Tharopatey		*Rambangey*
					Ramsai
					Seremna

The findings on Large Cardamom can be summarized as:

- *Cultivar varieties are more in higher altitude*
- *Darjeeling has significantly large number of varieties*
- *State sponsored distribution of seeds has resulted in lesser verities of large cardamom in Sikkim*

6.2 Seasonality of crops

One objective of this study was to examine the seasonality of the selected major crops across different agro-climatic zones in eastern Himalayas. Such zoning is officially done by demarcating the location of the field in terms of altitude and is already described in Section 3. In plains of India, temperature and rainfall within a small geographical location varies only with time. Accordingly, crops grown in a particular time of the year can be uniquely identified in terms of calendar months and are classified as *Rabi, Kharif* or *Aman*.

In hill area, altitude differences make such distinction blurred. Temperature varies across altitude in the same calendar month, although rainfall is not that much associated with altitude. Accordingly, the crops which are more sensitive to temperature (and less to rainfall) are grown in different time of the year across altitude. Also, the average maturity period of a crop sometimes show variation across altitude. There is no primary data readily available that documents such differences.

This study tried to build a baseline data to this effect. While surveying the farming households at different altitudes, the sowing time and harvesting time were recorded against each crop as the respondent did in last year. Within the same agro-climatic zone and for the same crop, sowing and harvesting time actually showed some variation across households. Since a mean is not representative for this case, the mode (the month and week identified by most of the farmers) for each zone and crop has been identified. Table 7 lists all such time points against the crops covered under this study. Cardamom and Broom Grass are not recorded here as they are perennial crops and not sown every year.

It was found that Radish and Carrot shows remarkable variation across zones in their sowing and harvesting time. It can be concluded that these two crops cannot be identified with a particular season in eastern Himalayan hills. For other crops, altitude doesn't make significant difference in their seasonality. But the average maturity period (calculated as the mean difference between sowing and harvesting time) shows some variation across altitude. It suggests that for most of the crops, maturity period is less at higher altitudes with Maize and Carrot being exceptions.

Table 7: Sowing and harvesting time of different crops across agro-climatic zones

Crop	Agro-Climatic Zone	Average Sowing Month	Average Sowing Week	Average Harvesting Month	Average Harvesting Week	Avg. duration to maturity (Wk)
Rice	Tropical	July	1	Dec	1	20
	Sub-tropical	July	1	Nov	4	19
	Temperate	July	2	Nov	4	18
Maize	Tropical	Feb	3	July	4	21
	Sub-tropical	Feb	2	Aug	1	24
	Temperate	Feb	3	Aug	1	23
Black Gram	Tropical	Aug	1	Nov	2	16
	Sub-tropical	Aug	1	Dec	4	18
	Temperate	Aug	1	Nov	4	15
Radish	Tropical	*(Not found)*	*(Not found)*	*(Not found)*	*(Not found)*	*(Not found)*
	Sub-tropical	**Sept**	**4**	**Jan**	**1**	**16**
	Temperate	**April**	**1**	**June**	**1**	**10**
Carrot	Tropical	**Sept**	**4**	**Nov**	**1**	**5**
	Sub-tropical	**Oct**	**2**	**Dec**	**4**	**10**
	Temperate	**Jan**	**1**	**June**	**1**	**19**
Ginger	Tropical	Feb	1	Dec	4	44
	Sub-tropical	Feb	3	Dec	4	42
	Temperate	Mar	1	Dec	4	37

6.3 Productivity of crops

For calculating productivity, information on quantity of production and the area of land devoted to each crop was needed. There was a challenge to convert every response to common units so that productivity can be expressed in a standardized unit such as *Quintal/Acre*. While units for production was fairly standard, it was observed that the area devoted for production of a crop, as reported by the respondent households, is often reported in different units. It was already known from Focus Group Discussions (FGDs) that *Hal* is the most commonly used unit for measuring farmland in hill area. But in actual survey, few

households were also found who could only describe their cultivable land area in some other local units (like *Gara*, *Thalee* and also '*kg of seed used*'). It was very difficult to convert them into one common measurement unit later on. So, some of these observations were omitted in calculating productivity.

For the most common unit *Hal*, there was also further difficulty for converting it into *acre*. Usually a *Hal* refers to the amount of land that one bullock can till in one day (eight hours). However, the physical area corresponding to one *Hal* can vary according to the type of soil and the gradient of the land parcel to be tilled. Local agriculture experts informed that they often use a constant conversion factor[4] between *Hal* and *Acre*. But talking to the farmers revealed that it might lead to gross underestimation or overestimation of the physical area. So, each farmer who reported his land unit in *Hal*, was also asked about the conversion factor between *Hal* and *Acre* in his judgement. While this is not authentic, there was no other way to arrive at a conversion factor with objectivity. The equivalence of one *Hal*, as reported by the farmers, varied from 1 Acre to 4 Acre. Relying on the 'law of averages', this study had converted all the *Hal* units to *acre* by the mean value of the reported conversion factor[5]. Such conversions made the productivity estimates less robust as it is not backed by actual physical measurement of the land. But in a small scale quick survey, this is the best result that could be achieved.

Table 8: Average productivity of Rice (Quintal/Acre)

	Sikkim	Darjeeling
Tropical	3.8	7.0
Sub-Tropical	5.0	6.4
Temperate	9.7	NA

Table-8 describes the study finding regarding rice productivity and it shows a larger productivity in Darjeeling compared to Sikkim. For Rice, no cultivator is found in Temperate zone in Darjeeling. The effect of altitude seems contradictory across two states. While in Sikkim rice productivity shows a steady increase with altitude, in Darjeeling the trend is reversed. There is no clear explanation for this phenomenon and it might be considered as a

[4] A conversion factor that was reported by local experts is 2 Hal = 1 Acre
[5] The mean is found to be approximately 2.5 *Hal* = 1 *Acre*

data limitation at this stage. The larger productivity in Darjeeling over Sikkim might be explained by the fact that Darjeeling receives a larger quantity of rainfall being the first recipient of monsoon rain and parts of Sikkim remains in the shadow of Darjeeling hills. Rice being a water-intensive crop, larger rainfall gives Darjeeling an edge over Sikkim in rice productivity.

Table 9: Average productivity of Maize (Quintal/Acre)

	Sikkim	Darjeeling
Tropical	4.8	12.6
Sub-Tropical	4.6	13.8
Temperate	4.6	7.7

Turning to Maize, it is seen from Table-9 that no significant pattern of productivity changes across zones in evident for this crop. While in Sikkim it remained fairly constant across altitudes, in Darjeeling it showed an irregular pattern. This again can be attributed to the lack of robustness in productivity estimates (as explained before). But the highlight is again a larger productivity in Darjeeling compared to that in Sikkim. The reason might be explained by rainfall as in the case of rice.

Table 10: Average productivity of Black Gram (Quintal/Acre)

	Sikkim	Darjeeling
Tropical	0.8	0.8
Sub-Tropical	1.2	1.2
Temperate	2.3	NA

For Black Gram, no producer was found in the sample for Temperate zone in Darjeeling. However, it is seen from Table-10 that there is no effect of state provisions on productivity and that productivity distinctly increases with altitude.

Average productivity of both Radish and Carrot shows a consistent increase with altitude and no differences across states. In addition, Radish is not found to be produced by the survey

households either in Sikkim or in Darjeeling at lower altitudes. This is shown in Tables-11 and Table-12.

Table 11: Average productivity of Radish (Quintal/Acre)

	Sikkim	Darjeeling
Tropical	NA	NA
Sub-Tropical	24.0	24.0
Temperate	29.3	29.3

Table 12: Average productivity of Carrot (Quintal/Acre)

	Sikkim	Darjeeling
Tropical	10.9	10.9
Sub-Tropical	21.9	21.9
Temperate	39.1	39.1

Ginger shows a remarkable consistency of increased productivity with higher altitude both in Darjeeling and Sikkim (Table-13). This can be taken as a robust result as many of the farming households reported its production (number of sample units is fairly large). Again Darjeeling scores over Sikkim in Ginger productivity across all zones. Such results are more convincingly explained by relative abundance of rainfall in Darjeeling hills over Sikkim.

Table 13: Average productivity of Ginger (Quintal/Acre)

	Sikkim	Darjeeling
Tropical	10.8	17.7
Sub-Tropical	21.9	39.2
Temperate	30.5	56.2

Productivity of Broom Grass show different relations with altitude in Sikkim and Darjeeling (Table-14). This might again be attributed to data limitation. However, Darjeeling again

scores over Sikkim across all zones in its productivity. The product being forage crop, this is most probably again a result of higher rainfall in Darjeeling.

Table 14: Average productivity of Broom grass (Quintal/Acre)

	Sikkim	Darjeeling
Tropical	2.25	2.45
Sub-Tropical	2.27	3.46
Temperate	1.74	4.13

Large Cardamom is presently the most remunerative cash crop for this region's farmers, Sikkim scores over Darjeeling (Table-15) in its productivity. In Darjeeling, no sample farmer

Table 15: Average productivity of Large Cardamom (Quintal/Acre)

	Sikkim	Darjeeling
Tropical	0.70	NA
Sub-Tropical	0.69	NA
Temperate	1.05	0.73

has produced it at lower altitudes during last one year. FGDs with local experts identified the reason with some virus attack to this high-value crop that plagued the Darjeeling farmers in recent years. As a result most of them had shifted to ginger. Sikkim remained relatively protected in this respect perhaps due to greater awareness campaigns undertaken by the Sikkim Government. Table-15 also tells us that productivity of Large Cardamom increases with altitude.

6.4 Costs of cultivation and selling prices

To calculate profitability of crops, farm-gate prices of crops and their costs of production has to be known apart from productivity. In the survey, the prices the farmers received for their sales last year were recorded. The average realized prices of different crops have been calculated across altitudes and states. This is described in Table 16. It is seen that low-value crops generally get a lower price at higher altitude perhaps because they are sold to local traders who require incurring a higher transportation cost for their trading. But high value

crops like ginger and cardamom get a better price at higher altitude which might indicate better quality of these products at higher altitudes.

Table 16: Average realized prices per quintal across different zones and state

Crops	Average prices across Agro-Climatic Zones (Rs. Per quintal)					
	Tropical		Sub-Tropical		Temperate	
	Sikkim	Darjeeling	Sikkim	Darjeeling	Sikkim	Darjeeling
Rice	4250	4350	5250	4400	4000	NA
Maize	2000	3000	3000	3000	3000	3000
Black Gram	12000	10000	10000	10000	10000	NA
Radish	3000	NA	3000	3500	2000	1200
Carrot	3000	NA	2500	2000	NA	2500
Ginger	3000	3000	4000	3700	7500	4500
Large Cardamom	80000	NA	107000	NA	117000	124000
Broom Grass	3000	3600	3700	2900	2000	2750

The survey also recorded the different cost components reported by the farmers to produce different crops. It was found that cost of fertilizer and pesticide is almost zero for farmers in Sikkim and Darjeeling. Almost all farmers maintain some livestock (cow, goat, pig) and use the dung as manure.

Ground water is not available and there is no market for irrigation water. Agriculture takes place almost entirely depending on rains and small water channels (*Jhora*). Small rain-water harvesting infrastructure (plastic drums or dug-out small ditches) are seldom found, and is often facilitated by government provisions (free provision of tanks/plastic sheets). Private investment in irrigation, if any, is seen in terms of putting pipelines to draw water from nearby springs/channels. Such investments are permanent in nature and such costs cannot be considered as irrigation cost for a particular crop. So, irrigation cost is also absent or negligible in hills agriculture.

Agricultural machinery (like tractors and harvesters) are also non-viable in hill terrain. So cost of agriculture accounts for seed/sapling costs, cost of bullock for ploughing, cost of labour at different stages and cost of transporting the harvest, if not sold on field.

These cost data has been obtained from each farmer and for each crop. But the major component of it, cost of labour, shows wide dispersion. There are villages where labour was exchanged between households without any monetary transactions. Obviously, many households were using family labour only. In those cases they failed to provide a reliable figure about the labour days they invested as field are adjacent to their homestead land and they couldn't recall the labour hours that were put into different crops.

Such responses made it difficult to compute the imputed cost of labour as well. So, crop wise cultivation costs have been estimated by the actual monetary costs that they farmers have reportedly incurred for different crops. To make the estimates robust, the number of observations against each crop had to be maximized. Also, it was found that such costs are not very different across two states. So, cost estimates had been made taking observations from both states together. Table-17 describes the crop wise costs per acre. To have a better understanding of costs incurred at different stages, costs had been broadly categorized as costs for (i) Land preparation and sowing (ii) Weeding and maintenance and (iii) Harvesting and transport.

Table 17: Total cost and its distribution across major crops

Crop	Total Cost per acre (Rs.)	Percentage distribution of total cost across three major components		
		Sowing &land preparation	Weeding & maintenance	Harvesting and transport
Rice	15380	51	24	25
Maize	12675	41	32	27
Pulses	10070	34	36	30
Radish	13060	50	28	22
Carrot	13188	36	40	24
Ginger	16425	35	35	30

Cost of cardamom could not be reliably estimated because cardamom is a multi-year plant. Different farmers have planted their fields with cardamom at different years and there is no usual longevity of a cardamom field. The whole field may die suddenly due to virus attack. Plantation costs also differ widely due to varied sapling costs. In the State of Sikkim, many farmers were provided parts of their saplings by the state and hence their cost was very low. In presence of these multiple problems of accounting, a reliable cost estimate for cardamom cultivation per unit of land could not be arrived. It requires a much larger sample on cardamom growers and a more detailed investigation to reliably find out the same.

From Table-17, it is observed that ginger requires the highest monetary cost of cultivation per acre among the crops listed, followed by rice. Radish and carrot are also relatively costly to produce. Among these four, only rice is not a cash crop for the hill households. This indicates why rice cultivation among such households is rapidly declining.

6.5 Profitability of crops under study

With the productivity, realized prices and detailed cost information, it was possible to look at the profitability of different crops covered under this study across the three agro-climatic zones. In doing so, short duration crops and perennial crops are separated out because there is a different set of considerations in their choices by farming households. The six crops which are cultivated within one year are compared in terms of their 'profitability per acre'. Such relative profitability of a crop can also vary across climatic zones. Recognizing this possibility, the profitability comparison has been carried out separately for each climatic zone. These are described in the following Tables.

Table 18: Average profitability of different crops in tropical zone (Rs. '000/Acre)

	Sikkim	Darjeeling
Rice	0.425	17.625
Maize	-1.525	28.925
Pulses	-0.725	-0.275
Radish	NA	NA
Carrot	18.2	NA
Ginger	11.1	36.25

Table 19: Average profitability of different crops in sub-tropical zone (Rs. '000/Acre)

	Sikkim	Darjeeling
Rice	7.6	13.11
Maize	0.35	30.75
Pulses	0.75	3
Radish	58.1	72.95
Carrot	40.25	32.3
Ginger	67.5	129.09

Table 20: Average profitability of different crops in temperate zone (Rs. '000/Acre)

	Sikkim	Darjeeling
Rice	24.15	NA
Maize	-4.1	9.05
Pulses	11.5	NA
Radish	43.95	23.36
Carrot	NA	85.5
Ginger	216.7	240.6

It is seen from the Tables (18, 19 and 20) that Ginger is the most profitable among short duration crops across both the states and across all altitudes. This is followed by carrot and radish. Also, farmers in Darjeeling are better placed in earning profit from the listed crops (four out of six) compared to those in Sikkim. This might be partly explained by its location *vis-a-vis* the nearest urban centre (city of Siliguri in West Bengal) implying lesser transportation cost for trading. Also, part of this excess profitability can be explained by lesser labour cost in Darjeeling. Throughout the altitudes, it was found that the labour cost is more in Sikkim compared to Darjeeling. So, especially for labour-intensive crops, farmers in Darjeeling enjoy an edge over their Sikkimese counterpart in profitability. However, a detailed and more robust explanation for such differences calls for a more intensive study on costs and prices.

The Tables also show that profitability improves for most of the crops with altitude. However, for radish and carrot, relative profitability between Darjeeling and Sikkim gets reversed across Sub-tropical and Temperate zones. There is no obvious explanation for this and it needs a closer look. However, overall better profitability in agriculture in Darjeeling over Sikkim is observed over all the Tables. The reasons that are provided for Table-18 also hold for the other two Tables as well.

Table 21: Average profitability of perennial crops (Rs '000/Acre)

	Broom Grass		Large Cardamom	
	Sikkim	Darjeeling	Sikkim	Darjeeling
Tropical	1.6	2.8	50.3	NA
Sub-Tropical	4.0	3.1	64.5	NA
Temperate	1.6	7.4	107.3	80.3

Profitability of large cardamom and broom grass were computed separately as these are perennial crops (Table-21). In doing so, the plantation costs had not been considered for difficulties stated before. So, the profitability was calculated as revenue minus operating cost per acre and per year. Also, the profitability of these two crops are found to be very different. Profitability from Broom Grass cultivation shows a steady increase with altitude in Darjeeling but a confusing relation with altitude in case of Sikkim. This can again be due to insufficient number of its growers in our sample from Sikkim. This result stands for further scrutiny with possibly a larger data set.

Large cardamom, by far is found to be the most profitable agricultural output across all altitudes in Sikkim and Darjeeling. The realized price per quintal is also consistently increasing over time. The reason for all farmers not adapting to this highly profitable crop is that it is a perennial crop which starts its yield at least two years after plantation. Devoting a piece of land to cardamom means parting away with staple food crop that could be grown there for at least two years. Many of the small farmers cannot afford to do so. Also, the high risk associated with it lies in the fact that such plantations get affected by virus attacks against which farmers don't have an effective antidote till date. Against this backdrop, a high

plantation cost and a gestation period of two years proves to be highly costly for poor farm households.

The difference made in state provisions can be seen in case of this high value crop. The Sikkim government is providing seeds and training for expansion in cardamom cultivation in that state. This resulted in a much wider spread of cardamom cultivation in Sikkim. In our sample, all altitude of Sikkim showed cardamom planters but in Darjeeling, it is confined in temperate zone only. Profitability of large cardamom is seen to be consistently rising with altitude. Also, effective marketing and other state support has resulted in higher profitability of cardamom in Sikkim compared to Darjeeling.

6.6 The Labour intensity

In FGDs, it was repeatedly pointed out by the local farmers that the major hindrance to growth of agriculture in hills is the scarcity of labour. With opening up of more communication channels and increasing job opportunities in metropolitan cities in India, younger generation of hill residents is moving away from agriculture. Due to difficult terrain and small plots, extent of mechanization in hill agriculture is still very low. So, machines could not substitute the dwindling size of agricultural labourer force in this region.

In this backdrop and with the available data, it was interesting to look at the relative labour requirement across production of different crops. For a meaningful comparison, the total number of labour-days required has been normalized to 'per-acre' requirement. The number of labour-days per acre includes all stages of operation from sowing and land preparation to maintenance and harvesting.

Table 22: Requirement of labour for different crops (number of man-days per Acre)

	Rice	Maize	Pulses	Radish	Carrot	Ginger
Tropical	68	50	46	62	65	94
Sub-Tropical	82	61	50	62	65	88
Temperate	119	82	50	62	65	93

Table-22 shows the study finding in this regard. It shows that rice, maize and ginger usually requires more labour per acre compared to radish, carrot and pulses. This might be one of the reason why rice production is going down in hills. Maize is also going down, but not that significantly, may be because it requires less of the other scarce input water. Ginger, though relatively labour-intensive, is actually expanding its area because it is a cash crop with high profitability. It is interesting to note that for rice and maize production, the number of labour days per acre is not only larger in absolute terms, but it also increases with altitude. This can additionally explain why rice production in high altitudes is diminishing more rapidly.

6.7 Cropping intensity and household labour availability

The previous analysis indicates that in deciding the crops to produce, one of the factors might be households' own labour availability in absence of a vibrant labour market and little possibility for farm mechanization. It calls for a closer inspection of households' crop-choice and status *vis-a-vis* supply of labour from within the family. For this purpose, the survey households are classified as *small*, *medium* and *large* as described in Table-23.

Table 23: Size definition of households

Number of family members	Size definition	Number of such households in the sample
Less than or equal to 4	Small	84
Between 5 to 7	Medium	175
More than 7	Large	55
	Total=	314

With this classification, using the survey data, percentage of households opting for a certain crop has been estimated irrespective of zones and states. The result shows a remarkable pattern when such percentages are plotted for three types of households against different crops.

Table 24: Percentage of sample HHs producing different crops across HH size

	Rice	Maize	Pulses	Radish	Carrot	Ginger
Small	15	75	20	14	10	52
Medium	30	78	31	7	4	63
Large	31	87	24	11	5	75

Table-24 shows that rice, maize and ginger – the three most labour-intensive crops identified before, are produced by a relatively larger percentage of households with larger size. This is a very interesting finding as it suggests that crop choices are also influenced by the available assured labour supply from within a farming household, apart from its profitability.

6.8 Usage and sources of other inputs

Apart from labour, two other major inputs for agriculture are fertilizer and water. It is already discussed that for hill farmers, fertilizers are almost always bio-fertilizers. Also, promotion of organic farming is being undertaken intensively in eastern Himalayan hills, and especially in Sikkim. However, to empirically validate this phenomenon, the questionnaire had asked each farmer, against all crops, whether they are using chemical or bio-fertilizers. Also, within the bio-fertilizers, there are two varieties. Traditional bio-fertilizer refers to mainly cow-dung and kitchen wastes, which is produced at farmers' home. Modern bio-fertilizer refers to packaged products like vermi-composts which are produced and marketed by different agencies and NGOs. The information on usage of such fertilizers, as was obtained from the respondents, is summarized in the following table.

Table 25: Fertilizer usage across states and zones

Types of fertilizer	No. of instances of use (all crops)					
	Tropical		Sub-Tropical		Temperate	
	Sikkim	Darjeeling	Sikkim	Darjeeling	Sikkim	Darjeeling
No Fertilizer	0	0	4	2	8	0
Fully bio-fertilizer (Traditional)	39	24	241	220	48	62
Fully bio-fertilizer (Modern)	0	0	2	0	0	0
Partially bio-fertilizer	0	0	1	0	0	1
Fully chemical fertilizer	0	0	0	0	0	0
Any other	0	0	0	0	0	0

It is clear that an overwhelming number of households use traditional bio-fertilizer only, irrespective of altitude and state. It can also be stated that intensive state campaigns (done by Sikkim government and not so much by West Bengal governmental through GTA) didn't

result in any significant difference in fertilizer usage pattern. It tells us that state allocation of large funds for promoting bio-fertilizer in hill area is perhaps unnecessary.

Turning to the other important input water, it was already pointed out that there is no canal irrigation and no possibility of lifting groundwater for agricultural use in hill area. The only source of irrigation, apart from rainwater, is small streams that run through the hill slopes. Sometimes such a stream directly passes by a plot of cultivable land and its water can be directly used. But often times, the streams are a bit away. Then the water has to be diverted to the field by putting some blocks in its course. Sometimes this is done by individual efforts and sometimes by collective action by villagers. The survey asked for the use of possible irrigation sources and the information obtained is summarized in the following table.

Table 26: Frequency of different types of irrigation across zones

Types of Irrigation	Tropical		Sub-Tropical		Temperate	
	Sikkim	Drjling	Sikkim	Drjling	Sikkim	Drjling
Only rain water (no irrigation)	32	17	166	191	43	31
Directly from stream	0	1	32	15	11	0
Stream water channelled Collectively	2	3	16	7	0	7
Stream water channelled privately	3	3	18	9	1	24
Any other	2	0	0	0	0	1

The table shows that majority of the hill farmers, across all agro-climatic zones, practice their agriculture depending on rainwater only. However, relatively larger number of farmers uses stream waters in Sub-tropical zone of Sikkim and Temperate zone of Darjeeling. In these cases, some evidence of collective action by farmers is visible as significant numbers of them reported that they collectively use the stream water.

6.9 State support in agriculture

State provisions are supposed to induce and improve agricultural activities through various ways. Apart from providing subsidized inputs, state often provides training and advises to the farmers. In Sikkim, the Department of Agriculture is considered as a major Department and

many schemes for promotion of agriculture and horticulture in the state is in operation. While it is hard to assess their impact on the farmers in a quantitative survey, some aspects of state support could easily be recorded from the possible beneficiaries.

Against different crops produced over last one year, each respondent was asked to provide information on the source of seed/saplings. While most of them are home grown and a lot of them are procured from the market, a significant number of respondents from Sikkim said that they have got it free of cost from the government. Table 27 describes this.

Table 27: Sources of seeds for different crops across states

Source of Seed	Rice		Maize		Black gram		Radish		Carrot		Ginger	
	Skkm	Drjlng	Skkm	Drjlng	Skkm	Drjlng	Skkm	Drjlng	Skkm	Drjlng	Skkm	Drjlng
Home Grown	100	96	85	86	74	90	38	39	20	0	97	80
Market procured	0	0	0	5	20	3	46	50	60	100	2	18
Provided by Govt.	0	0	13	10	2	0	15	0	20	0	0	0
Provided by NGO	0	0	0	3	0	0	0	0	0	0	0	0
Any Other	0	0	1	0	4	0	0	0	0	0	3	0

It seems that in Darjeeling (West Bengal), government only provided some maize seeds, while Sikkim government had provided seeds for many other crops as well. This is a concrete evidence of differential state support that the study has found. In other respects, the study finds that climate is a more significant determinant of agricultural differences than state support programmes across Sikkim and West Bengal.

In previous discussions, it turned out that most of the crops show greater number of cultivars in Darjeeling compared to Sikkim. Table-27 substantiates the fact that a significant number of Sikkimese farmers are receiving free seeds from state agencies. It can be understood that left to themselves, the farmers tend to maintain the diversity of crop varieties. State support might have reduced such diversity in Sikkim.

7. CONCLUSION

This study by AERC (Santiniketan) has tried to fill the information gap and bring to light certain aspects of hill agriculture that cannot be obtained from an aggregative study. Farm level data collected from over three hundred farmers at various altitudes in Sikkim and Darjeeling highlights the following points:

- Agricultural and horticultural crops are found to be mostly confined within 2000 metre altitude. Largest variation in cultivars of crops is seen in the sub-tropical zone (610-1524 Metres).

- Crop cycles vary significantly with altitude. So, it is hard to classify crops by their seasonality according to calendar months.

- This phenomenon is more pronounced in case of crops like radish and carrot which is more sensitive to temperature than rainfall. For crops which are more dependent on rainfall, like rice, seasonality is somewhat maintained. In such cases, altitude difference results in more local cultivar.

- The terrain doesn't allow large land parcels and hence farm mechanization is almost absent in hills. There is no canal or groundwater irrigation facility. In absence of large fields and with little control on irrigation, application of chemical fertilisers is naturally not viable. Modern HYV seeds for staple food crops like rice are also not suitable in hills.

- Though there is a large variety of agricultural and horticultural crops produced by the farming households, farmers are increasingly shifting to high value commercial crops such as large cardamom and ginger.

- There is a severe shortage of agricultural labour in hills area because youth is increasingly moving out to other parts of India and even abroad. In absence of a vibrant market of agricultural labourers in these sparsely populated isolated villages, crop choices are being influenced by the available assured labour supply from within a farming household, apart from its profitability.

- Food crops like rice and maize require more labour and also more prone to wild animal raids. So, farmers are moving away from these food crops, compromising with local food security.

- In spite of better state support to Sikkimese farmers, productivity and profitability of most of the crops is better in Darjeeling compared to Sikkim. This might be the result of better rainfall in Darjeeling and its proximity to the city of Siliguri, nearest trading point in plains.

- State support in Sikkim is being directed towards high value commercial crops like large cardamom and ginger, and hence there is a decline to staple food crops like rice and maize.

- The Govt. of Sikkim is providing reasonable support to its farmers for training, inputs like seeds and saplings and facilitating the marketing of their produce. However, in the process, it might have reduced the diversity of crop varieties. Darjeeling has shown more cultivar varieties of major crops compared to Sikkim.

- Profitability of large cardamom is seen to be consistently rising with altitude. For this crop, effective marketing and other state support has resulted in higher profitability of cardamom in Sikkim compared to Darjeeling.

- Given the nature of very small plots of cultivation and lack of control over irrigation water, crop varieties are almost entirely local. With substantial livestock holding and using livestock waste, home-made bio-fertilizers are invariably used for all types of crops both in Sikkim and Darjeeling hills.

8. POLICY IMPLICATION

Informed policy making for agricultural development of a region calls for detailed insight on local agricultural practices. While there is no dearth of such detailed studies in plains of India, such studies are rarely found for eastern Himalayan hills. Information is available on

hill agriculture at an aggregated level like Blocks or Districts. This study is a recent and unique one that generates farm level understanding of agricultural practices in Eastern Himalayan Hills. In doing so, it comes up with the following points that might be relevant to the policy authority:.

- State support to farmers in Sikkim is being primarily directed towards high value commercial crops like large cardamom and ginger, and hence there is a decline to staple food crops like rice and maize. Such supports may be extended to staple food crops like rice and maize to enhance local food security in Eastern Himalayan Hills.

- The stated objective of Sikkim to make itself hundred percent organic, and the lack of such state efforts in Darjeeling, does not show up in any significant difference in fertilizer use pattern across the two regions. Local geographical constraints in hill area do not support adaptation of modern agricultural inputs and HYV seeds. So, it might be wasteful expenditure to promote organic farming when it is in practice by default. Money spent on awareness building on organic farming might be better used by providing the farmers with tangible agricultural inputs like free distribution of seeds.

- State support is lacking to control the virus attacks that are plaguing farmers for high value crops like large cardamom and ginger. In certain parts of Darjeeling and Sikkim, these profitable horticultural crops had been wiped out due to virus attacks though it was previously produced and was very remunerative. More state sponsored research and technology development for curing this specific crop disease is required.

- Large cardamom is the most remunerative crops among all the crops produced in the hill area of Sikkim and Darjeeling. Since large cardamom takes at least two years after plantation to yield profit, poor farmers cannot devote their land to it as they cannot afford such a long gestation period. To promote this crop to enhance farmers' income, specialized credit facilities should be devised. Special provisions for medium term agricultural credits to poor farmers should be made for large cardamom promotion.

- Crop insurance practice is almost totally absent in hill agriculture. This is primarily due to non-availability of specialized insurance schemes for hill agriculture. Such schemes should be developed through further studies and farmers need to get expert consultancy on crop insurance to promote profitable crops like large cardamom and ginger.

9. NEED FOR FURTHER STUDY

The study admits that it has faced huge challenges in dealing with unconventional measurement units of land as reported by the respondents. The diversity in hill agriculture has sometimes resulted in a small respondent size for a specific crop in a specific zone and in a particular state. This might cast some doubt about the robustness of productivity and profitability estimates that this survey has reported.

However, the study has thrown open the possibility of a detailed study in similar line incorporating a much larger set of crops and farmers. Also, the dynamics of hill agriculture in recent times could not be captured in such one-shot study. There is good scope of revisiting these same farm households at regular intervals so that relatively more 'successful' farming practices and the factors enabling them can be filtered out. This is specially important in light of the recently announced resolve of the Government of India of "Doubling Farmers' income by 2022". So, more detailed farm-level studies at regular intervals in Eastern Himalayan Hills remain open as a future research agenda - both for AERC (Santiniketan) and for any other interested agency.

ANNEXURE-1

Comments Received on the Draft Report Submitted in May, 2016

1. Name of the study under Review **"A Study on Productivity and Profitability in Agriculture and Horticulture in Eastern Himalayan Region"**

2. Date of Dispatch of the draft study : 26/05/2016
3. Date of Receipt of the study : 02/08/2016
4. Date of Dispatch of the Comments : 06/08/2016
5. Comments on objectives of the study : It is well designed in respect of problems.
6. Comments on Methodology of the study : It is well persued.
7. Comments on the Study Findings :
   i. Productivity of crops has been presented in figures *(1-8)* only. It should be presented in tables also.
   ii. The analysis under section 6.4 *(cost of cultivation and selling prices),* selling prices has been shown in earlier paragraphs whereas it should be placed in later paragraphs.
   iii. Profitability of crops under study *(section 6.5),* analysis of data has been made with the help of figures *(9 to 13)* only. Tabular presentation of data may be added for better understanding of the analysis.
   iv. In section 6.6 *(The Labour Intensity),* tabular presentations of the data may also be incorporated.
   v. Figure 15 *(page No. 26),* tabular presentation of the data may be made.
   vi. Table No. 13 is missing in the report. It may be incorporated.
   vii. In section 7 *(Conclusion and Policy Implications),* only 2 or 3 policy implications are given under last two bullet points. Policy implications may be separate by given with policy attention.
8. Overall View
   i. Since Ministry sponsors the study for policy feedback, which the present study has highlighted adequately. Policy prescriptions should be more specific.
   ii. In view of desirability of further study on the theme, it would be better to mention such things in a separate section for catching the attention of the Ministry and others.

Finally, the report may be accepted with suggested modifications.

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Actions Taken on the Above Comments

Comments (i), (iii), (iv) and (v) has reasonably asked for explicitly providing the numbers in tabular form instead of indicating them in figures. The point is well received and all the figures have been replaced by tables in this revised version. In presence of tables, the figures would have been redundant and hence have been omitted. The references to those figures in the text have been changed to the corresponding tables.

Comment (ii) was a result of composing difficulties as that paragraph was placed before to accommodate a figure without breaking across pages. It is rectified now.

Comment (vi) was a result of an inadvertent typographical mistake in the earlier version. There was no 'Table-13'. Instead it was intended to refer to 'Table-12' in that version. It is rectified now.

Comment (vii) has been addressed by breaking the 'Conclusion and Policy Implication' section into two different parts, and incorporating the 'Need for Further Study' Section.

APPENDIX

A1: Justification for choice of crops covered in this study

The financial resources and time allocation for this study didn't allow it to cover all the agricultural and horticulture crops that are produced in hills for a detailed inspection. Accordingly, few of them have been focused on depending upon their relative importance and abundance in the region. They are selected from the categories of cereals, pulses, spices, vegetables and forage.

The available information on production and productivity of cereals in Sikkim (ENVIS Centre: Sikkim, *Status of Environment and Related Issues*[6]) suggests that Maize and Rice are the two leading cereals according to area, production and productivity in Sikkim. Turning to Darjeeling, it is seen that by area, production and productivity, Maize is the leading cereal followed by Rice (Darjeeling District Statistical Handbook, 2004). So these two field crops are considered under this study. Going by local agriculture experts and FGDs, the only common crop under Pulses that is cultivated widely both in Sikkim and Darjeeling is identified as Black Gram (also known as Maskalai or Urad). This is included for this study consideration.

Among Spices, for which the eastern Himalayan hills are famous, the most valuable crops are Large Cardamom and Ginger. These are identified by available average domestic price in different markets for the year 2014-2015[7]. Both of these spices are produced in all altitudes in Sikkim and Darjeeling. So these two crops are included in the study.

Vegetables are of many varieties and this study did not have scope to cover them all. Through FGDs it came out that among the vegetables that are commonly grown in hills, maturity period is very short for Radish and is quite long for Carrot. This is also supported from some web resources[8]. Also, these crops are more sensitive to temperature and show a greater variability in growing season (calendar month) across altitude. One of the objectives of this study was to look at such effects of altitude to sowing time and harvesting time of crops. So, these two vegetables have been included in the study.

FGDs also suggested that Broom Grass, which can be categorized as *Forage*, has become a widely cultivated cash crop for almost all climatic zones in hills and across states. This has also been included in this study.

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[6] http://www.sikenvis.nic.in/Database/Agriculture_777.aspx

[7] http://www.indianspices.com

[8] : https://www.mastergardeners.org/publications/plantingYourVegGarden.html
http://www.burpee.com/vegetables/eggplants/

A2: List of Selected Villages and Gram Panchayets in the study:

Zone (Altitude)	Sikkim			Darjeeling (West Bengal)	
	Dist.	**GP**	**Village**	**GP**	**Village**
Tropical (Below 610 Metre)	West	Chumbung	Chakung	Goke-1	Kamjer
		Soreng	Malbasey		Lower Goke
	East	Patuk Singbel	Patuk	Takling-1	Bara Mangwa
			Nakha 10 mile		
Sub-tropical (610-1524 metre)	West	Chumbung	Chakung	Goke-1	Upper Goke
		Gyezing	8th mile		Upper Goke
		Samsing	Sawali Gaon		Lower Takbia
		Todong-Rinchenpong	Lower Rinchenpong		Upper Takbia
	East	Aho-Yangtam	Lower Aho		Lower Rangdu
			Tinghara		Upper Rangdu
			Yangtam	Lamahatta	Lower Lamahatta
		Budang Kamase	Pachak		Dukpa gaon
		Namli	Radang	Lodhoma-1	Upper Bansbotey
		Patuk Singbel	Patuk		Upper Linseybong
		Radong-Timtek	Marchak	Relling	Gumba Taar
	South	Poklok-Denchung	Samsabong		Lamagaon
		Poklok-Danhang	Sanatar		Samsu
					Lower Samsu
					Relling
					Thapa Gaon
					Upper Relling
				Takling-1	Bara Mangwa
					Chhota mangwa
					Takling
					Middle Takling
					Upper Takling
				Takling-2	Chegra
					Kolbong
					Soreng
Temperate (1574 – 2743 metre)	West	Arigaun-Chonzong	Arigaun-Chonzong	Lamahatta	Dukpa Gaon
					Sherpa Gaon
		Begha mangmoo	Begha		Yoluo Gaon
			Mangmoo	Lodhoma 1	Upper Bansbotey
			Upper mangmoo		Upper Linseybong
	South	Rangang-yangang	Upper yangang	Relling	Gumba Taar
		Sripatam Geyong	Menglee		Lamagaon
					Upper Relling
				Takling-1	Choota Mangwa
				Takling-2	Kolbong

* some villages are reported against more than one altitude zones as they are extended vertically and crossed over to two such adjacent zones.