# FOOD SECURITY AND MILLET CULTIVATION

## IN THE KUMAON REGION OF UTTARAKHAND

Research Report for Gene Campaign

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# INTRODUCTION

The present report concerns a study that was carried out between November 2011 and February 2012 to assess the situation regarding millet cultivation and food security in three districts of the Kumaon region of Uttarakhand, India. The study was conducted at the initiative of Gene Campaign, a research and advocacy organization that works for the conservation of genetic diversity as a way to ensure the sustainability of food systems.

Within the context of climate change and increased socio-economic pressures on our natural resources, the future holds big uncertainties regarding the ability to produce enough food to feed the human population. At the same time, the equitable distribution of resources remains an unsolved issue. Unfortunately, it is often the case that the poorest of the planet are also the most vulnerable in times of crises.

In order to ensure food and livelihood security for vulnerable farming communities, Gene Campaign's actions are aimed at enabling the development of local agro-food systems that build on traditional knowledge and which use crop species that are well suited to the local conditions. Uttarakhand is one of the areas where Gene Campaign is active.

The following pages summarize the main findings from the field regarding current agricultural and food practices in Uttarakhand, as well as the theoretical and methodological considerations surrounding this study.

# CHAPTER 1: THEORETICAL BACKGROUND

## MACRO-TRENDS

Against the background of an unprecedented growth of the human population combined with increasing environmental pressures and competitive land use, concerns are being raised about our ability to produce enough food for everyone in the coming decades. Furthermore, food distribution and equity issues are raised, as even today, when we are living in a world of relative abundance, an estimated number of 850 million people are undernourished or chronically hungry (FAO 2008). Price volatility, higher commodity prices and an increasingly inelastic demand in the rich world further expose the poor to food insecurity and malnutrition risks (OECD-FAO 2011).

Regarding future demand and production, several factors might play a limiting role in the ability to further extend or intensify agriculture. Firstly, climate change, water scarcity and the negative feedback between the two will lead to a decline in agricultural capacity: under the business-as-usual scenario, this could mean a fall of as much as 40% for India (Cline 2007). In addition, concerns are raised over the implications of the energy and credit crises (Hanjra and Qureshi 2010). While high commodity prices provide an incentive for investments in the agricultural sector, the unavailability of financial capital, together with the increasing costs of production provide for a global projected growth of this sector of only 1.7% annually, in the coming decade (OECD-FAO 2011).

Secondly, producing more food in a sustainable manner will require yield increases, but also more land. With part of the current arable land and food crops now being diverted to biofuel production, the projected expansion with 13% by 2030 in developing countries (120 million ha) will probably account for significant deforestation (FAO 2003). It is also expected that by 2020, 13% of the global coarse grain production, 15% of vegetable oil and 30% of the sugar cane production will be used for biofuels (OECD-FAO 2011). As far as yield increases are concerned, a significant role needs to be played by developing irrigation systems in current rainfed areas (FAO 2003). However, there might not be enough water in the future to meet such demands – it is now believed that water scarcity, and not the availability of land, will be the major constraint for increasing food production (UNDP 2007).

In the face of all these challenges, it is the poor of the rural world that are most at risk. At the macro-level, the dependency of developing countries on food imports exposes the population to high price volatility. While in the developed world consumer demand will not be highly affected by an increase in price (OECD-FAO 2011), in other regions even the slightest variation might make the difference between sufficiency and starvation. The fact that the southern regions of the globe, where most vulnerable groups reside, are also the ones that will experience most seriously the effects of climate change, such as heat stress and droughts, further adds to the inequity of the situation.

In the next sections, we will look more in-depth at what vulnerability and food security entail, as well as at the relationship between the two concepts. Then, we extend this discussion for the situation in Uttarakhand and discuss the contribution that millet cultivation might have to enhancing food security in the region.

## VULNERABILITY

With respect to the trends and challenges presented above, the concept of *vulnerability* is often used to assess the extent to which people could be affected by sudden changes in the environment. Originally an extension of risk analysis (especially for natural hazards), there has been recently an increasing understanding that human vulnerability should be studied in an integrated manner, where the natural and human environments are seen as strongly interrelated.

Most models of **vulnerability** distinguish three main comprising elements, with *resilience* being one of them, along with *exposure* (threat) and *sensitivity* (Turner et al. 2003). Starting from a definition by Chambers (1989 qtd. in Bohle et al. 1994), Bohle et al. (1994, p. 38) specify vulnerability as a function of:

- *"Risk of exposure to crises, stress and shocks;*
- *Risk of inadequate capacities to cope with stress, crises and shocks (which implicitly subsumes timely and effective external interventions);*
- *Risk of severe consequences of, and the attendant risks of slow or limited recovery from crises, risk and shocks."*

In opposition to the concept of vulnerability, as solutions or ways to reduce the risks involved, the concepts of resilience, adaptation, and coping are also brought into discussion.

**Resilience** refers to the intrinsic ability of a system to withstand and recover from shocks. Whether the concept is applied to ecosystems or integrated socio-ecological systems, the Resilience Alliance (2002) distinguishes three defining characteristics:

1) *"The amount of change the system can undergo and still retain the same controls on function and structure;*
2) *The degree to which the system is capable of self-organization;*
3) *The ability to build and increase the capacity for learning and adaptation."*

**Adaptation** refers to the ability of a system to change in order to develop resilience. This concept has been particularly studied in relation to the issue of climate change and it concerns a process, not an outcome. For instance, the IPCC (2007, p.750) defines adaptation as an "adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities."

In practice, adaptation strategies employed in developing countries cover a full spectrum of activities, from generally addressing the drivers of vulnerability – by reducing poverty, for example – to specifically managing or confronting certain risk – e.g. by planning disaster response in anticipation of climate change effects (WRI 2007).

Lastly, **coping** is reactive in nature and refers to the ways in which individuals or communities respond to stresses from the environment.

Vulnerability is a central approach in food security studies analyses. It provides the avenues to assess risks in an integrative manner, looking beyond the simple availability or unavailability of food at a

certain moment in time. In a further section, the relationship between vulnerability and food security is presented in more detail.

## Food Security

But what does being food secure mean?

The United Nations defines food security as a state where both the *availability* and *accessibility* of food are ensured (UN 2008), which means that there should be enough food to cover the demand and that people can afford to buy it. At the consumer's end, food *utilization* (sometimes also referred to as "consumption") is also a key element. Bringing in this latter aspect, USAID, the United States' foreign assistance agency employs the following definition:

> *"When all people at all times have both physical and economic access to sufficient food to meet their dietary needs for a productive and healthy life."* (USAID 1995, p.7)

Food utilization is here understood as dealing not only with meeting the necessary dietary needs, but also with the availability of potable water and adequate sanitation (USAID 1995).

When it comes to assessing food security, practitioners and scientists alike recommend developing indicators which are particularly suited to the situation at hand. Within the context of this study, the definition above was extended with elements of vulnerability, so as to address also the long-term sustainability of the agro-food systems in Uttarakhand (see Chapter 2).

## Food Security and Vulnerability

When talking about the relationship between food security and vulnerability, the main question is how to tackle hunger now and in the future? In other words, how can vulnerability be assessed and tackled so that present and future generations will have sufficient food to meet their needs.

To answer this question, one needs to look first at the causal structure of hunger and famine – where does the problem come from? Watts and Bohle (1993) propose a trilateral causal structure, where the space of vulnerability is to be found at the intersection of human ecology, political economy and expanded entitlements. Without going into the details of this model, their view should be retained that economic capability, class power and property relations embedded within a certain socio-economic environment are essential in determining whether a certain individual or community runs the risk of being exposed to hunger or not. Their theoretical framework brings to attention not only the problems of resource allocation and entitlements within an economy, but also issues of politics between and within different groups, including, for instance, gender discrimination. It also allows for a methodical identification of those who are vulnerable (Watts and Bohle 1993).

Other researchers have also stressed the fact that country-level data and macro-indicators of food security might not reveal those groups that are most at risk. Sahn (1998), for example, talks about individual food intake differences at the household level and across seasons. In fact, he considers seasonal patterns and fluctuations in food availability as a major, yet often ignored, contributor to poverty and chronic food insecurity (Sahn 1998). This observation is also aligned with a recent report of the United Nations that states that despite overall increases in total food production and income in developing countries, the percentage of people who are hungry has stagnated at 16% in recent

years (UN 2011). This disconnection between poverty alleviation and hunger has prompted the FAO to rethink its methods for assessing undernourishment. No hunger statistics have been published by FAO since 2009 and the release of a new framework is still expected (FAO 2012).

At the household level, food security could be defined as “adequate access to enough food to supply the energy needed for all family members to live healthy, active and productive lives." (Sahn 1998, p.3). However, when it comes to measuring food security and consumption deprivation at the micro-level, we enter significantly controversial territory. Furthermore, the seasonal dimensions of food availability and accessibility make it a very complex task to understand who the hungry are, what feedback loops they are caught in and what possible leverage points could there be.

In general, enhancing the overall resilience of the system, by enabling households to shift strategies according to circumstances, could be a way to break the poverty cycle. A socio-ecological environment that is adaptive, modular and leaves as many options open as possible seems to be a sound strategy for dealing with future uncertainties. However, the details of what such a system might entail depend on the worldview of the proponent.

To tackle food security, some people might advocate further liberalization of trade or increased investments in technological advancements, while others might suggest pursuing small-scale self-sufficiency. If sustainability is to be found by integrating different value systems (van Egmond and de Vries 2011), then steps in each direction might be necessary. One integrated strategy for food security would then aim at: strengthening local agro-food systems, increasing ecosystem resilience, building institutions that embrace change, experimentation and learning, empowering communities by providing gateway options, etc.

It is within such a scenario that regenerating traditional crops would also appear as a possibly good approach for ensuring food security in Uttarakhand. In India, and especially in the studied region, millets have been cultivated for millennia, but have recently started to be abandoned in favour of other crops. The properties of these pseudo-cereals, as well as their potential for increasing resilience will be explored in a later section.

## Assessing Food Security at the Household Level

There are two key elements when it comes to assessing food security at the household level: first, the overall access to food of the family; and second, intra-household food distribution (Sahn 1998).

To begin with, there is a lot of debate on what “enough” food might mean, both for the family and for the individual. This is strongly related to the food utilization aspect and the concept of consumption deprivation. There are two main views that theoreticians of nutritional adequacy are debating: the “genetic potential” model and the “adaptability” model (Payne 1998). The issue at stake here is the extent to which changes in metabolism in response to food intake can be seen as adaptive or pathological. The genetic potential model assumes that for each individual there is a preferred state of the functional variables and that malnourishment is a deviation from these values. Using body measurements as indicators of malnutrition in children stems from this view. The adaptability model states that it is not possible to make inferences about malnutrition based on such indicators, because individual’s genes also determine his adaptation capabilities. Thus,

> *"differences in body size among children […] from different socioeconomic environments are to be interpreted in the first place as indicators of the overall effects of those environments, since they show how much adaptive adjustment has been made by individuals living in them." (Payne 1998, p. 24)*

In addition to individual differences, the demand for nutrient intake is also seasonal (Behrman and Deolalikar 1998). Without entering into the finer details, one of the implications of these theories is that any assessment of food security based on body measurements can only tell the story of an individual relatively to his or her community and that caution is necessary when interpreting the results or trying to extrapolate them to larger groups.

In practice, within developing countries, *cereal consumption* is often used as an indicator for food deprivation, as cereals are the staple food of the poor and cereal expenditure accounts for more than one third of the total household budget (Kumar et al. 2009). Since income usually fluctuates for the poor, *total expenditure of the household* is also considered a good proxy for measuring poverty and access to food (Kumar et al. 2009). However, these measures only provide an image of the general level of food accessibility of a family, without giving an insight into the cultural dynamics of food utilization and intrahousehold distribution

For more refined analyses, food intake surveys are sometimes utilized, along with assessments of nutritional outcomes (based on weight and height), and qualitative "self-assessments" (FAO 2002). Nevertheless, these methods, too, have their limitations when it comes to revealing the link between poverty, hunger and malnutrition. What being food secure might mean for a household, and especially for an individual, remains a difficult question to answer. New developments in this field stress that hunger is not only a biological, but also a social problem, as "people who lack the means to acquire sufficient food may regard themselves as hungry, even if there are no clinically recognizable signs of undernutrition." (FAO 2002).

## The Potential Contribution of Millets to Food Security in Uttarakhand

Assessing millet cultivation in Uttarakhand was one of the mandates of this study, justified by the fact that millets could contribute to enhancing food security in the region. In the following sections, the potential of millets to enhancing the resilience of the socio-ecological system in Uttarakhand is being discussed. First, we explain what millets are and then explore some of the arguments in favour of maintaining these traditional crops as part of a sustainable food system.

### What are Millets?

Millets are small cereals (pseudo-cereals) that have been cultivated in Eastern Asia for the last 10.000 years. They appear as grass crops whose seeds or straws are harvested for food or animal feed, and have been long valued for their versatility and nutritional properties. The ancient Chinese, for instance, considered millets to be sacred crops. In Europe, foxtail millet was traditionally grown as a summer crop until the 17$^{th}$ century. Nowadays it is only cultivated in small quantities, mostly for bird feed (Panaud 2006).

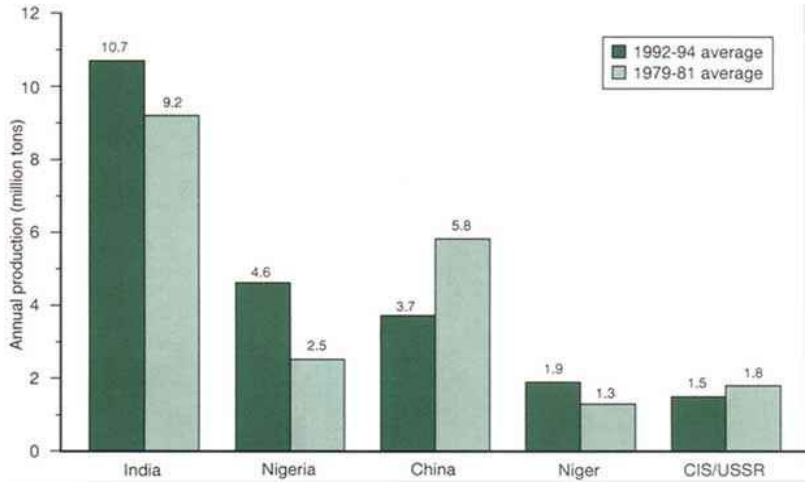


**FIGURE 1. THE WORLD'S MAJOR MILLET PRODUCERS; SOURCE: FAO AND ICRISAT 1996**

Globally, the most cultivated species are pearl millet, finger millet, proso millet and foxtail millet, with India being one of the worlds' major producers today (see Figure 1).

In India, millets are usually grown under rainfed conditions, with the following eight species being predominant: sorghum, finger millet, pearl millet, foxtail millet, barnyard millet, proso millet, kodo millet and little millet (FAO and ICRISAT 1996). Table 1 gives an overview of the main types of crops that have been traditionally grown in Uttarakhand and their corresponding local names.

**TABLE 1. SPECIES OF MILLETS AND CORRESPONDING NAMES IN UTTARAKHAND**

| No. | English name | Species | Local name(s) |
|---|---|---|---|
| 1. | Finger millet | Eleusine coracana | **Madua**/Koda/Mandua/Ragi |
| 2. | Barnyard millet | Echinochloa frumentacea | **Maadira**/Jhangora/Sawa |
| 3. | Proso millet | Panicum miliaceum | **Cheena** |
| 4. | Foxtail millet | Setaria italic | **Kauni** |
| 5. | Amaranth | Amaranthus caudatus | **Chua**/Marsu |
| 6. | Buckwheat | Fagopyrum esculentum | **Ugul** (grains and vegetable) |
| | | Fagopyrum tataricum | **Phaper** (straw) **/ Kutu** (grain) |
| | | Fagopyrum cymosun (wild) | |

In recent times, millets have come to be gradually replaced by other crops, mostly wheat and rice, due to a variety of practical, economic and cultural reasons. The success of wheat over millets could also be attributed to the fact that the former can be used for raised bread. By comparison to rice, millets have a harder texture, making them difficult to dehusk and cook. Moreover, millets are often perceived as food for the poor or the ill (Dida and Devos 2006).

### ARGUMENTS FOR MILLET CULTIVATION

While millets might have decreased in popularity in the past decades, there are many arguments for the (continuation of) cultivation of millets, especially in the advent of environmental stresses that might lead to a future food crisis.

#### Historical versatility

The historical argument is that millets have been successfully cultivated for millennia, which could indicate both their resilience to a variety of conditions, but also some intrinsic qualities that deserved

the appreciation of so many generations. We know, for instance, that finger millet is adapted to a wide range of climates, soils, and altitudes. It can be found in tropical soils by the sea, as well as in the drylands at over 2000m in the Himalayas (Dida and Devos 2006).

**Resilience in difficult environments**

The fact that millet cultivation stood the test of time over centuries can be attributed to the fact that they are well suited to difficult production environments. As they require little water, millets are particularly adapted to regions of low moisture and difficult soils, as it is the case in the drier climates of Northern India. Their deep root systems and short life cycles make it possible for millets to grow in places where the mean annual precipitation is as low as 300mm (Panaud 2006). Rrequiring on average 60 days to reach maturation after planting, millets can be used as "catch crops", where other crops have failed.

The fact that they are annual grasses, self-pollinated, and require almost no maintenance, is also an advantage for hilly regions and terrace cultivation. Their chemical and physical properties make millets quite resistant to pests and diseases and little input during growth is necessary (FAO and ICRISAT 1996).

**Nutritional properties and health benefits**

When it comes to nutrition, not only have millets been shown to be rich in protein, but they are also valued for their high content of vitamin B, folic acid, phosphorus, iron and potassium. Finger millet contains 16 times more calcium than maize and, in fact, it is believed that its replacement with rice as a staple food has had serious health implications, leading to widespread anaemia (Dida and Devos 2006).

In addition, millets are gluten-free, easy to digest and suitable for special diets, such as those associated to wheat intolerance, stomach ulcers or high cholesterol levels. Although there is little research in this area, it appears that millets are a great source of antioxidants and might have anti-carcinogenic properties (Dykes and Rooney 2006). Millets can thus provide a wide variety of nutrients where dietary diversity is problematic.

**Long storage**

For regions that are economically weak and where there is little potential for investment in storage facilities, millets present the advantage of preserving very well, without necessitating special conditions. In particular finger millet is very resistant to grain mould and insect attack, a property that can be most probably attributed to the presence of tannins (McDonough et al. 1986). This provides vulnerable farmers with a certain amount of food security where income or access to other staple foods might be unstable.

**Economic potential**

As a driver for economic development, millets can also provide an opportunity for profit from niche markets. As Taylor et al. (2006) suggest, millet-based foods and beverages are well-suited to respond to an increasing demand for gluten-free foods. Lastly, preliminary studies show that pearl millet might be interesting in the future for ethanol production (Wu et al. 2006 qtd. in Taylor et al. 2006).

The above-outlined reasons offer a basis for reflection on the potential contribution of millets to food security. In recent years there has been a revived interest in millet cultivation and consumption.

In India, the government is setting in place an Initiative for Nutritional Security through Intensive Millet Promotion (INSIMP), while in the developed world amaranth and other ancient grains have appeared on the shelves of specialized shops. However the properties of millets and their potential for agriculture and nutrition remain largely unresearched.

# CHAPTER 2: ASSESSING FOOD SECURITY AND MILLET CULTIVATION IN UTTARAKHAND

After having depicted the larger context surrounding the issues of food security and millet cultivation, we will now explain in further detail the purpose and methodology of our research. The present study was conducted in three districts of Uttarakhand, and it aimed to collect first-hand information about the situation on the ground with respect to the status of millet agriculture and food security at the household level.

This research was meant to support the work of Gene Campaign in both its advocating activities and immediate intervention programmes. More specifically, it provided a basis for choosing priorities and defining future strategies for improving the livelihoods of the people in Uttarakhand.

## RESEARCH QUESTIONS

With this mandate in mind, the following two research questions were proposed by Gene Campaign:

1. To what extent is there food insecurity in Uttarakhand and what are the key factors influencing the availability, accessibility and utilization of food?
    - Focus on Nainital, Almora and Bageshwar districts
2. To what extent are millets still being cultivated in Uttarakhand and what are the key determining factors of the decision on whether to grow these crops or not?
    - Focus on varieties being cultivated

## RESEARCH FRAMEWORK

The research project consisted of four phases:

- Desk study – literature review, system analysis;
- Developing the conceptual model – including a set of indicators that served as a basis for constructing the questionnaires;
- Data collection
    - → Field data: 50 interviews were carried out in 15 villages across 3 different districts;
    - → Documents: information about the region and context from official governmental sources;
- Data analysis – qualitative analysis of field data and triangulation with information from other sources.

In practice, there was an iterative process, where the conceptual model was consistently refined based on new information acquired from the field. Up to a certain point, the methodology was also adjusted based on inputs from key informants, especially with regards to relevant site selection. Figure 2 schematically depicts this process.

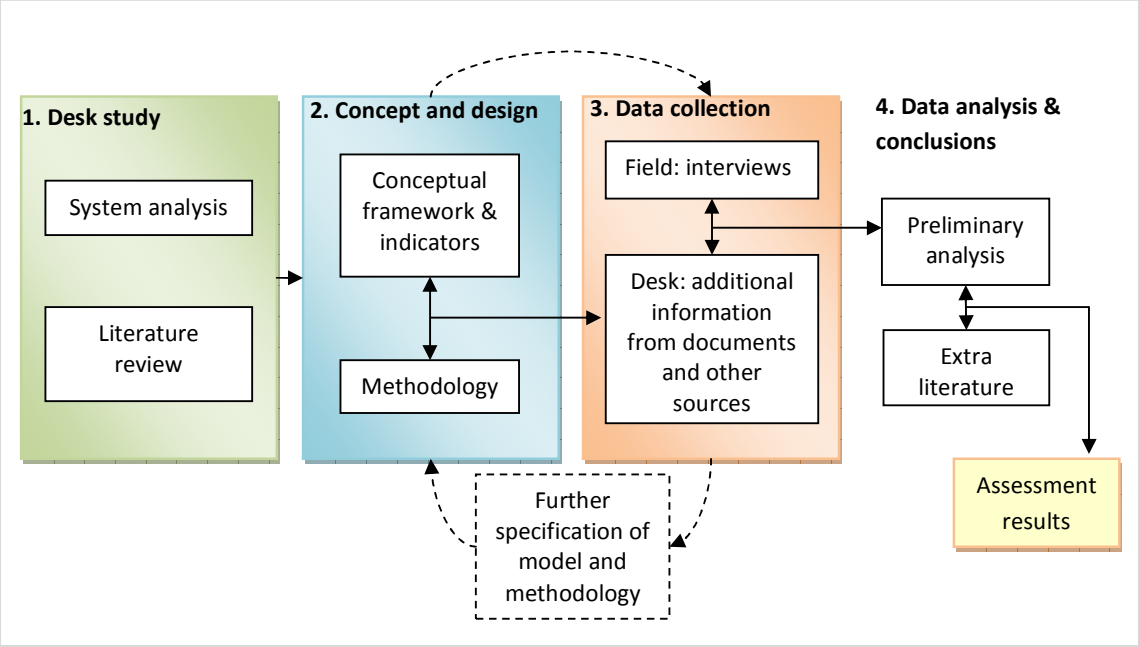


**FIGURE 2. RESEARCH FRAMEWORK**

Firstly, we reviewed the general literature on food security and best practices for gathering information at household level in developing countries. To understand more about millet cultivation in Uttarakhand, the archive of the VPKAS reports (the governmental research centre for agriculture in Almora) was consulted, as well as at reports written by local NGOs and researchers. Not all of these articles had been published in peer-reviewed journals, and since access to other sources was very limited during that stage, it was not possible to come up in advance with relevant hypotheses to be tested in the field. However, this was not a problem in itself, as one of the secondary purposes of this research project was to outline directions for future studies, especially given the scarcity of scientific content that addressed food security in that particular region.

In order to overcome the available information, a grounded theory approach was used, where an initial conceptual framework was consistently revised based on early interpretations of the data from the field. As the first step in building this model, we employed previous personal knowledge and the initial literature data to sketch a causal loop diagram of the food system. Next, for each aspect of the research, food security, on one hand, and millet cultivation, on the other, a list of 'themes' and relevant indicators was generated. Before starting the actual data collection, experienced researchers and practitioners from the region were consulted for feedback and advice on any possible gaps in the issues addressed. A questionnaire was then built to explore farmer's perceptions and, where possible, the information provided by them was triangulated with data from other sources and across interviews.

At the same time, throughout the study period, any new relevant elements that were observed were noted to be used later in the interpretation of the data – e.g. lessons from the presentations of some interns about micro-credits, gender discrimination, the importance of middlemen etc. This procedure aimed at addressing Blumer's critique that indicators emphasize what is common, while running the risk of overseeing what is particular (1954, qtd. in Bryman 2008, p.373). This also meant that during

the data analysis stage it was essential to go back to academic literature to critically interpret the preliminary findings in relation to the state of the art knowledge.

## Developing an assessment framework and Questionnaire

### System Analysis

In the construction of the causal loop diagram presented in Figure 3, variables from the environmental, economic and social spheres were considered. Since the population in Uttarakhand consisted mainly of subsistence farmers, the departing unit of analysis was the household, expressed as stocks of food produced on the farm, food available in the house (or at the community level) and the food consumed by the people in their households. The initial diagram was subsequently revised based on new inputs from the local environment.

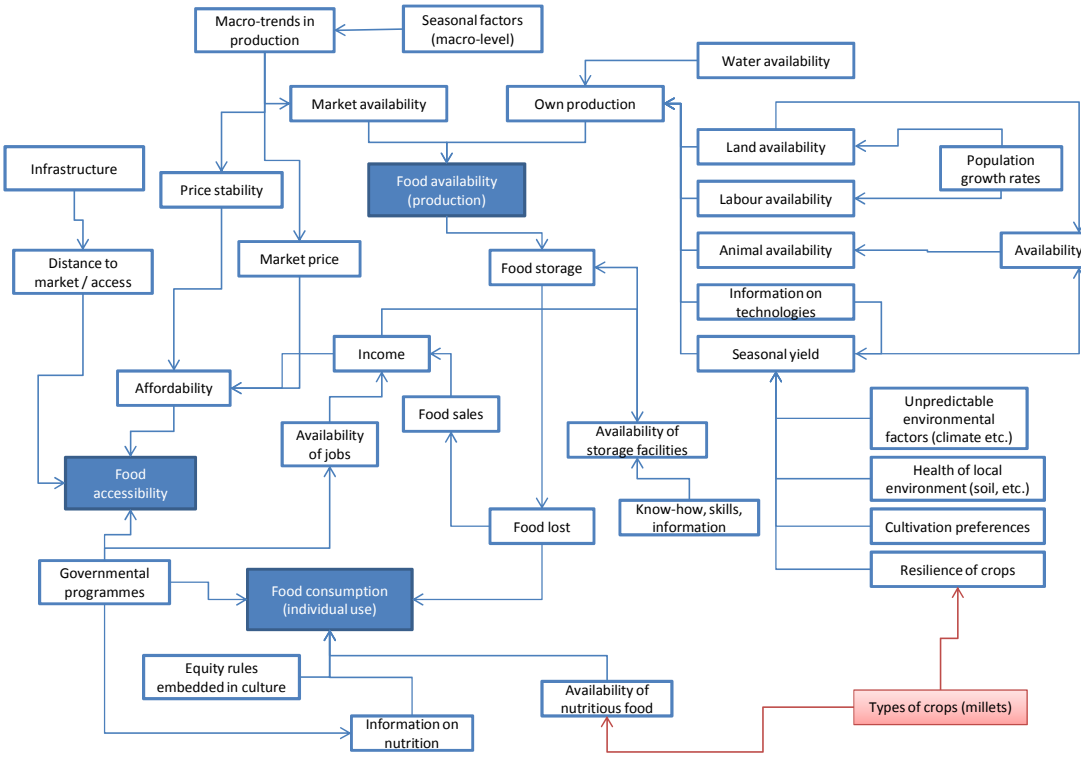


**FIGURE 3. CAUSAL LOOP DIAGRAM**

While in a first phase a comprehensive picture of the food security issue was painted, when constructing the indicators the focus was particularly on those factors or conditions that appeared to have the most links. The following elements were selected as key to an assessment of food security in the region:

- **sources** of food available in the household;
  - → to what extent does the food available in the household come from own production and to what extent is there reliance on an external market or other sources (e.g. governmental aid, exchanges with other community members etc.)?
- **limiting factors** for the availability of food in household;

→ what are the bottlenecks that affect the total amount of food available in the household? Are there problems with the production or acquisition of food from the market?

- **limiting factors** in the conversion of total food in the household into food available for consumption;
  → how are allocation decisions taken at the level of the household? To what extent is the food available being stored for later consumption or converted into cash?
- **limiting factors** for the productivity rate / **changes** in productivity rate;
  → which variables are most responsible for current productivity, how have these changed during the past 10-20 years and why?
- **limiting factors** for food utilization at the individual level;
  → to what extent do individual family members meet their nutritional requirements and what socio-economic or cultural factors might prevent them from doing so?
- **flow** of nutrients in soil;
  → which agricultural practices are in use and how do they affect the flow of nutrients in soil and, consequently, the productivity rate?
- **sources** of income;
  → to what extent do sources of income matter for food sufficiency at the level of the household and what are the opportunities for ensuring a stable income?

### FOOD SECURITY - INDICATOR LIST

Starting from the definition of food security and on the basis of the system analysis a list of indicators was constructed (see Table 2). These covered the three main components of availability, accessibility and utilization, but also the long-term sustainability of the agro-food system. The scale of the analysis was thus extended beyond the micro-level, within a village, or a household, to the general patterns and trends in the region that might affect livelihoods in the future.

**TABLE 2. FOOD SECURITY INDICATORS**

| Category | Indicators (broken down) | | |
|---|---|---|---|
| Food availability | Supply covers demand | Source of food | |
| | | Extent of market reliance | Amount of food purchased |
| | | | Types of food |
| | | | Availability of specific foods |
| | | | Source of food from the market |
| | | | Monetary expenditure |
| | Stability of supply | Seasonal availability | |
| | | Seasonal reserves | |
| | Long-term availability of self-grown food | Changes in production | Cultivated area |
| | | | Types of crops |
| | | Changes in yield | |
| | | Storage facilities | |
| | Livestock ownership | | |
| | Extent of food anxiety | | |
| Food accessibility | Market prices | Staple food affordability | |
| | | Seed affordability | |
| | Market access | Distance | |
| | | Infrastructure | |
| | | Frequency | |
| | Governmental aid | Availability of programmes | |
| | | Participation | |
| | | Efficiency of programmes | |
| Food utilization (consumption) | Nutritional adequacy | Types of food eaten | |
| | | Amount | |
| | | Gender issues | |
| | | Child nutrition | Malnutrition cases |
| | | | Infant food |

| | | | |
|---|---|---|---|
| | | | Changes in customs |
| | Fit with local preferences | | |

| | | | |
|---|---|---|---|
| Sustainability | Economic | Price stability | |
| | | Diversity of income sources | |
| | Social | Trends in population | |
| | | Changes in preferences | |
| | | Gender issues | |
| | | Coping strategies | |
| | Environmental | Agricultural practices | Crop rotation |
| | | | Fertilization |
| | | | Pest management |
| | | | Technological improvements |
| | | Soil status | Current situation |
| | | | Management |
| | | Water availability | Current situation |
| | | | Water management |

## MILLET CULTIVATION - INDICATOR LIST

A second indicator list was constructed in order to collect data on millet cultivation, including change over time. This was based on previous desk study and refined in consultation with local experts. Table 3 presents the themes that were used in the construction of the questionnaire.

**TABLE 3. INDICATORS USED IN ASSESSING MILLET CULTIVATION AND USE**

| Category | Indicators (broken down) | | |
|---|---|---|---|
| **Cultivation** | Types and varieties of millets grown | | |
| | Amount | | |
| | Purpose | | |
| | Agricultural methods | Local practices | |
| | | Technology availability | |
| | | Source of seeds | |
| | | Access to information from agricultural centres | |
| | Changes in cultivation | Types cultivated in the past | |
| | | Reasons for change | Perception changes |
| | | | Economic value |
| | | | Environmental preferences |
| **Storage** | Type of storage | | |
| | Losses | | |
| **Consumption & uses** | Local preferences | | |
| | Local customs | | |
| | Medicinal uses | | |
| | Other uses | | |

## QUESTIONNAIRE

The questionnaire (see Appendix A) comprised of 42 questions grouped under the following main themes:

- Household situation;
- Sources of food available in the household;
- Limiting factors for availability of food in the household;
    - *Access to food from market:*
    - *Availability of self-produced food and limiting factors:*

- Limiting factors to productivity / changes to productivity rate;
- Limiting factors in the conversion to food available for consumption & coping strategies;
- Limiting factors in the conversion food for sale – income;
- Food/millet consumption and utilization.

## Research Design & Methodology

From the beginning, interviewing farmers in Uttarakhand was a given, as it was seen as an important endeavour in order to complement and verify the scarce data about food security and millet cultivation that is available officially. Moreover, the interest was not as much in obtaining quantitative data (surface cultivated, types of crop etc.), as in collecting information that would allow for an assessment of farmers' perception about their own situation. Nevertheless, sources available in the region were used to complement the understanding of the local context. As secondary data, annual reports of local agricultural research centres were also used (VPKAS reports, see Appendix B).

### Data collection - Field

During the time spent in the field three types of data were collected:

- Detailed notes of semi-structured interviews with subsistence farmers – core data;
- Notes of unstructured interviews with community members and key informants;
- Own observations and field notes.

#### 1) Interviews with farmers

In total 48 farmer interviews were carried out in 15 villages, in 4 different areas (see Table 4). At least a week was spent in each study area, with daily visits to different surrounding villages. In addition, occasional family stays made it possible to immerse more into the villagers' life.

**TABLE 4. VILLAGES AND NUMBER OF INTERVIEWS** *(T1, 2... = TRANSLATOR 1, 2...; NGO1, 2... = NGO EMPLOYEE 1, 2...)*

| Area | Village | No. of farmer interviews | Other interviews | Who |
|---|---|---|---|---|
| **Mauna** | Mauna | 5 | | T1 |
| | Chapar | 3 | | T2 |
| **Orakhan** | Garhau | 3 | | T4 |
| **Suyalbari** | Manarshar | 2 | 1 | T3, NGO1 |
| | Chimmi | 3 | | T3 |
| | Kamoli | 5 | | T3 |
| | Gangori | 3 | 1 | T3, NGO1 |
| | Suyalbari+Thapli | 3 | | T3 |
| | Sirsa | 3 | | T3, NGO2 |
| **Bageshwar** | Chaugounchina | 3 | | T4, NGO3 |
| | Ganotiparli | 3 | | T4, NGO3 |
| | Agar | 3 | | T4, NGO3 |
| | Chona | 3 | | T4, NGO3 |
| | Belori | 3 | | T4, NGO3 |
| | Shakira | 3 | 1 | T4, NGO3 |
| **TOTAL** | **51 =** | **48** | **+ 3** | |

**Village and household sampling**

The four main study regions were chosen based on practical reasons related to the available opportunities for accommodation, orientation and translation from Hindi/Kumauni into English. A local NGO that is very active and highly esteemed locally supported this research in terms of logistics.

As far as village selection is concerned, cluster sampling was employed, based on personal observation, with the aim to have some variability in the characteristics of the villages, such as: distance to road, environmental and agricultural conditions (proximity to forest, availability of water), altitude (valley, slope or hill top).

On most occasions the visited households were chosen randomly. All efforts were made to avoid personal biases of translators or accompanying persons when visiting homes of families of their acquaintances. A particularity of the villages in the region was that the houses were often grouped in clusters of three to five. Traditionally each house has a large terrace (courtyard) at the front that communicates with the terraces of the neighbours. It was for this reason that sometimes other people than the interviewees and their families would be present. While third parties were asked not to interfere in the discussion, as a further measure to avoid farmers influencing each other in their responses, only one interview was carried out in each cluster of houses. Moreover, it was found that for a village with about 10-15 such clusters, 3 to 5 interviews were enough to reach a certain degree of theoretical saturation, beyond which no new relevant data was emerging (Strauss and Corbin qtd. in Bryman 2008).

**Interviewee selection**

Where possible, the family of the selected household was interviewed: this would be either the woman or the man in charge of daily affairs, whoever was at home of the two. When neither the wife nor the husband was available, older persons from the family, with more experience in agricultural practices, were preferred over young members and children. Sometimes, when both the husband and wife of the family were present, conflicting viewpoints arose, especially when it came to open questions about qualitative issues. This indicates that for a number of topics a focus group might be a more appropriate research method.

**Ethical considerations**

All the farmer interviews were carried out following the rule of informed consent. The translator was particularly instructed to explain the scope and objectives of the study and to ask politely whether the head of the house would agree to participate in a discussion about agricultural methods and practices. There was no instance in which a family refused to participate in the study.

**Procedure**

In many instances, the researcher and translator were accompanied to the study villages by someone working for the local NGO, and with whom the farmers had already had previous contact. Our assumption is that the presence of a key figure made farmers more willing to have a long discussion (anywhere between 30 minutes and 1hour) and also to open up on a number of sensitive or personal issues, especially in relation to food utilization.

Before going into the field a questionnaire was prepared as explained previously (see Appendix A). Many issues were to be covered, but in practice it was not possible to go through every question with every individual. There were three reasons for this: the impromptu nature of the interview (no previous appointment) meant that sometimes the interviewee would not have a lot of time available; the rhythm of the discussion differed to a large extent between translators; some issues were more

accessible to certain people than to others. For instance, some men found it more difficult to talk about child feeding than women, while older people would be more willing to talk about changes than younger ones. That is why the chosen format was that of a semi-structured interview. Depending on the interviewee, follow-up questions were asked regarding those topics that seemed to be of most interest to them. The questionnaire would serve as a guideline for themes, but the discussion otherwise flew into the direction that best suited the situation. Nevertheless, extra care was taken in covering all pre-defined themes within each village. To the extent possible, and when appropriate, probing questions were also employed and information was cross-checked between interviews.

Along the lines suggested by Beardsworth and Keil (1992 in Bryman 2008, p. 439) an iterative process was used for refining the questionnaire, by including themes identified during earlier interviews into later ones. For instance, specific questions about the soil condition were included in later interviews based on the information provided by the first interviewees.

**2) Informal discussions with community members and key informants**

Another source of data was represented by unstructured interviews with community members and key informants. Four interviews were organized within this category.

In three of the villages visited interviews with the local *anganwadi* workers were set up. These are usually women who follow a 4 month governmental training programme in health, child-care and nutrition and consequently are responsible with supporting the community healthcare and child development. They organize – among others – pre-school activities, advice sessions for pregnant women and health check-ups for children. The purpose of these interviews was to collect some more objective data on child nutrition that could be later compared with the situation reported by the farmers.

As far as key informants are concerned, the original plan had been to use snowball sampling (i.e. one interviewee provides the names of other people to be interviewed and so on) as a way of identifying local researchers and public administrators that could provide statistical data and up-to-date information about the key variables in our study. However, after a first visit to the headquarters of VPKAS, Almora – an institute of the Indian Council of Agricultural Research – it was decided to abandon any subsequent visits to agricultural centres at the village level, or other state organizations. Despite the warm welcome during a meeting arranged at the courtesy of the institute's director, it quickly became clear that governmental records of e.g. millet cultivation either do not exist even at institutional level, or cannot be easily disclosed due to confidentiality or political policies. The conclusion was that substantial information would only be obtained under the conditions of a clear and transparent research agenda, more awareness about cultural norms and better immersion within the network – premises that were missing in this case. Instead, we had to resort to public, but scarce data available on the Indian governmental websites.

**3) Own observations and field notes**

Lastly, notes of personal observations were made, especially with a view to Gene Campaign's need to identify people who could further cooperate in projects on millet cultivation. These included, among

others, also relevant information, as presented by a group of students from the University of Washington, U.S.A., who had also carried out research projects in the region.

### Challenges of Field Work and Limitations

A few observations need to be made concerning data collection and the ability to get access to quality information.

**Cultural norms:** Firstly, in order to be able to work with the information gathered, the researcher needs to be well aware of the local context and cultural norms. Immersion in the community and sensitivity to the environment are essential for interpreting the data. There were many instances where other people than those interviewed were listening to the discussion. On one hand, asking for a private interview would have been impolite given the circumstances. On the other hand, estimating the degree of bias that the presence of others might have brought into the answers requires greater familiarity with the cultural subtleties. To what extent can one expect that the income or expenditure value reported are correct? To deal with this shortcoming and yet confer some transferability to our findings, a thick description of the context in which these interviews took place would be needed, as suggested by Geertz (1973a qtd. in Bryman 2008). It is for this reason that Chapter 3 attempts to describe the socio-ecological context, although the understanding of local social norms remains very limited after only two months in the field.

**Sensitive issues and trust:** Secondly, poverty, food utilization and inequalities within the family are all sensitive topics. In order to be able to get to the core of these matters, a relationship of trust needs to be built between the researcher and the subjects. This requires time and was not possible within 6 weeks, with such a large number of villages. We see this as an explorative study, where we chose for breadth rather than depth. Limiting the number of villages in combination with longer home-stays in each of the locations could be a way to address this problem in future studies.

**Translation:** Thirdly, translation is crucial. In the case of this report, the shortage of translators in the region was the most challenging aspect. The hosting NGO did everything possible to secure some form of translation, yet the shortage of locals that would be able to help with this task meant that we had to accept whatever we could get. In the Kumaon region, farmers would generally speak Kumauni, but would also be able to understand and speak some Hindi. The two languages are quite similar, yet there are differences, especially in regards to specific terms. T1 and T2 were local NGO employees who spoke limited English, but were fluent in Kumauni and spoke good Hindi. To ensure a certain degree of accuracy in the re-presented information, they were asked to take notes in Hindi whenever they felt that they could not convey the full meaning in English. These notes were later translated by someone who had excellent knowledge of both languages. T3 was a young high-school graduate from Bangalore who had lived abroad and spoke perfect English and good Hindi. While language was less of an issue in this case, one of the challenges was to keep her interested, focused and disciplined regarding the work. There were several instances when there was little control over the direction of the discussion, as translators would engage in conversations with the locals but only communicate back to the researcher the conclusion. Feedback sessions did not fully change the situation. T4 was one of the best matches – she was a local, spoke good English and Kumauni and was also mature enough to understand some of the requirements of the work involved. All translators did their best and a lot of gratitude is directed towards them. Yet, for a sound scientific

study, one cannot emphasize enough the importance of having a good translator who is trained in social science research and understands the weight that each word has in conveying a certain message.

**Hierarchy and authority:** Lastly, in relation to institutions and the administrative environment, the hierarchical and authoritarian nature of Indian society needs to be accounted for. When consulting documents from the state or interviewing public officials one must be aware of the possible biases and power politics involved. Again, being familiar with the context and knowing the right people can make a tremendous difference in the kind and reliability of the information received.
Overall, for a foreigner spending 6 weeks in the Himalayan hills and with no previous experience with India, one needs to acknowledge that there is a great cultural barrier to understanding more in depth the topics explored. While this barrier is by no means insurmountable, gaining real access to information requires very good preparation, adequate resources, diplomacy and sensitivity towards the environment, and time.

### DATA COLLECTION – DESK

As described in the research framework, it was essential to triangulate some of the information acquired from the farmer interviews with official statistics and governmental documents, in an attempt to distinguish perception from objective facts. Within this stage, additional desk research was conducted to collect factual data about key indicators in the region, which were touched upon during the interviews, such as precipitation patterns. This step aimed, thus, at providing the basis for what Denzin (1978, qtd. in Bryman 2008) would call *methodological triangulation*, i.e. by employing more than one method of data collection.

### DATA ANALYSIS

**Coding frame**

In order to organize the notes from the interview, a coding frame was used that built on the pre-defined set of indicators and classes. A database was created where each piece of information in the interview was assigned to one thematic (sub)category.

By their very nature, some of the questions asked required quantitative answers: e.g. those related to the surface of available land or the yield of certain cereals. The intention was not to have precise measurements, but only some initial rough estimates of the quantities involved, so the procedures for collecting this type of information was not strict and relied solely on what the interviewees reported. While this data cannot be used to make statistical analyses or infer anything about the larger population, it was aggregated into a table as a way to provide context to the qualitative information.

**Preliminary Analysis & Final Conclusions**

Once a preliminary analysis was completed based on the interviews and official documents, additional literature on food security and millet cultivation helped to better understand and describe in written the local context. It is for this reason that another step of interpreting findings through the lenses of newly acquired information was necessary before answering the research questions and making some useful recommendations.

# CHAPTER 3: DESCRIBING THE LOCAL CONTEXT

## THE STUDY AREA: QUICK FACTS

The study was carried out in four different areas within the Kumaon region of Uttarakhand, in the "Lesser" or "Middle Himalayas", at altitudes ranging from about 1500m to 2000m. Two of the studied areas were in the district of Nainital, one was at the border of Nainital and Almora, while the fourth one was part of the Bageshwar district (see Figure 4) .

### CHARACTERIZATION

Uttarakhand is a middle-sized state, crossed by the Himalayan range, situated in the northern part of India, close to the borders with Nepal and China (see Figure 4). With an area of 53 483 sq km, it represents about 1.6% of India's total territory. Although it is a mountainous region, with dry soils and steep slopes, it is quite densely populated, with a state average of 159 inhabitants/sq km (India. Ministry of Statistics and Programme Implementation 2012). Uttarakhand is comprised of two main regions: Kumaon and Garhwal. Administratively, each region is further divided into districts, tehsils and developmental blocks.

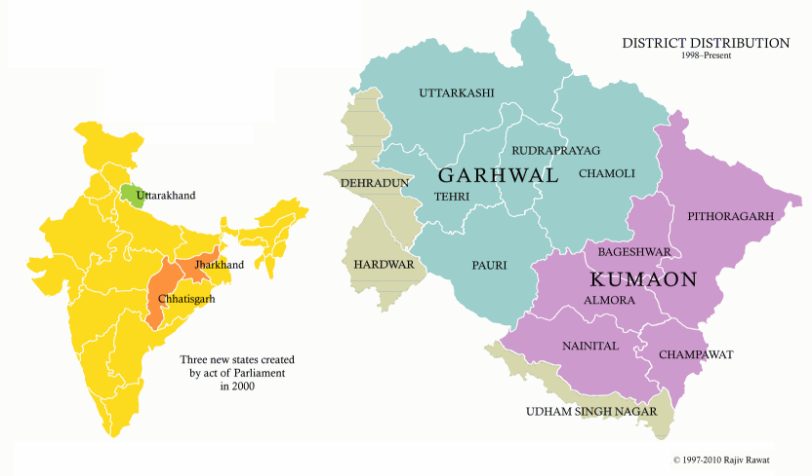


**FIGURE 4. MAP OF UTTARAKHAND AND DISTRICTS. SOURCE: RAJIV RAWAT, UTTARAKHAND.ORG**

### CLIMATE, VEGETATION AND SEASONS

Uttarakhand lies on the southern slope of the Himalayas, which means that within a distance of 300km in straight line, there is an increase in altitude of up to 7000m. Consequently, climate and ecology vary greatly with elevation and slope.

Two main ecoregions can be distinguished at the moderate elevations where the study was carried out: the Western Himalayan broadleaf forest and the Himalayan subtropical pine forest. The first one corresponds to a temperate climate and forms a band from 1500m to 2600m altitude, while the latter refers to subtropical forest dominated by Chir pine, which extends mostly on south-facing slopes between 1000m and 2000m (WWF 2007). As it was also observed in the field (see Figure 5), throughout the centuries most of these forests have been gradually replaced by terraced agriculture plots. While some large patches remain as conservation areas – e.g. the Jim Corbett National Park,

the oldest such park in India, even today deterioration and forest clearing for logging continue. It is estimated that about two thirds of the Western Himalayan broadleaf forest natural habitat has been lost or degraded and half of the habitat of the Himalayan subtropical pine forest (WWF 2008). The interaction between human activities and the ecosystems is discussed further in the section "Socio-ecological interactions".

**FIGURE 5. SUBTROPICAL PINE FOREST CONVERTED TO TERRACED AGRICULTURAL LAND**

Despite the high altitudes, agriculture has been possible in the sub-Himalayas due to the relatively mild climate provided by the monsoon. There are two major cropping seasons in Uttarakhand: *rabi (*from October to July, crops sown between October and February and harvested by June) and *kharif* (monsoon season, from July to October, crop sown April-July). In some accounts (Singh et al. 2008), references are made to three seasons: warm and rainy (July to September), winter (October to March) and dry summer (April to June)

Data records from the past 100 years from the Mukteshwar meteorological station (close to the Orakhan area, yet at an altitude of 2171m) show that indeed the months of July-September record the highest precipitation levels, while maximum temperatures are reached between April and June (see Figure 6).

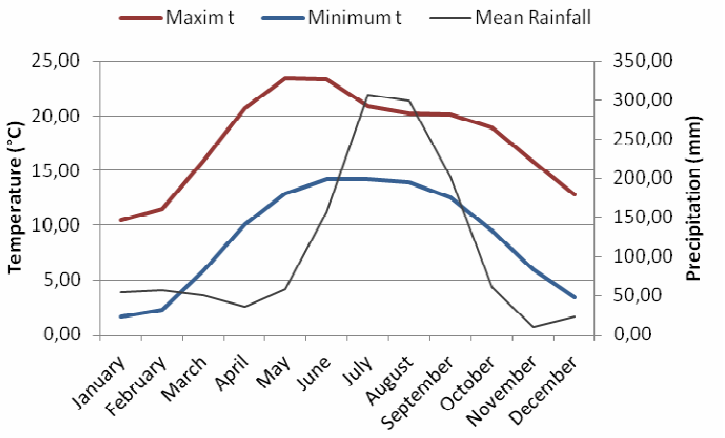


**FIGURE 6. MONTHLY MEAN MAXIMUM AND MINIMUM TEMPERATURES AND TOTAL RAINFALL BASED ON 1901-2000 DATA IN MUKTESHWAR, KUMAON REGION**

## POPULATION

According to the preliminary results of the 2011 national census, Uttarakhand population numbers have increased by 19.17% in the last decade (1.6 million people), currently reaching a total of around 10 million people (Figure 7). This increase is higher than the national average: across entire India the population raised by 181 million in the last decade, which represents a growth of 17.64% relatively to year 2001. In 2011, the population of Uttarakhand represents about 0.82% of India's total population (India. Ministry of Home Affairs 2011a).

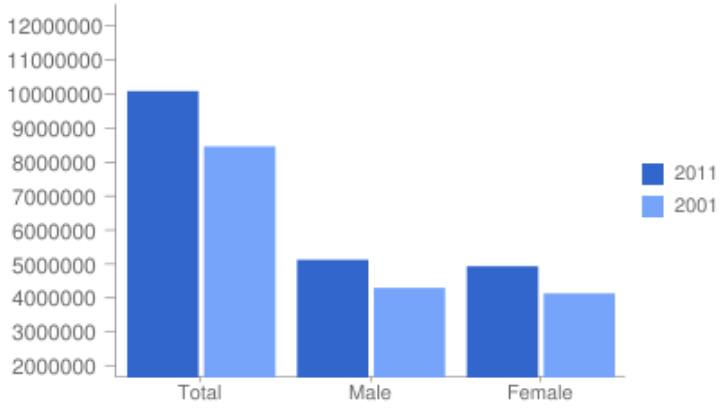


**FIGURE 7. POPULATION OF UTTARAKHAND; SOURCE:** INDIA. MINISTRY OF HOME AFFAIRS (2011A)

## HEALTH

In the last two decades, the health status of India's citizens has gradually improved, as shown by indicators such as the Infant Mortality Rate (number of infant deaths – up to 1 year old – at 1000 live births) or Death Rate (see Figure 8). However, in 2011 in Uttarakhand, about 42 in 1000 children die in their first year of life, with 30 of these dying in the first 29 days (India. Ministry of Home Affairs 2011b).

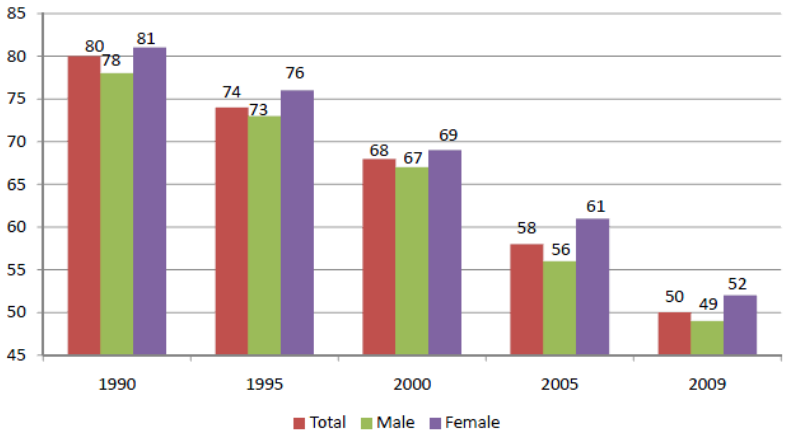


**FIGURE 8. INFANT MORTALITY RATE BY SEX ACROSS ENTIRE INDIA, 1990-2009; SOURCE:** INDIA. MINISTRY OF HOME AFFAIRS (2011C).

## URBANIZATION

Figure 9 presents the rural/urban population ratios for the different districts in which this study was conducted. While the percentage of rural population in whole Uttarakhand decreased from 74.33%

in 2001 to 69.45% in 2011, little can be said about rural-urban migration within the state, as the number of towns also increased. According to the Census Bureau, in 2011, an 'urban' area was defined as a place with a municipality, cantonment board or notified town area committee that had: a) a population of at least 5000 people; b) at least 75 per cent of male working population engaged in non-agricultural pursuits and c) a minimum density of population of 400 people/sqkm.

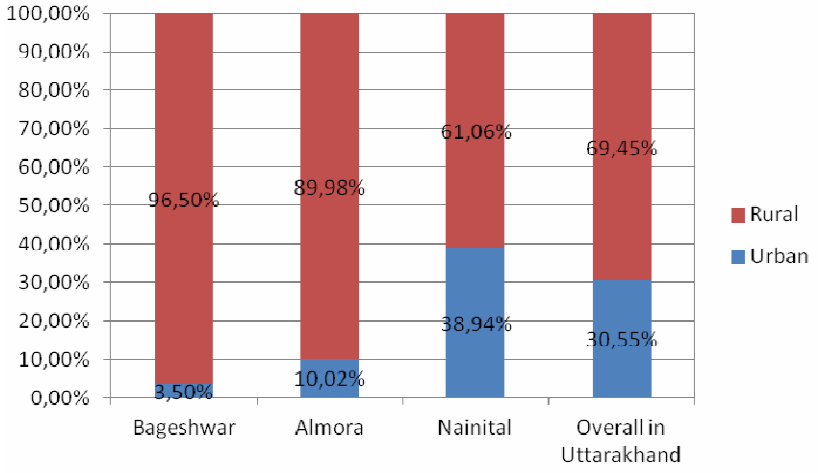


**FIGURE 9. PROPORTIONS OF RURAL/URBAN POPULATION IN THE STUDIED DISTRICTS**

## SOCIO-ECOLOGICAL INTERACTIONS

The facts mentioned above present some of the trends in Uttarakhand and already indicate the related challenges that they might pose to livelihoods. In the following paragraphs, the long-established agricultural systems and socio-ecological interactions are presented in more detail.

### TRADITIONAL FARMING SYSTEMS

Traditionally, agriculture has been practiced in Uttarakhand under rainfed conditions, in a crop-livestock mixed system, on terraced fields that have existed for generations. While many of these fields had been long used for the cultivation of coarse grains, in recent decades, farmers have increasingly shifted to rice, wheat and oil seeds (Kumar et al. 2009).

In a case study in the Garhwal region, at altitudes between 900m and 1000m, Singh et al. (2008) identify four types of settled agriculture: i) homegarden systems, where vegetable crops are planted under dense crown cover of fruit trees; ii) rainfed agroforestry systems, where scattered trees occur between food crops (up to 10-20% crown cover); iii) rainfed crop systems, without any trees and iv) irrigated crop systems. Within the Kumaon villages covered by the current study, rainfed crop systems occurred most often. In addition, there exist also forests managed by government agencies.

Forests play a crucial role in the daily lives of the farmers, as they provide fodder for the livestock, leaves for manure and wood for fire. Before the introduction of governmental forest management in the 1950s, forests used to be owned and managed by local communities. At least in some regions, forestry policies promoted dominance of timber species, which in turn led to a decrease in the availability of fodder (Nautiyal et al. 1998).

In terms of cultivated species, previous studies show that crop diversification is the traditional strategy of addressing climate vulnerability. More specifically, the number of crops cultivated by one household is reported to be anywhere between 17 and 30 (Saxena et al. 2005), with species/cultivars chosen based on knowledge about performance under different monsoon conditions (Singh et al. 2008). For instance, millets, and especially finger millet and barnyard millet, have been usually cultivated on marginal lands, with lower nutrient input than other crops (Singh et al. 2008).

In recent times, however, changes in the socio-ecological environment have also started to affect traditional faming systems, requiring farmers to be innovative in adapting to the new conditions. Among the types of changes reported in the literature, we find: replacement/abandonment of traditional crops, domestication of new crops, abandonment/expansion of agricultural land use, increase in livestock population and loss/replacement of traditional multipurpose trees (Saxena et al. 2005). Since most of these trends point in the direction of reduced biodiversity, and a corresponding increased vulnerability to economic and environmental risks, interventions that recuperate ecosystem functions are called for (Saxena et al. 2005). It is against this background that preserving traditional plant genetic resources and promoting millet cultivation are seen as one possible avenue towards this objective, by organizations such as Gene Campaign.

### Millet Cultivation

Official national statistics regarding the areas under agricultural cultivation, indicate that finger millet is an important crop in Uttarakhand, amongst cereals (see Figure 10). In absolute numbers, these means: 153 000 ha under finger millet cultivation (about 2,86% of the total area of the state of Uttarakhand), 398 000 ha for wheat, 296 000 ha for rice and 75 000 ha for other small millets.

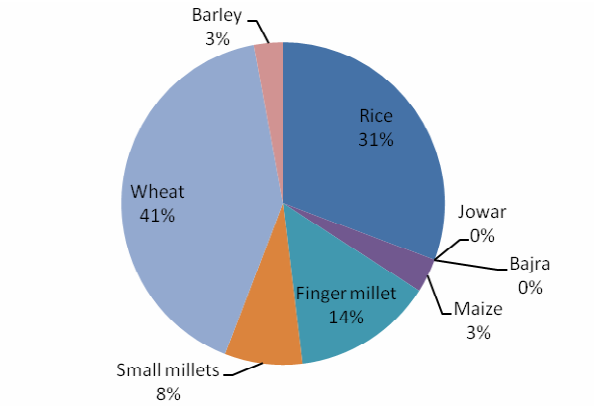


**FIGURE 10. RELATIVE IMPORTANCE OF DIFFERENT CEREAL CROPS, BY AREA CULTIVATED; DATA SOURCE:** INDIA. MINISTRY OF STATISTICS AND PROGRAMME IMPLEMENTATION (2012B)

By comparison to other millets, data obtained from the local media and from the Agricultural Research Centre (VPKAS) in Almora indicate that finger millet is being cultivated on areas twice as large as those dedicated to barnyard millet and 20 times bigger than those for amaranth. Table 5 provides an overview of the production of these millets at district level.

**TABLE 5. MILLET PRODUCTION IN UTTARAKHAND - DATA FOR 2007-2008, PROVIDED BY VPKAS ALMORA**

| | Finger millet | | | Barnyard millet | | | Amaranth | | |
|---|---|---|---|---|---|---|---|---|---|
| | Area (ha) | Production (t) | Productivity (q/ha) | Area (ha) | Production (t) | Productivity (q/ha) | Area (ha) | Production (t) | Productivity (q/ha) |
| **Chamoli** | 7720 | 11797 | 15.28 | 2515 | 3576 | 14.2 | 2357 | 667 | 2.83 |
| **Dehradun** | 1737 | 2855 | 16.44 | 569 | 799 | 14.04 | 464 | 278 | 5.99 |
| **Pauri** | 29850 | 37759 | 12.65 | 18 852 | 21538 | 11.42 | 98 | 23 | 2.38 |
| **Rutraprayag** | 6303 | 11017 | 17.48 | 3249 | 5550 | 17.08 | 145 | 73 | 5 |
| **Tehri** | 13871 | 22618 | 16.31 | 20101 | 28527 | 14.19 | 471 | 141 | 3 |
| **Uttarkashi** | 6308 | 10431 | 16.54 | 2899 | 4298 | 14.83 | 2496 | 1497 | 6 |
| ***Almora*** | ***36599*** | ***42796*** | ***11.69*** | ***14868*** | ***16733*** | ***11.28*** | ***93*** | ***23*** | ***2.5*** |
| ***Bageshwar*** | ***6137*** | ***8623*** | ***14.05*** | ***685*** | ***733*** | ***10.7*** | ***608*** | ***183*** | ***3*** |
| **Champwat** | 6385 | 10989 | 17.21 | 1761 | 2612 | 14.83 | - | - | - |
| ***Nainital*** | ***4178*** | ***6276*** | ***15.02*** | ***402*** | ***583*** | ***14.50*** | ***2*** | ***1*** | ***6.25*** |
| **Pittoragarh** | 9086 | 13572 | 14.97 | 1258 | 1794 | 14.26 | 26 | 12 | 4.5 |
| **Uttarakhand** | **128156** | **178733** | **13.95** | **67159** | **86783** | **12.92** | **6760** | **2898** | **4.25** |

While millets appear to still hold a large share of agricultural output in Uttarakhand, there is also evidence that in some regions of the Himalayas the area of millet cultivation has been gradually reduced in favour of cash crops (Saxena et al. 2005). As a farmer-driven phenomenon, largely dependent on the development of market economies and socio-cultural changes, this trend is not yet general. For instance, in a village in Garhwal, it is reported that cash crops are only grown on a scale that does not threaten local food self-sufficiency, the hypothesized explanation being that farmers will only resort to modern agricultural methods when they will have exhausted their options by conventional farming (Singh et al. 2008). Whether or not this is also the case in the Kumaon region, remains to be discussed in the next chapter.

# CHAPTER 4: LESSONS FROM THE FIELD

Having looked at the particularities of the studied area in Uttarakhand, the current chapter presents what was learnt from the interviews regarding different topics. The information in the following pages is based on the perception of the farmers, as reflected in the encounters in the field. Where adequate, a wider theoretical analysis is attempted and some new hypotheses are advanced. Most of the discussions and interlinkages are reserved, however, for Chapter 5.

## FOOD AVAILABILITY AND ACCESSIBILITY

**Crops grown and purpose**

Most of the farmers interviewed are doing agriculture for their own family's consumption. Surpluses are usually sold on the local market, but the quantities and kind depend largely on the land available, on the type of produce and on access to intermediaries.

In the *rabi* season, the most cultivated crops include: wheat, barley, lentils, garlic, mustard, onion, coriander, spinach and other green vegetables. During *kharif*, people report cultivating, among others, millets, rice (a variety that can grow under rain fed conditions), black soybeans, corn, pulses and sesame. In addition, vegetables are being grown, such as: tomatoes, peas, radishes, capsicum, chillies and cucumber. Spices, in general, were also mentioned, but without further specification - in a few instances coriander was mentioned as one of them. Most of these crops are being cultivated for personal use, with surpluses being sold on the local market or exchanged for other goods.

In the regions of Mauna, Suyalbari and Bageshwar fruit are generally scarce, with a few trees growing on some farms. Occasionally, depending on yield and access to the market or intermediaries, surplus fruit are also being sold, mostly at the market in the nearest big city, Haldwani.

Around Orakhan, the situation is different from that in the other studied regions. It appears that farmers here have gradually switched to cash crops (i.e. crops that are grown to be sold right away and transformed into cash, rather than for own consumption), as they report growing potato and fruit, with the explicit goal of selling them. While this is not yet the case in the other areas, this trend is slowly developing, beginning with the villages that are closest to the road. For instance, in the Suyalbari region, in Chimmi, a village right on the main road to Orakhan, one farmer reports having recently started to grow vegetables as a way to ensure a stable income. The same idea is not at all present in neighbouring villages that are only 4-5 km away, but perhaps less accessible.

**Animals**

On average, people have few animals on their farms, around 4-5 per family. These can be cows, buffalos, oxen and goats. Generally these are kept for manure for the land, to plough the land and for milk. However, it is also reported that there is a trend in having less animals. Several of the interviewees said that in the past people would drink more milk and eat more cheese, as they used to have more animals. Now this is not possible anymore, because of space and food requirements. Often times, farmers have to send their cows to the forest for fodder, because they cannot afford to feed them. However, this also results in a loss of manure, which means a lower return to the investment in keeping the animal.

**Storage**

In general, no important food reserves are made, mainly due to inadequate storage facilities or methods. When reserves do exist, these usually involve small quantities of staple foods for the short-term, or, in rare instances, specialty foods, such as pickles. Derivative products, such as flour, are rarely made, because of the external costs involved (e.g. paying for the mill).

One of the reasons behind this behaviour seems to be the general perception that it is not possible to store food from one year to the next, as most crops would go bad after a while. Finger millet, for instance, can be stored for up to 6 months, according to some interviewees, while others say that millets and wheat can be kept for up to one year. However, even the latter recognize that they prefer to deal with their needs as they arise, instead of counting on long-term storage that might not be successful. Consequently, a second important factor emerges: a prevailing tendency to adapt to, rather than prevent, shortages – "when tomorrow comes, you look at it" (villager from Sirsa).

While storing food is not part of the households' security strategy, it is invariably reported that part of the cereal produce is saved for seeds. In the old times, people used to keep the grains in wooden boxes, but nowadays they switched to tin boxes ("drums" or "canisters"), which provide better protection from moulds and insects. No significant losses are reported in the areas where using such canisters is the norm. In the Bageshwar area, though, some people still use the wooden boxes for wheat and they admit to having problems

**Food bought from the market**

There is an increasing dependency on the market for food – and interviewees realize that this makes them more vulnerable to external pressures: "we are more dependent on market food and that is bad" (farmer from Agar, near Bageshwar). This dependency is created by the fact that they are no longer able to produce enough food on their farms to cover the needs of the whole family. On average, farmers report that the food produced on their farms is sufficient for about 7.7 months, but there are wide variations between families.

Oil, rice and wheat are the foods most often mentioned as being bought from the market. Spices, sugar, tea, pulses, flour, mustard, masala are next priorities. Few people mention fruit and vegetables as being on their shopping list.

In general, farmers acquire these goods from the market or shops in the nearby villages, usually those that have access to the road. If a village is on the top of the hill, most probably there is no shop there and the people would have to walk 2 to 5 km to the nearest one. However, the interviewees don't see the walking distance as a problem.

Once in a few months, people would travel to a bigger market in Almora, or Bageshwar, for instance. Although they admit that the prices on the local market are higher than those in cities, when they count the price of transportation they believe it is the same. Hence, they rely on local providers for their current needs and only visit bigger markets when there are more important acquisitions to be made. By some farmers, though, the prices at the local market are regarded as being very high. A few villagers in Chimmi, Suyalbari area, report that prices at the local market go up all the time and that "it is only people with jobs that can afford these things" (see also section "Income sources"). As examples, they mention that if rice price has increased from 6.5 rupees/kg to 15 rupees/kg in 5 years, while a litre of oil that cost 70-75 only a year ago, it is now 90 rupees.

This trend reflects that the poorest might be trapped in a vicious circle, where they are mostly dependent on their land and whatever yield they can get out of it. In order to deal with their insufficient production, many have to rely on the ration shop and on governmental programmes that support them with food: the BPL(below poverty line)-APL(above poverty line) ration schemes.

**Economic output**

Most farmers do not sell any of their produce, unless there is some surplus. For instance, if they have too many vegetables, they might sell them on the local market in the village. Generally, they state that they do not have enough food so there is nothing left to sell. In a few instances, livestock is seen as investment, but those are rare cases and might have to do with historical occupations in the family. For instance, in one instance in Bageshwar someone reported that they were growing chicken to sell eggs and meat. In a few other cases, people were keeping goats to sell them, or reported selling calves if they would get them when they would not need them. However, most farmers only keep a few animals, as these also require land and food that they do not have.

Out of all studied areas, Orakhan seems to have the highest economic output, with fruit, cabbage and potato being grown to a large extent as cash crops. However, when asked, farmers do not report making any difference in terms of input use between what they send to the market and what they keep for their household. This reflects, to a certain extent, that these crops are not grown with a business mentality or a drive for maximum yields and profit. In most cases, selling farm produce seems to have emerged as a strategy out of a combination of need and opportunity. On one hand, farmers had been faced with difficulties in securing enough food for the household, while on the other, the proximity of the road and the opportunity provided by middlemen meant that it was easy for them to convert to a model where cash crops would bring more stability to their financial and food flows.

**Income sources**

The increased dependency on food from the market, coupled with uncertainties regarding own food production, have made people consider currency as a better guarantee of food security than crop storage. This is why most of the families try to diversify their sources of income as much as possible. However, job opportunities are scarce and are generally related to governmental or NGO programmes, or – in exceptional cases – certain industries. For instance, some people report being involved in forestry restoration work (especially in Mauna and Bageshwar), or having a job at the mine (in Bageshwar area). Most families also rely on at least one family member who has taken employment in a city, sometimes as far away as Delhi.

Since 2005, there is also a National Rural Employment Guarantee Act, where farmers can subscribe and are guaranteed by the government 100 days of paid work/year, consisting of manual unskilled activities such as road reconstruction work. However, as villagers report, the jobs associated with this plan involve hard physical work, mostly suitable for men. Women, in turn, sometimes are employed as cooks in the school, ASHA (Accredited Social Health Activist) workers or anganwadis. Joining the army or holding administrative functions in the village are regarded highly, as these are generally well-paid jobs.

On average, about one third of the families interviewed had no steady source of income, such as a job or a pension. This number is just indicative and should be used with caution, as people did not always report consistently their income situation. In a number of interviews there were internal

contradictions, probably caused by the different understandings of the words “job” or “work”. Nevertheless, these people represent a significant share of the population who is most at risk of food insufficiency. Not only do they have to struggle with the same constraints in terms of land and productivity as those that have family members in some form of employment, but they also depend on these other families and are affected by the migration patterns that employment outside the village triggers.

To be more specific, the unemployed depend on circumstantial availability and demand of goods. Between the studied regions there are no major differences in the type of activities that this category of population engages in as a way to make some income. As already explained, one major source of fast cash for most farmers is selling food surpluses, sometimes also part of the rations received from the government. Other activities include labour on other villagers’ farms and more organized commercial activities, such as having a shop in the village or renting tents for weddings. Those who are better off in the village – due to remittances from relatives – contribute thus greatly to creating a demand of labour and goods that that those more vulnerable can fulfil. However, migration causes a positive feedback loop: as more and more people move away from the villages, those left behind become more helpless, making it imperatively necessary that they move too.

Gradually land is abandoned and the concern expressed by some farmers becomes legitimate: “Now they found job and they do not want to work on the farm; if this thinking continues who will grow food in the future?” (farmer from Garhau, Orakhan).

**Access to market for selling produce**

Since many farmers depend for their monetary income on selling food surpluses produced on their farm, it is relevant to assess how easy it is for them to gain access to markets. Grains and vegetables in excess are usually sold within the village, either to a local shop or directly to other people. Maximizing price is not an issue, as people prefer to satisfy local demand first, even for a lower amount: “it is better like that” (says a villager from Manarshar).

Animals, such as baby calves or goats, are usually sold on request. When someone is looking for an animal to buy, fellow villagers and friends will indicate the person who might have a few for sale. The role of networks is again evident.

Commerce is more organized when it comes to fruit and vegetables, as these are regarded as goods of higher value that are worth converting into cash. In most regions a system is in place where intermediaries (*banyias*) collect such goods and transport them to the big markets in nearby cities. For instance, in Suyalbari, farmers reported sending fruit in boxes to Haldwani with “whatever car is going down”. In Mauna and Orakhan, middlemen also play an important role, although farmers often complain that the prices they get hardly cover the expenses they have to make for the boxes. Since there are no independent cooperatives, farmers depend on the banyias for the smallest income and are not in a position to negotiate prices that are at their best interest.

Dairy products are also being sold, but most often through central collection centres, such as those provided by certain organizations (e.g. “Mother Dairy”).

**Perception of own situation**

When asked about worries for the future and how they perceive their own situation, people often report the decline in production as being one of the biggest problems (see also Table 6). There are several perceived reasons for the decreasing availability of food from own production.

Firstly, many farmers report that weather has become more and more erratic in the past few years, leading to seasonal anomalies that are not favourable to agriculture. For instance, they mention that the *rabi* season is too dry, with little rain. At other times it rains too much, leading to floods that destroy the crops. The uncertainties associated with the availability of water render a general feeling of hopelessness. Even when farmers see irrigation as a solution that would partially solve this problem, they still feel that the costs of infrastructure are beyond their capacities and doubt that the government would take the necessary measures.

Secondly, land division and fragmentation is seen as a major cause of poverty. As the population is growing, the available land needs to be divided each time between new brothers, leading to increasingly smaller fields per family. In addition, large joint households have been gradually replaced by smaller families, meaning that there is less manpower available to do the necessary work.

Thirdly, most farmers are aware that the environment is being slowly degraded, albeit they do not necessarily see how these will pose a risk to their livelihoods. Some farmers report that they noticed how they have become increasingly dependent on chemical fertilizers, once they started using them. In other instances, remarks are made about how the forest had been gradually cut and how this influenced climate. Environmental problems are an important concern, because – in the words of a farmer – "these are those that they can't do anything about". However, short term goals and the daily battle for survival take precedence over other considerations: "We don't think about future, but about how to live now.." (a farmer from Sirsa).

Confronted with insufficiency of self-produced food, the villagers of Uttarakhand have to look into alternative ways to provide for themselves and perceive their situation as lacking opportunities for employment and earning a living. To many, moving to the city and trying to make a living there is the solution of last resort, yet one to which they believe everyone will eventually have to adhere: "what will the children do – without land and job?" (villager from Belori). Against the further socio-cultural developments in terms of occupation preferences and level of education, questions are then raised about the future of agriculture and of crops: "There are less people farming so maybe in the future these grains won't exist anymore.."

**TABLE 6. TOP 10 PERCEIVED PROBLEMS / WORRIES FOR THE FUTURE (# OF INTERVIEWEES MENTIONING THAT PROBLEM)**

| | |
|---|---|
| **1:** | Rain problem: 8 |
| **2:** | Unemployment/lack of opportunities, moving to the city: 4+3 |
| **3:** | Unavailability of sufficient food: 5 |
| **4:** | Land scarcity (including ownership and condition of "free" land): 5 |
| **5:** | Reliance on market and prices going up: 5 |
| **6:** | Environmental degradation and problems: 4 |
| **7:** | Abandonment of agriculture and loss of types of crops: 4 |
| **8:** | Energy: 2 |
| **9:** | Education: 1 |

| | |
|---|---|
| **10:** | Animal menace: 1 |

## AGRICULTURAL PRACTICES

### Crop rotation and inter-cropping

In all studied regions, locals were aware of and practiced crop rotation, usually through long-established patterns. Usually planting of wheat would be followed by rice, then finger millet and then a period of fallow land. Others would also plant rice in between the wheat and the finger millet seasons. No consistent pattern emerged from the claims, nor any differences between the regions. Some also mention growing onions after rice or alternating potato with pulses and radish with garlic and coriander.

When it comes to inter-cropping, the practice of mixing different crops seems to be more spread out in Bageshwar and Mauna than in Orakhan and Suyalbari. More specifically, in Bageshwar finger millet is often grown together with black lentils (urad dal), black beans (black bhatt), barnyard millet and amaranth. Rice and foxtail millet are sometimes planted around the field of the main crop. In Mauna, it is also quite common to mix barnyard millet with finger millet, horse gram and black soybeans. Lastly, in Orakhan and Suyalbari, most people report cultivating all crops separately, sometimes with borders of a different crop. For instance, rice can exist on the side and coriander with garlic between onions.

### Fertilization, pest control and soil quality

Across all regions, most people report using cow manure as the main fertilizer for their crops. However, as this is sometimes not available in sufficient quantities, some farmers also use urea and commercial fertilizers generically referred to as “NPK”, mostly with wheat crops. At the initiative of local NGOs, some farmers have also started to use vermicomposting, particularly in the Bageshwar and Mauna regions. Those who have tried vermicomposting report a general increase in the quality of their soils, although one farmer said he stopped using it, as this made the soil drier. In the Suyalbari area there seem to be most reports of chemical fertilizers. There are accounts of how the use of fertilizers began 10 years ago and became necessary on certain crops. For instance, a farmer form Suyalbari village explains how she needs to use DAP (diammonium phosphate) and urea on onion crops as they otherwise wouldn’t grow. Artificial fertilizers are also sometimes used on cauliflower, cabbage, chillies or other vegetables. An interesting observation is that no farmer reported the necessity to artificially fertilize millets.

When it comes to pests, there seems to be an understanding that losing a certain part of the crop to a pest is a natural process, which requires no special measures for control. As a farmer from Taphli expressed it: “Sometimes parts of the crop might go bad, or the worms and insects in the soil will eat the leaves or the roots of the plants, but that’s OK”. Bageshwar is the only region where farmers mentioned using some form of organic pesticide that they obtained from the local agricultural centre, as well as from local NGOs.

The most significant problem related to soil condition is the presence of white grubs. These are larvae of beetles that feed on the roots of the plants, thus affecting the yield. The occurrence of this pest was reported in all studied regions, although differences in severity between villages are difficult to estimate based on farmers’ reports solely. Among those who mentioned this issue, most farmers claimed that the presence of the white grub had started to become a problem relatively recently, as the number of larvae increased in the past 5 years.

**Changes in agricultural practices**

When asked about their agricultural practices, in all regions farmers talk about knowledge that for decades has been passed over to the younger generations. People grow "whatever the parents used to grow" (farmer from Thapli), in the traditional manner, and by using their own seeds that have been in the house for a long time. Especially for staple foods, there seems to be a preference for saving part of the produce as seeds for next season. It is only for vegetables that farmers rely more on the seeds available at the market or via agricultural centres.

In general, contacts with governmental agricultural centres are almost non-existent, and any innovations that reached the farmers are due to the work of NGOs or other parties: e.g. introduction of vermicomposting and organic pesticides.

Some changes in the crop types or quantities grown are acknowledged, and these are associated with new preferences, the availability of more diversified foods at the market, environmental conditions and migration.

## FOOD QUALITY AND CONSUMPTION

**Food habits and health**

In terms of food quality and habits, it is difficult to make an assessment of changes in diets over time and relate these to recent developments in agriculture. When asked about the food eaten, people mention traditional Indian meals, consisting of *roti*[1], rice and vegetables. Most families have three meals a day, while some mention only two. No pattern is observed regarding frequency of meals across different regions. For breakfast and dinner, people usually eat roti with vegetables, while lunch also includes rice and pulses. At the same time, some farmers talk about a preference for rice that seems to have partially replaced the consumption of millets.

Regarding the types of foods that are considered "healthy", there seems to be a tendency for people to confirm as "healthy" the food they regularly eat. Generally, people often mention wheat *roti*, rice, milk and vegetables as being very healthy, with green leafy vegetables considered as being especially recommended to pregnant women. Finger and barnyard millet are also regarded highly, especially by some of the older people. In several instances comments were made about how the current generations are less strong, even when they eat more food. This is, in their view, a result of diets that are perhaps tastier, but poorer in necessary nutrients than the coarse grains that people used to eat in the past.

There is also awareness that food grown organically is better for health than that treated with agrochemicals. It is also for this reason that people trust more the food they grow at home than what is available on the market.

An interesting development that emerges from the interviews is that people eat fewer proteins than in the past. This is due to the fact that with less land they can keep fewer animals than they used to, resulting in a lower availability of dairy products. Older farmers recollect how in the old days people would eat more milk, butter and yoghurt, while now they cannot afford to keep more than one or

[1] Traditional type of flat bread

two cows of buffalos. Furthermore, families that do have milk in their household are likely to sell it to local commercial collectors, such as Mother Dairy. This is particularly the case in Orakhan.

**Intra-family food distribution**

The intra-family food distribution is a delicate subject, and thus it is difficult to ask it directly and to obtain accurate straightforward answers. Interviewees stated that everyone in the family eats equally, yet the direct observation was that women ate last, and usually what was left. In reality, it is thus possible that there exists a consistent difference between the diet of men, women, and older children.

**Infant feeding**

Infants are breast fed for up to two years. After the first six months, they are gradually introduced to solid food, such as rich, light vegetable mixtures (*khichdi*), roti, and pulses. Eventually they thus share the meals of the family, although with less spices (masala), a practice that is different from those in the past, when animal milk with roti was widespread as infant food. The common mentioned use of millets in infant food is in the form of roti, while only in Bageshwar interviewees recalled past use of finger millet and foxtail millet in pureed form, with milk and sugar. In recent years, farmers increasingly use processed baby food from the market, such as Cerelac and Bournvita.

**Interviews with Anganwadi workers**

Anganwadi workers are trained women, working within a governmental program, assisting the community with child care, education and health. Periodically they participate in trainings provided by the government and play a key role in advising families about child nutrition, supervising and encouraging vaccinations and teaching elementary kindergarten notions/skills. Three workers from different villages were interviewed, each working with around 20 children under the age of 7. The main purpose of these interviews was to triangulate data about nutrition and diets obtained from families with information about general health state of the community, as reflected by body measurements of the children.

In general, Anganwadis considered children to be adequately fed and healthy. They confirmed the information on breastfeeding and changes in infant diets, as well as the drop in animal milk consumption. However, they also saw positive developments, as they believed child diets were now more diverse and balanced than in the past. A role here was attributed to the government, which supported them in providing not only information for parents, but also 100kg of dhalia for each child, as well as vitamin supplements.

Where underweight child cases had been identified, Anganwadis claimed to have taken remedial actions, usually by talking to the parents and also obtaining nutritious food, such as fruit, from other villagers who would have it. Most cases of underweight children were reported in Bageshwar (Shakira village), in the poorer families, where there was also mention of pregnant women and infants not eating enough eggs and milk.

## MILLET CULTIVATION AND PREFERENCES

**TABLE 7. REPORTS OF MILLET CULTIVATION AND USES (PER REGION)**

| | Madua | | Madira | | Chua | | Ugul | | Kauni | | Cheena | | Total interviews |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Yes | No | Yes | No | Yes | No | Yes | No | Yes | No | Yes | No | |
| **Bageshwar** | 16 | 2 | 12 | 3 | 11 (3VS;3S;3V) | 5 | 7 (7V) | 1 | 13 | 2 | - | 2 | 18 |
| **Mauna** | 8 | - | 7 | - | 5 (2VS; 2V) | - | 3 (2V) | 3 | 4 | 3 | 1 | - | 8 |
| **Orakhan** | 3 | - | - | 3 | 3 (1VS) | - | - | - | - | 1 | - | 1 | 3 |
| **Suyalbari** | 19 | - | 17 | 1 | 8 (1VS; 3S) | 4 | 2 (1V) | 2 | 4 | 10 | 3 | 4 | 19 |

*VS = leafs used as Vegetable, grain used for Sweets; V=leafs used as vegetable*

Table 7 comprises an overview of the millets grown by villagers per main area of study. The local names are used in this entire section, to make it more convenient for Gene Campaign and future researchers to link the analysis to the field data. For conversion to the English or Latin name of the species, please refer back to Table 1.

The values under "yes" and "no" refer to the number of interviewees who mentioned that they were growing or not the respective crop. When these two numbers do not add up to the total number of interviews, it usually means that the farmers did not know what the respective crop was. For example, few people had heard about "cheena". There were only a few situations in which the non-response is due to not asking about that specific crop.

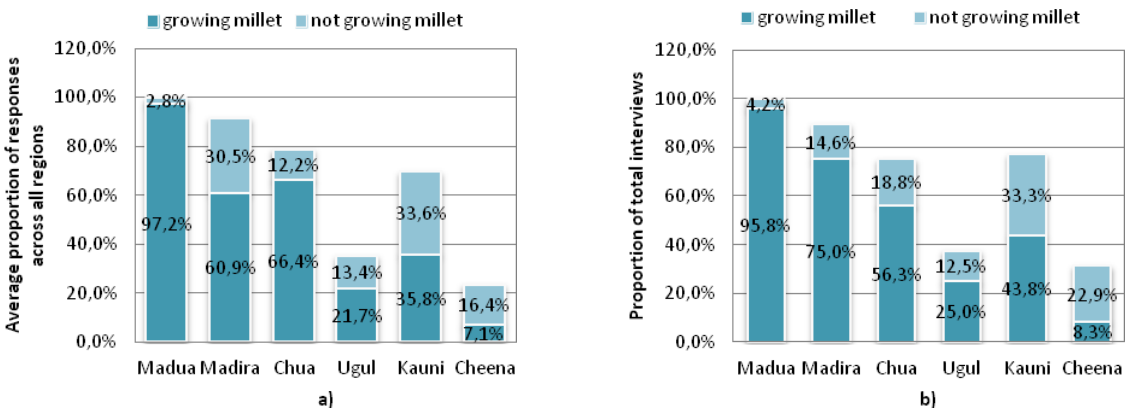


**FIGURE 11. A) NORMALIZED RESULTS MILLET CULTIVATION PER CROP.** This graph averages across all regions the percentages of respondents who reported growing or not growing the respective crop. This normalization accounts for unequal number of villages per study area and observed differences in interest for certain crops at this area level**; B) RESULTS MILLET CULTIVATION.** In this graph the proportions of respondents who reported growing or not growing a certain crop are calculated relatively to the total number of interviews. This is relevant to the extent to which we treat individual villages as theoretically identical and attribute any observed differences across regions to chance.

The number of discussions about a certain type of crop by comparison to the total number of interviews can be interpreted as an indicator of the perceived importance of that particular crop in the region. From the charts above (Figure 11) one can see that cheena and ugul are virtually unknown to many farmers. Especially in relation to these two, particular attention was paid to asking farmers whether they were growing them or not, and so the large difference in percentage by

compared to madua, for instance, cannot be attributed to the methodology employed in asking the questions.

Madua is by far the most popular type of millet grown in the studied region. Everybody knows about it and almost everyone grows it, across all four areas. Madira comes on the second place, but the interviews reveal that it is mostly used as fodder for animals. Chua and kauni are the next two crops in importance, but their cultivation patterns differ across regions. Cheena appears to be largely unknown. A further study should verify that there is no other local name by which this millet type might be known.

### Analysis by Type of Millet Crop

The following paragraphs provide more details regarding cultivation and use for each type of millet crop. An overview of the results of the qualitative analysis is presented in Table 8. While this does not serve exclusively as a basis for the next few sections, it provides a brief overview of the main findings.

**TABLE 8. MILLET PRODUCTION AND CONSUMPTION – CODING AND RESULTS**

| | Madua | Madira | Chua | Kauni | Ugul | Totals |
|---|---|---|---|---|---|---|
| **TRENDS** | | | | | | |
| Recognize decline in production | 5 | 4 | 3 | 6 | 1 | 19 |
| People don't eat the grain anymore | 1 | 8 | 3 (roti) | 3 | | 15 |
| **GROWING** | | | | | | |
| Grown only for animals | | 8 | | 2 | | 10 |
| Grown to sell | 1 | | | | | 1 |
| Still eating the grain | 35 | 1 | | 7 | | 35+8 |
| **EATING** | | | | | | |
| Is healthy | 14 | 6 | | 5 (med) | | 14+11 |
| As good as new crops | 1 | | | | | 1 |
| Better than other crops | 1 (jhoa) | | | | | 1 |
| Good taste | 4 | | | 1 | | 5 |
| **NOT GROWING / GROWING LESS** | | | | | | |
| Never grew here / not traditional in house/village | | 2 | | 1 | 1 | 4 |
| Modern times | 1 | 1 | | 1 | | 3 |
| New preferences young generation | 2 | 4 | | 1 | 1 | 8 |
| Replaced - better crop for food | 1 fruit | 2 wheat,rice | | 2 wheat | | 5 |
| Replaced - better crop for money | 1 veg | | | | | 1 |
| Difficult to grow | | 3 | | 2 | | 5 |
| Animal menace | | 1 | 2 | 1 | | 4 |
| Moved to city / Quit farming | 2 | | 1 (alone) | | | 3 |
| No seed available | | | 1 | 3 | 1 | 5 |
| Not enough land / resources (cow manure) | | 3 | | 1 | 2 | 6 |
| Not enough water to grow it | 2 | | | | 1 | 3 |
| **NOT EATING** | | | | | | |
| Food for poor | 1 | 1 | | | | 2 |
| Taste not good (people don't like it) | 2 | 3 | | 1 | | 6 |
| Health benefits unrecognized | 1 | | | | | 1 |
| Difficult to digest | 1 | 3 | | | | 4 |
| Cold-hot | 1 (hot) | 3 (cold) | | 1 (hot) | | 5 |
| Not enough to eat the grain | | 2 | 1 | 1 | 2 | 6 |
| Difficult to dehusk | | 7 | 1 | | 1 | 9 |

### Finger millet / Madua

Out of all the people interviewed, only two of them did not grow madua on their farm, out of which one had given up agriculture completely. Madua is grown solely for the household (or at most, to sell in the community) and people use it as flour to make *roti*.

Especially in the Suyalbari area farmers seem to be aware of the health benefits of madua – they mention that it is rich in calcium and that it can be used as heart medicine – while also appreciating the grain for its palatability: "everyone likes it and everyone eats it", reports a villager from Kamoli. In contrast, in the Bageshwar region, some people refer to madua as not being tasty, which could indicate a slight difference in preference between these areas. However, also here madua is spontaneously given as an example of what is considered healthy food.

Regarding cultivated varieties, it was only in Bageshwar that people could specify the type grown: "Nangchunia". In Suyalbari, they described it as a traditional variety, which grows up to 1 metre tall, reaches maturation after 6 months from planting and presents mixed flowers – some open fist, some closed fist.

**Barnyard millet / Madira**

Many people still remember a time where madira used to be part of their meal, but almost no one is eating the grain anymore. Instead, the straws are used as fodder for the animals. Madira is reported to be particularly difficult to dehusk and it is mainly for this reason that people decided to give it up from their diets when presented with more convenient alternatives, such as wheat or rice. In addition, its properties make it a difficult food to tolerate: most farmers say it is hard to digest, not tasty and essentially a "cold" food.

While the older generations still recognize the nutritional value of madira, the above-mentioned disadvantages, in combination with a scarcity of land (and thus a need to prioritize crops) make it an unattractive option for the young. In fact, when confronted with space pressures, farmers might abandon growing this crop completely and let their animals graze in the forest instead.

An interesting observation is that, although widely known in general, farmers in the area of Orakhan stated that madira had never been grown in their village. This is a region where many families have switched to cultivating cash crops already for some time, thus the question is raised whether the farmers' perception reflects an objective fact, or it tells a story about how a crop was abandoned and immediately removed from the collective memory of the village. A survey of a larger sample should be carried out in the area to further reveal this aspect, as it could have important implications for understanding the ways in which these ancient crops might be wiped out and forgotten in the face of new economic opportunities.

**Amaranth / Chua**

While many farmers still cultivate chua, most of the time they do it in very small patches and often mixed with other crops. The double utility of this crop – green leaves as vegetable and grains to prepare some traditional sweets – make it a popular type of millet. In the Bageshwar area some people still use chua as flour for roti and the overall interest for this millet seems to be higher than in other parts, with 89% of the interviewees mentioning it and 61% growing it.

While it is only possible to speculate on the matter, one of the reasons for this could be that chua had been grown in this region on a much larger scale than elsewhere or that the decline in cultivation

happened more recently than in the other studied areas. That would explain why it is still possible to find here people who use chua for roti and it would also match one farmer's testimony that his family used to grow this crop in quantities that were large enough for them to give it away for free to other villagers.

If that is indeed the case, then the causes of this decline need to be looked at in more detail. The only indication so far is that chua might be more susceptible to being attacked by animals (monkeys and mice) than other millets.

**Foxtail millet / Kauni**

The story about kauni is particularly interesting, as this seems to be a type of millet currently in transition. Most reports of cultivation come from the Bageshwar area, where farmers still eat the grain by preparing it similarly to rice. They also perceive it as having medicinal properties, especially useful for stomach problems or chicken pox.

In Suyalbari, on the other hand, while most farmers know about this crop, they also report that they used to grow it, but not anymore. This could indicate that kauni cultivation was abandoned quite recently. Many reasons are being invocated for this change, but no consistent pattern can be found in the answers; although some of its health benefits are still mentioned, and kauni is appreciated as "hot" food, and good grain for roti, it simply seems that kauni has grown out of fashion: "this is old stuff, nobody grows it" (villager from Sirsa), or "whoever likes it, eats it" (villager from Sirsa).

Lastly, in the area of Mauna people remember kauni, but state that they do not have the seeds anymore, while near Orakhan they do not know this grain at all.

**Buckwheat / Ugul**

Ugul is still being used near Bageshwar and Mauna, but it merely survives because of its leaves that are being eaten as vegetables. There was only one instance, in a remote village in the Bageshwar study area, when someone remembered ugul as once having been used as a grain for roti. The grains from ugul had been considered as acceptable during fasting, but that was not the custom anymore, reported a farmer from Ganotiparli.

None of the interviewees could provide information about papher, the buckwheat species that is used for straw (*Fagopyrum tataricum*). In one case someone said that papher only grew where there was water, but the context of this remark was not very clear, so this might have been a misunderstanding.

**Proso millet / Cheena**

As already pointed out, cheena remains the mystery millet crop in this study. While several people responded positively when asked whether they were growing this crop, no further information could be obtained about it.

### PATTERNS OF CHANGE

What could be said so far about the overall patterns of change in millet cultivation? First of all, it is clear that madua is a crop that is here to stay for a while, even though it might continue to be cultivated solely for personal use. The well-recognized health benefits, together with the palatability of the grain are probably the underlying causes of its popularity. However, madua stands as an outlier in the overall attitude regarding millets.

For other millets, a crossroad is apparent: most farmers acknowledge that there is a certain decline in the overall production (however it is not clear whether this is in absolute terms or relatively to other crops), while only about half of them report that they are still eating such grains. The opportunity for abandoning millet cultivation is created by land insufficiency and the necessity to prioritize crops, on one hand, and the hard work involved in processing these small grains, on the other. The driver in pursuing this path is comfort – in other words, if given a choice, people might prefer convenience over marginal improvements to health, for instance. It was only in few instances that an economic pursuit was offered as a justification for abandoning millet cultivation, in the Orakhan region where a few farmers have started to gradually convert to cash crops.

Culinary preferences come secondary to this and seem to be mostly reactive in nature to already changed habits. If the new generation does not prefer certain foods anymore this appears to be simply a consequence of the fact that they are no longer eating them. As soon as new preferences emerge, they seek to reinforce the new habit. Eventually a new state of equilibrium is reached, in which the memory of the initial state is lost.

In Figure 12 a general change model that builds on these findings from the field is proposed. While this needs to be further tested before any predictive power can be attributed to it, one can already use it as a mental scheme for understanding the stage in which a certain community might be regarding the cultivation and consumption of a certain crop. For each region and millet crop studied, the relative position is depicted on the change axis. Understanding the direction of development and the drivers behind it can help with identifying places for intervention.

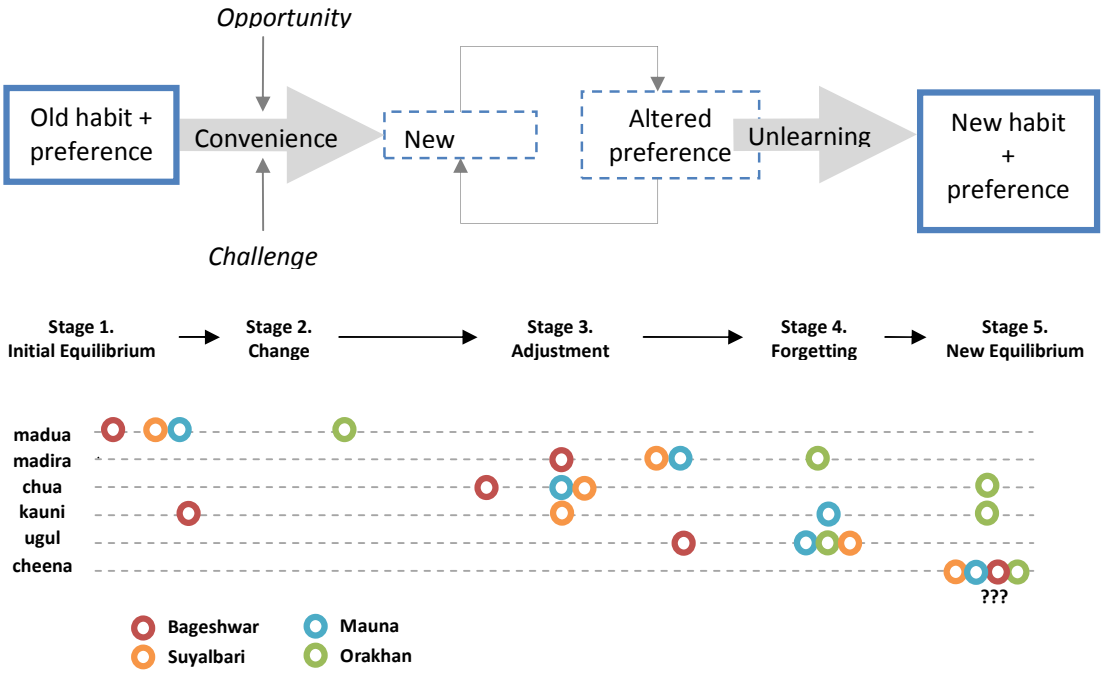


FIGURE 12. PATTERNS OF CHANGE IN MILLET CULTIVATION AND CONSUMPTION IN UTTARAKHAND

# CHAPTER 5: CONCLUSIONS

## TRENDS CONCERNING FOOD SECURITY AND MILLET CULTIVATION

In regards to the main questions of this study, and against the background of the results presented in the previous chapters, there are two major trends that have been observed as being at work in the Kumaon region of Uttarakhand:

1. Confronted with unavailability or inaccessibility of food, the major survival strategy that is adopted by subsistence farmers is outmigration. Switching to cash crops or starting other activities to generate sufficient income are no-go options for most families, who lack the knowledge or the investment capacity required by such businesses. This indicates that, without external intervention, abandonment of land and agricultural activities by locals might be the default outcome. If there is a future of agriculture in Uttarakhand, that will probably be under the ownership of other actors than the traditional local farmers.

2. In general, there is a total reduction of the areas and quantities of millets grown. As a type of food becomes less available, social preferences seem to be immediately adjusted, making it even less likely that the forgotten crop would be later on reintroduced. This means that a cultivated species can be wiped out in only a few generations if, for various reasons, it ceases to be interesting as a crop for a certain society.

The following sections discuss some of the underlying factors of these trends and the long-term consequences they might have on food security and millet cultivation.

## FOOD SECURITY BOTTLENECKS

**Insufficient Food Availability**

As it has become evident from the previous chapters, while farmers in Uttarakhand have been for centuries able to provide for their own food, today this is no longer possible. There are multiple *causes for the unavailability* of sufficient food, many of which are systemic and reinforced by other factors in the environment:

a) *Land scarcity and property relations:* with increasing population (in absolute numbers and in density) and land division, there is simply not enough land anymore to sustain the demand. Where abandoned land does exist, it is not necessarily accessible to those who need it, due to property relations. While in several cases, farmers reported having gotten permission from fellow villagers who moved to the city to use their abandoned land, there is no law that would protect the needy, and such uses are circumstantial.

b) *Erratic weather patterns and climate change*: The discussion about the effects of climate change on agriculture and the risks it poses to livelihoods has been treated elsewhere. In the present study, a recurring theme in field interviews was the lack of rain, a claim that is verified by meteorological data, showing negative deviation of rainfall relatively to normal values (see Figure 13). If this is indeed a sustained trend, the reduced availability of water might have long-term impacts on food availability.

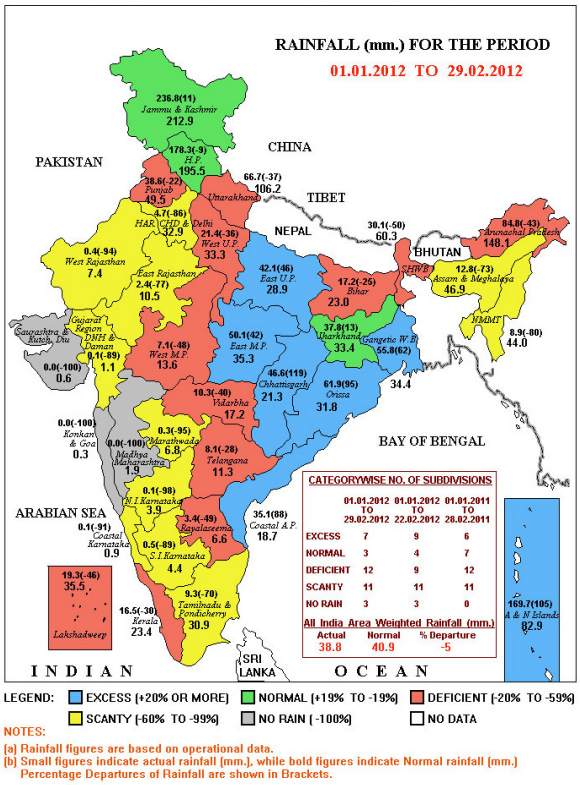


**FIGURE 13. RAINFALL IN INDIA DURING RABI SEASON 2012; SOURCE:** INDIA METEOROLOGICAL DEPARTMENT (2012).

c) *Lack of irrigation and water storage systems*: Most agriculture in Uttarakhand is rainfed, which means that even expected shortages of water cannot be compensated in the absence of irrigation infrastructure. In those few instances when they do exist, as it is sometimes the case in the region of Bageshwar, irrigation systems are old and unreliable and farmers cannot afford to maintain or repair them.

d) *Unavailability of manure*: With little land available, farmers can no longer afford to grow fodder and consequently they breed fewer animals, which are left to graze in the forest, which is also of degenerating quality. This results in a decrease of the quantities of manure available for agriculture. Studies show that in order to cultivate one hectare under rainfed conditions, anywhere between 2 and 15 hectares of forest land are needed for fodder and manure (Hrabvozsky and Miyan 1987 qtd. in Saxena et al 2005)

e) *Environmental deterioration:* Little is known about the quality of soil and the availability of nutrients, but observations of farmers denounce a decrease in yield. The use of agrochemicals in an ad-hoc manner might further exacerbate this problem in the future through e.g. land erosion.

f) *Lack of manpower and technology:* With the socio-cultural turn away from big joint families and because of outmigration, there is a lack of sufficient manpower to cultivate the fields at maximum capacity, following the traditional methods. Furthermore, this is also not compensated by technology (machinery), most likely due to the high costs involved, lack of information, and difficulty of the terrain.

g) *Lack of adequate information about agricultural techniques*: Despite VPKAS promoting a number of programs and running experiments on millet variety improvements (see also Appendix B), none of these efforts was mentioned in any of the farmer interviews. In general there seems to be little contact between farmers and governmental agricultural centres, with the exception of vegetable seed distribution. On the contrary, when it comes to techniques for improving yields, it is the local NGOs that are most active. Their introduction of new methods has been known to have positive effects (as it is the case of vermicomposting and organic fertilizers), but also negative ones in some cases (e.g. distribution in some villages of improved varieties of millets, at the expense of losing the traditional seeds).

**Inadequate Food Accessibility**

With lower food availability from own production, one might conclude that there is an increased dependency on the market. However, this is only partially true: since the main source of income for most farmers is the sale of perishable food or animals, when food insufficiency is due to too little land, there is also no capability to compensate it by buying food elsewhere. Figure 14 presents the data points at the intersection of land availability/capita and market expenditure/capita. With the reservation that the data should be treated with maximum caution, as it is based on rough estimates resulting from qualitative interviews, the graph indicates a clustering of points which suggests that indeed those with little land are also those who spend less money at the market. In the absence of alternative options for generating income, the poorest are the most vulnerable, as they will lack the means not only to produce enough food, but also to access food from elsewhere. In food security studies, cereal deprivation is often used as a proxy for poverty, as it is assumed that when cereal availability/capita declines it is the poor who will consume fewer cereals. *Land availability* becomes, thus, also a cause of inadequate food accessibility.

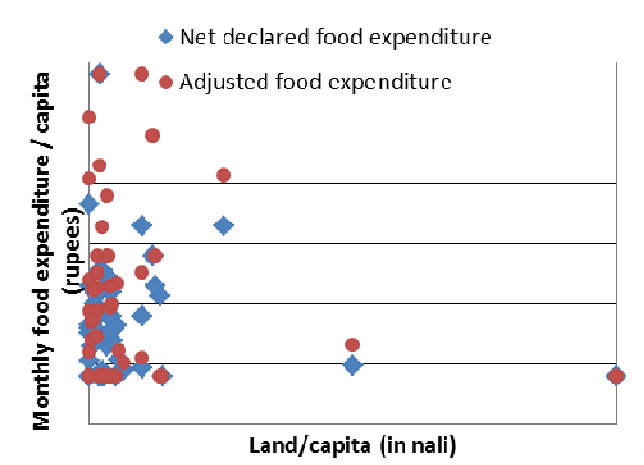


**FIGURE 144. RELATIONSHIP BETWEEN LAND/CAPITA AND MONTHLY FOOD EXPENDITURE/CAPITA (VALUES ARE ROUGH ESTIMATES)**

An additional bottleneck to food accessibility is the *lack of economic opportunities* for diversifying income sources. Other than the National Rural Employment Guarantee Act and occasional employment provided via NGO programmes, villagers need to move away from their home area in order to obtain a job. On the positive side, their remittances help fuel a local economy, thus

supporting other farmers who need a market to sell their produce. The downside is that this removes workforce from the community, making it more economically fragile.

The low purchasing power of local communities does not only affect food accessibility in a quantitative manner, but also qualitatively. Certain products such as fresh dairy and fruit are *unavailable on local markets*, due to their higher cost, while others may display higher prices because of the low demand.

**On food utilization**

The challenges related to food availability and accessibility also have consequences on the ability of villagers to meet dietary needs. It is often the case that higher nutrient food (e.g. milk, animals, eggs, fruit, vegetables) needs to be traded for bigger quantities of *lower nutrient foods* (e.g. rice) that can nevertheless sustain families for longer time.

Furthermore, the lack of sufficient land means that there is *land use competition* and farmers need to prioritize the crops to be cultivated. Such choices are not as much about nutritious qualities, as they are about risk distribution and taste preferences.

Lastly, cultural norms, in combination with insufficient food, might mean that certain age and gender groups are more exposed to nutritional deficiencies than others.

## Feedback Loops and Coping Strategies

From a systemic point of view, there are three major positive feedback loops that occur and that might need further attention, as they could also provide the opportunities for intervention:

1) The lack of manpower leads to less capacity for doing agriculture, which leads to unavailability of food and outmigration and thus even less manpower;

2) The more nutrient inputs are used without adequate testing of soil, the more the soil may get degraded which in turn will lead to even higher use of nutrient inputs;

3) Insufficiency of food produced on the farm, in combination with lack of other opportunities for income, triggers the necessity to sell part of this food which means that even less food will be available for consumption (or of lower quality).

In order to ensure resilience to causes of food insecurity, enhancing the ability of communities to break away from these feedback loops is essential. At the moment, there are three main coping strategies that farmers employ:

1) Use of governmental schemes: this refers to both employment programmes and food rations;

2) Use of local community as a safety net: people will help each other in times of need; the existence of SHG (self-help groups) also plays an essential role by providing, among others, access to loans and resources, as necessary;

3) Changes in diet: families will adapt their diets to what they can reliably procure in a certain season;

## Findings: Millet Cultivation Bottlenecks

The presently reduced cultivation of millets can be primarily attributed to land use competition in combination with changing preferences, as explained before. In addition, social perceptions that these crops are "food for the poor", as well as the extra work necessary to dehusk and process the grains, do little to increase the attractiveness of millets. During most of the interviews it appeared that only older people still remembered the health benefits of millets, while almost no mentions were made of their resilience to adverse environmental conditions. It seemed that valuable knowledge about millets had already been lost, as the younger generations have simply grown in the times of different food preferences and diets.

## Closing the Circle

Only one question remains to be answered in this study: could millet cultivation provide a solution to food insecurity?

In the beginning it was said that vulnerability involved the risk of exposure to crises, the risk of inadequate coping and the risk of severe consequences. The current field study revealed that food is becoming increasingly insufficient in Uttarakhand and that the ability of locals to cope with this problem without migrating elsewhere is very limited. The consequences of inaction are severe. If the people of Uttarakhand are to become more food secure and self-sufficient, the feedback loops mentioned earlier need to be broken, by: creating more economic opportunities locally, enhancing agricultural efficiency through, for instance, agro-forestry systems or irrigation infrastructure, educating farmers about nutrition and supporting them in continuing to practice intercropping and organic farming.

Millets might help with all these three aspects, especially if the economic potential of derivative products, such as beer, could also be exploited. While now on a declining path, perhaps millet popularity could be reversed if the farmers would regain knowledge of these cereals' properties.

Regardless of the strategies and policy interventions to be adopted in the future, one important aspect that needs to be kept in mind is that, faced with resource shortages, people will continue to exhibit an opportunistic behaviour, where they will strive to find temporary fixes to their needs. Generating income will stay a priority, as legal tender is seen as insurance in front of all other uncertainties related to agricultural production. However, the degree of success at fulfilling the needs of the family does not depend only on the personal characteristics of the individual, but also on the given circumstances, such as resource availability, education, access to information etc. The saying that "the rich get richer while the poor get poorer" remains true, even when in this case "rich" is something relative, referring to people who are essentially poor, but just slightly better off than the others. Encouraging millet cultivation, or any other such measure alone, cannot be a solution to the problems of the most vulnerable. The nutritional properties of grains or their commercial value do not help the family that only owns 1 nali of land, in the same way in which the monthly ration of wheat cannot take all their worries away. For these groups, reforms and aid need to go further beyond such measures.

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# APPENDIX A: FOOD SECURITY AND MILLET CULTIVATION – INTERVIEW QUESTIONS

**Household situation:**

1. How many people live in this household? How big is your farm (in nali)?
2. Does anyone in the family have a job outside the farm?

**Sources of food available in the household:**

3. How much of your family's food do you grow at home? What do you grow? In which seasons?
4. Which pseudo-cereals (madua, madira, cheena, kauni, amaranth/chua/marsu and ugul/papher/kutu/buckwheat) are you cultivating today?
5. How much of the family's food is bought from the market?
6. I see that there are forests around – is there any food growing there? E.g. mushrooms, berries.. etc.

[If 2]: Food purchased and consumed outside of home: does that family member get food at work?

7. Do your children get food at school? What do you think about that? Do you participate in other governmental schemes?
8. Do you make food reserves for times of bad crops or from one season to another? What do you store? Any problems?
9. Do you exchange food with other family members outside this farm?

**Limiting factors for availability of food in the household:**

*Access to food from market:*

10. What kind of food do you buy on the market? When? Is it hard to find these foods on the market?
    a. For e.g. What did you buy in the last week?
11. Is the market difficult to reach? Is that a problem? Also when it snows?
12. How often do you go to the market to buy food?
13. How much money (per month) do you spend on buying food? What share of the income is this?
14. What sources of income do you have?
    a. Do you sell some of the food you produce on the farm? What?
    b. How else do you earn your money?
15. Generally, you find the food that you buy on the market to be: a) very expensive; b)expensive; c)affordable; d) cheap; e)very cheap;
16. Do you think that the prices of the food on the market changed in the last years? How? a) Become more expensive; b) Become less expensive; c) The prices remained more or less the same; d) I don't know.

*Availability of self-produced food and limiting factors:*

17. Do you think you produce enough food for your family? What are the problems?
    a. What are some of the things you do to ensure that there is always enough food?
18. Do you have animals? How many? What do you feed them? From own production?
19. What surface do you cultivate? Is it the same as last year?
20. How much food did you produce this year? How much did you produce last year?
21. Millets: How much of the millet crops do you cultivate? (Land - nali, Production)
    a. Do you cultivate these for food/fodder(straws) or to sell?
    b. Do you cultivate and process these grains by hand / with the help of a machine?
22. Do you rotate your crops? Intercropping? What do you mix them with? (also millets)
23. What do you think about the soil?
24. How do you fertilize your crops? Compost? What kind? Why?
25. How do you protect your crops from pests? What about in the past?
26. Do you use artificial pesticides?

**Limiting factors productivity / changes to productivity rate**

27. How was this year's crop by comparison to last year? (better, worse, the same). Why? (weather, changes in agricultural practices)
28. Did your methods of cultivation change? How and why?
    a. Are you cultivating different crops than 10 years ago? Why?
        i. Where you cultivating more millets or different types in the past?
        ii. Why have you abandoned these pseudo-cereals? Problems? (wild animal menace/non-availability of good strain/seeds, etc.)
        iii. Was the earlier cultivation of small cereals better for food? Or is it better now? Why?
        iv. Are the crops you are cultivating now better for money?
        v. Is it less or more work to grow these crops by comparison to the ones you were growing in the past? (weeds, etc.)
    b. Did you switch to new varieties of crops? Do you use hybrid seeds?
        i. Do you use improved varieties of seeds?
29. Which of the following types of millet seeds do you use?
30. Do you store your own seeds or have to buy them every year? Where do you get them from?
31. Would you like to produce more food? What are the problems?
    a. Do you have enough man power?
    b. Do you use any machines?
    c. Have you noticed any changes in the environmental conditions in the last 10 years?
    d. Do you think you have enough access to information about the best agricultural practices / new technologies etc.? From which sources? (Chirag, agricultural departments..)

**Limiting factors in the conversion to food available for consumption & coping strategies:**

[If 12a]: How much of the food you produce do you sell? How do you decide what to sell and what to keep for your own consumption?

32. What do you sell? Do you also sell milk or cheese? When?

33. What do you do in a year of bad crops? A) buy more food on the market; b) eat food stored from previous year; c) eat less food; d) rely on help from family/friends; e) other
    a. Are you worried that you might run out of food in a bad year?
34. In times of crisis (health problems, family situation, loss of job) what did you do? Who helped you?
    **a.** Did you buy/cook different foods in such a situation?

**Limiting factors in the conversion food for sale - income:**

35. Where do you sell the food? Cooperatives? Help?
36. Do you think you get a fair price for the food you sell? What are the problems?

**Food/millet consumption and utilization**

37. What is eaten in the family for each meal? Can you give me as an example – the last 24 hours?
38. What does the man eat? What does the woman eat? What do the children eat?
39. How long do you breastfeed newborns?
40. What are the infants fed before moving to solid food?
    a. What were they fed in the past?
41. Where do you get the water you drink? Is this source reliable?
42. What does a "good"/ "complete" meal mean? – quality, healthiness etc.? How often do you have such a meal?
    a. What do you eat for festivals? Are there traditional foods that you use millets for? Any special occasions? (fasts, festivals…)
    b. What kind of food you take/not during illnesses? Do you use millets as medicine? For what kind of illnesses? (fever..etc).
    c. Has anyone in the family been ill recently?
    d. Which foods do you like best? Do you like millets?
    e. In what other ways do you use millets? (buckwheat: honey plant, upholstery filling, beer, biological control of pests).

# APPENDIX B: VPKAS RESEARCH ON MILLETS

The following information is compiled from the annual reports of VPKAS Almora, over a period of 14 years.



## STATUS AND EVOLUTION OF **FINGER MILLET** IMPROVEMENTS

1997-1998:

**Released variety: VL Mandua 146**

- early duration (95-100 days)
- productivity in trials: 27,32 q/ha
    - 17% higher than early duration PES 400
    - 9% higher than medium duration VL Mandua 149

*Studies against*: VL Mandua 149; RAU-8, VL Mandua 124, VL 313, PES 400

*Disease management:* VL Mandua 204 -- treated with 5 fungicides -- best germination Carbendazim and Panchgavya (bio-product); Systhane reduced blast lesions to 17.6 and infection 20.7% compared to control

1998-1999:

*Studies against:* VL 146, RAU 8, PES 400, VL Mandua 149

*Pre-released:* VL 253 and VL 283 could not yield more than VL 149 (43.10 q/ha)

2000-2001:

African accessions

*Nitrogen tests:* pre-released VL 283 and VL 253 not higher than VL 146, best yield with 60 kg N/ha

2001-2002:

Under preparation: a finger millet germplasm catalogue with data on 30 qualitative and quantitative

traits of 873 accessions is under preparation.

2002-2003:

*Studies against* HR 374, VL 149, PES 400

2003-2004:

**Released variety: VL Mandua 315**

- out-yielded Vl Ragi 146 (10.61% margin) and PES 400;
- finger and neck blast incidence is less than in checks
- response up to 40 kg of Nitrogen application

2004-2005:

*Variety identified*: **VL Mandua 324**

- high yielding - 2046 kg/ha, out-yielded VL 146 by 23.7%
- medium duration (110-120 days)

*Studies against*: HR 374, VL 315 and VL 146

2005-2006:

**Released variety: VL Mandua 324**

- released by Uttaranchal State Varietal Release Committee for lower and mid hills of Uttaranchal
- Compact fist type ear head with densely packed grains. The grains are partly covered with glumes and very light copper colour

*Variety identified*: VL 326 out yields VL 146 by 16.86%

*Studies against*: VL 315, VL 149

2008-2009:

**Farmer perception**: "Farmers selected those finger millet genotypes which were having large and compact ears and disease resistant out of 33 genotypes. Genotypes VR 390 and VR 402 were selected by more than 70% farmers" (VPKAS Report 2008-2009, p. 24)

2010-2011:

*Studies:*

- on adaptability of brown grained finger millet strains and white grained finger millet strains;
- studies on pre-released medium duration varieities (OEB526 and PRM 6107) and early maturing (VL 347) -- OEB 536 highest

*Mention:* an initiative to develop high yielding, early maturing and blast resistant white grain finger millet genotypes suitable for hills is mentioned to have started in 2003-2004. That is because:

> "The dark colour flour of finger millet to some extent acting as a deterrent for its wide spread acceptability, especially in urban market. Chapatis from white coloured grains of finger millet are acceptable by urban millet consumer. However, majority of white grain finger millet genotypes are late and susceptible to blast disease, therefore not suitable for cultivation in hills" (p.x)

**Farmer perception:** VL 324 and SDFM 69 selected by 85% of farmers -- large and compact ear type coupled with early maturity and higher grain as well as fodder yield. High yielding genotypes not selected because of open ear and dwarf plant type.

*Farinograph:* better flour from brown millet

STATUS AND EVOLUTION OF **BARNYARD MILLET** IMPROVEMENTS

1997-1998:

*Studies*: against VL Madira 29 and VL Madira 21

*Disease management:* Consistently tolerant to grain smut disease: GECH 711, GECH 712, GECH 719,

GECH 742, VL 129 and VL 174

*Nitrogen application:* Nitrogen application under rainfed conditions:

- VL 175 and VL 178 tested under three levels of nitrogen (0, 20 and 40 kg N/ha), against VL Madira 29
- VL 178:
  - 22% more -- 18.33 q/ha
  - 40 kg N/ha -- 18.56 q/ha -- 42.2% higher than no nitrogen
    -- 13.8% higher than 20 kg N/ha

1998-1999:

*Studies*: VL 172 highest grain yield (25.98 q/ha) against K1

*Integrated Weed Management:*

- 18.24 q/ha -- highest -- hand weeding twice
- Isoproturon 0.75 kg/ha pre-emergence spray + hand weeding (17.66 q/ha)

2000-2001:

*Nitrogen application*: pre-releasd VL 181 -- highest grain yield compared to VL 158 and VL 179 and K1

2001-2002:

**Released: VL Madira 181**

- in Bihar, Karnataka, Madhya Pradesh and Tamil Nadu by CVRC
- mean yield: 1853 kg/ha -- better than VL 29 by 20%
- early flowering (47 days), early maturing (77 days) - suitable for 200% cropping intensity
- non-shattering, non-lodging habit and easy threshability

*Nitrogen application:* pre-released VL 182 highest yielder (2410 kg/ha), but significantly superior to RAU-11

2003-2004:

*Studies:* against checks VL 29, VL 172

2004-2005:

*Studies:* against VL 29, PRJ 1, VL 172

2005-2006:

*Studies:* against VL 172 and VL 29

2006-2007:

*Variety identified:* An easy de-hulling barnyard millet identified: Accession B-29 (usually de-hulling is a very cumbersome process

2008-2009:

**Released: VL Madira 207**

- High yielding, grain is smut resistant
- Developed by pedigree method from VL Madira 172 (high yielding) and GECH 506 (semi-dwarf genotype)
- 1642 kg/ha -- 20.65% more than VL Madira 29 (1361 kg/ha) and 22.63% more than K1 (1339 kg/ha)
- Improved plant type with high harvest index (25%) by comparison with checks
- Reistant reaction to grain smut (6.67%) -- a major disease in barnyard millet

*Farmer' selection*:

- VB 433m VB 440 and VB 447 - selected by more than 70% of the farmers. "Farmers selected those barnyward millet genotypes which recorded synchronous maturity" (p. 24)

2009-2010:

**Genetic Stock Registered: Kagazi Madira B29 (INGR 09023)**

→ Easy de-hulling type (also tested with Vivek Thresher), de-hulled 40-141.4% faster over other check varieties

*Disease management:* Grain smut caused by Ustilago panicifrumentacei Brefeld is the major disease of barnyard millet -- reduces grain yield by as much as 60%

2010-2011:

*Studies*: on pre-released VL 221 and VL 222. VL 172 (check) performed best. Also, no significant differences on N use.

STATUS AND EVOLUTION OF **AMARANTH** IMPROVEMENTS

2000-2001:

*Studies:* PRA 9101 highest yield (1700 kg/ha) compared to PRA 9801 (966 kg/ha)

2001-2002:

*Studies:* IE 3754 1776 kg/ha highest yield compared to PRR 9101 - 620 kg/ha(just trials, though)

2002-2003:

*Studies:* against PRA 9101

2003-2004:

*Studies:* against Annapurna

*Nitrogen application:* studies of pre-released VL 44 at different levels of nitrogen. VL 44 significantly superior to Annapurna (1385 kg/ha)

2004-2005:

*Studies:* none of the tests superior to check Durga - IC 35407

2005-2006:

**Release: VL Chua 44**

- → early maturing (110-120 days)
- → this is a pure line selection from IC 5564, yield superiority of 24.18% over PRA 9501 (1063 kg/ha), 36.36% over PRA 9401 (968 kg/ha) and 40.42% over PRA 8901 (940 kg/ha)
- → significantly superior to Annapurna at all nitrogen levels
- → matures 16-30 days earlier than other released varieties thereby escape leaf webber infestation.
- → non-spiny bract - reduce drudgery of women during threshing operation

*Variety identified:* IC 423400 -- an amaranth accession with ability to regenerate after frost injury – tested during rabi season 2005-06

Joshi and Rana (1991) had also reported more distribution of A. Caudatus at higher elevations – this accession is a collection from higher hills [need to check from which report this piece of information was]

2009-2010:

*Studies:* none of the test entries was found superior to best check IC-35407 (2.529kg/ha)

2010-2011:

*Studies:* none superior to Durga IC-35407

STATUS AND EVOLUTION OF **BUCKWHEAT** IMPROVEMENTS

2000-2001: Simla B1 (630 kg/ha) gave highest yield compared to VL Uggal 7 (248kg/ha)

2001-2002: none of the tests could surpass VL Ugal 7 (638 kg/ha)

2002-2003: studies against Himpriya

2003-2004: studies against PRB 1

2004-2005: none better than Himpriya (1250 kg/ha)

2009-2010: none of the test entries was found superior to best check VL Ugal 7 (853 kg/ha)

STATUS AND EVOLUTION OF **PROSO MILLET** IMPROVEMENTS

2005-2006: evaluations under organic mode. PRC 405 maximum yield 1213 kg/ha followed by PRC 407 (1150 kg/ha)

VIVEK THRESHER

2002-2003: pp. 87-89

- In order to reduce post harvest losses, a thresher was developed
- The purpose of **Vivek Thresher-1** is to thresh, de-husk and pearl madua and madira grains.
- *Mode of functioning:*
    - "It works on the principle of impact and shear on the grain for the purpose of threshing, de-husking and pearling. The threshing drum is fitted with a leather-flat as a cutting device, which provides gentle impact and shear on the grain. The threshing chamber is fitted with a sliding door, which is kept closed for specific period of time so as to allow repetitive impact and shearing to detach the hulk from the grain. It helps in complete threshing and de-husking of the mandua/madira. The sliding door is opened at a certain interval to take out the threshed materials. " p. 89
    - For madua: thresing and pearling are done simultaneously
    - No pre-treatment required
- *Threshing capacity*: 10-11 kg grain/hr
- *Efficiency:* 99% at 15% moisture content, % broken grain <1%,
- *Cost:* 5500 Rs.
- Advantages:
    - Rapid threshing
    - One man for whole operation
    - Lower threshing costs
    - Grain quality maintained
    - Minimal seed damage -- seed quality (germination) may be improved

2003-2004:

- Vivek Thresher-1 was *improved*
    - *Capacity*: increased to 30-35 kg grain/hr; efficiency 98%;
    - *Pearling capacity*: finger millet 40-45 kg grain/hr
    - *Pearling capacity*: barnyard millet 2.5-3 kg/hr
    - *Cost*: 7000 Rs.

2004-2005:

- Vivek Thresher-1: **98 units commercialized**
- Discussions on whether to build a paddy thresher

2005-2006:

- a **multi crop thresher** designed at VPKAS, after incorporating some modification in Vivek Millet thresher

2009-2010:

- A 5HP electric motor driven **millet dehuller** (capacity =40-50kg/h) was designed, developed and optimized for process and machine parameters.
- *Pay back period:* 9 months