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Trends in Agriculture and Agricultural Practices in Ganga Basin

Part I: Uttarakhand

GRB EMP : Ganga River Basin Environment Management Plan

by

Indian Institutes of Technology

IIT Bombay | IIT Delhi | IIT Guwahati | IIT Kanpur | IIT Kharagpur | IIT Madras | IIT Roorkee

Preface

In exercise of the powers conferred by sub-sections (1) and (3) of Section 3 of the Environment (Protection) Act, 1986 (29 of 1986), the Central Government has constituted National Ganga River Basin Authority (NGRBA) as a planning, financing, monitoring and coordinating authority for strengthening the collective efforts of the Central and State Government for effective abatement of pollution and conservation of the river Ganga. One of the important functions of the NGRBA is to prepare and implement a Ganga River Basin Management Plan (GRB EMP).

A Consortium of 7 Indian Institute of Technology (IIT) has been given the responsibility of preparing Ganga River Basin Management Plan (GRB EMP) by the Ministry of Environment and Forests (MoEF), GOI, New Delhi. Memorandum of Agreement (MoA) has been signed between 7 IITs (Bombay, Delhi, Guwahati, Kanpur, Kharagpur, Madras and Roorkee) and MoEF for this purpose on July 6, 2010.

This report is one of the many reports prepared by IITs to describe the strategy, information, methodology, analysis and suggestions and recommendations in developing Ganga River Basin Management Plan (GRBMP). The overall Framework for documentation of GRBMP and Indexing of Reports is presented on the inside cover page.

There are two aspects to the development of GRBMP. Dedicated people spent hours discussing concerns, issues and potential solutions to problems. This dedication leads to the preparation of reports that hope to articulate the outcome of the dialogue in a way that is useful. Many people contributed to the preparation of this report directly or indirectly. This report is therefore truly a collective effort that reflects the cooperation of many, particularly those who are members of the IIT Team. A list of persons who have contributed directly in preparing this report is given on the reverse side.

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1. Introduction

The Ganga river, being a perennial source of water, facilitates both surface and groundwater irrigation for agriculture. However, high population growth, rising per capita income, and as a result, increase in the living standard of people, have encouraged farmers to diversify agriculture towards high water intensive crops such as sugarcane, paddy and wheat which put more stress on the water resources of the basin area. Although, the Ganga and her tributaries flow across Uttarakhand, the use of river water in the agriculture of the state is quite limited due to sloppy and rocky terrain. Apart from minor irrigation works, there is hardly any possibility in the development of surface and ground water irrigation system in the hilly regions of the state. On the other hand, in the plain areas of the state, both surface and groundwater irrigation facilities are available. Agricultural productivity in the plain regions of the state is at par with that of Western Uttar Pradesh, Haryana, and Punjab, while in the hill regions, agricultural activities are mostly carried out at the subsistence level under rain-fed conditions.

For the effective and sustainable management of the basin, an understanding of growth and composition of population, sectoral composition of workforce, change in land and water use patterns, settlement patterns, livelihood patterns and their possible impact on the river water resources, inter alia, is imperative. Management of the basin is required to be viewed as a part of the broader environment and in relation to socio-economic demands and potentials, acknowledging the political and cultural context, as water is not only an economic resource but also a socio-cultural and environmental resource. Agriculture is the major livelihood activity of majority of rural population in the basin area. Thus, a comprehensive study needs an attention to document the dynamics of agriculture in the basin area, understanding the nature and extent of dependency on it, and to suggest alternative livelihood options to augment the income of rural workforce, reducing the stress on river water resources. Keeping these aspects in view, this report concentrates on the trends in agriculture in the Uttarakhand portion of the basin area and its implications for the river basin management.

The data and information presented in the present report are based on secondary sources available on website of Government of Uttarakhand (www.uk.gov.in) and Statistical Diary of both Garhwal and Kumaon Division for various years. For most of the agricultural indicators, the data and information are manipulated to present a scenario of at least 20 years in the state and its districts. The information on selected agricultural indicators are presented mainly in the form of proportions and averages during different periods and across the districts of Uttarakhand. Other specific methodology, if any, is presented in the relevant sections of the report.

2. A Brief Profile of the State of Uttarakhand

Uttarakhand is located between latitudes 29°5'-31°25'N and longitudes 77°45'-81°E covering a geographical area of 53,485 km^2 of which 93 percent is mountainous. The region comprises of two administrative units viz., Garhwal (northwest portion) and Kumaon (southeast portion). A separate state 'Uttaranchal' comprising the 13 districts of these two administrative regions and Haridwar district from Uttar Pradesh was created as the 27th state of the Republic of India on 9th November 2000. In January 2007, the name of the state was officially changed to Uttarakhand from Uttaranchal. Its capital is located at Dehradun. About 34,650 km^2 area is under forest cover. The recorded forest area constitutes 64.8 percent of the total reported area, though the actual cover based on remote sensing and satellite imagery information is only 44 percent[1].

As per the 2011 census, population density is 189 persons per km^2. More importantly, with over fifteen important rivers and over a dozen glaciers in the state, Uttarakhand is a valuable fresh water reserve. The average annual rainfall of the state, as recorded, is 1,547 mm. For the administrative purposes, the state has been divided into two sub-divisions, Kumaon and Garhwal. Kumaon division includes six districts, namely, Almora, Bageshwar, Champawat, Nainital, Pithoragarh, and Udham Singh Nagar; while Garhwal division consists of seven districts, viz., Dehradun, Haridwar, Pauri, Rudraprayag, Tehri and Uttarkashi. The state has 78 tehsils, 95 development blocks, 671 Nyaya Panchayats, 7,227 Gram Panchayats and 15,761inhabited villages[2]. Figure 1 depicts the geographical location of the state of Uttarakhand with all its 13 districts. The state shares the international boundary with Tibet in the wide northeast and with Nepal in the southeast. The state is also bounded by state of Himachal Pradesh in the north-west and Uttar Pradesh in the south.

According to Census 2011, the state accounts for 8.49 million population with 4.33 million males and 4.16 million females. Out of total 8.49 million population of the state, SC and ST constitute 1.52 million and 0.26 million respectively. The decadal growth rate of the population of the state has declined from 24.2% during 1981-91 to 19.2% during 2001-2011. It has sex ratio of 963 and has a literacy rate of 79.6 percent with 88.3 percent literacy among males and 70.7 percent among females. Literacy rates among SCs and STs are relatively lower at 63.4 percent and 63.2 percent respectively.

The workforce constitutes 37 percent of total population, of which 74 percent are main workers and 26 percent are marginal workers. Out of the total workforce, 1.57 million are cultivators (including main and marginal cultivators), 0.26 million are agricultural labourers, 0.07 million people work in household industries and 1.23 million people are engaged in other activities.

The major source of livelihood of the population in the state is agriculture. Almost 70 percent of the population is engaged in agriculture. Out of the total reported area, only 14 percent is under cultivation and over 55 percent of the cultivated land in the state is rain-fed with cropping intensity at 161 percent. Agriculture covers 7.81 lakh hectares of land, out of

which 4.43 lakh hectares appear to be under Hill regions, which is around 56.8 percent of the total agricultural land while the plain region constitutes 3.37 lakh hectares (43.2%). Irrigated areas in the Hills are around 10 percent whereas it is around 85 to 90 percent in the plain areas. The average size of land holding is around 0.68 hectare in the hills and 1.77 hectare in the plains. Of the total 9.26 lakh farmers in the state, small and marginal farmers constitute around 88 percent. The subsistence nature of agriculture in the hill districts provides nothing but a low and unstable annual income to the people, causing a sizeable out-migration of male members from the family, leaving behind a large number of female-headed households. As per the BPL survey 2008, about 36.5 percent of the population of the state lives below poverty line.

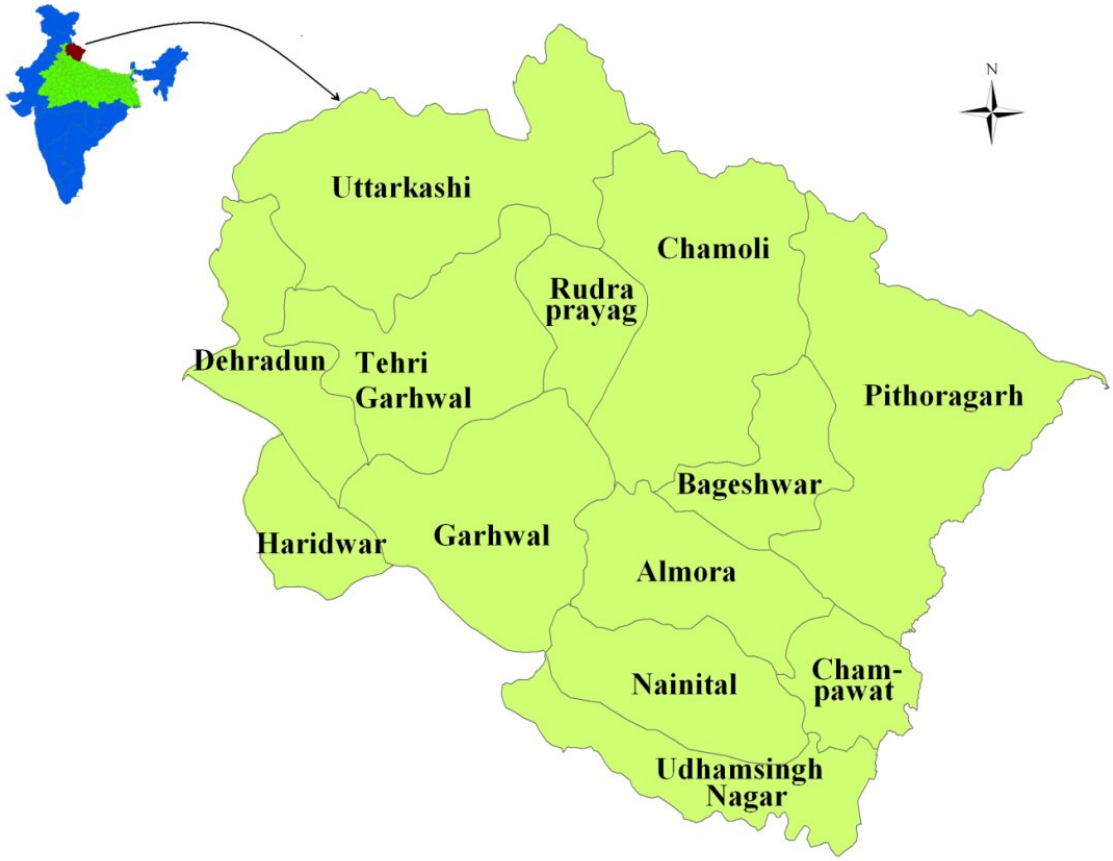

Figure 1: Location of Uttarakhand (with districts) in the Ganga Basin and in India

3. Trends in Sectoral Composition of GSDP

Trends in the sectoral composition of real gross state domestic product (GSDP) at factor cost are shown in Figure 2. Detailed data are given in Appendix. Primary sector comprises agriculture, forestry and logging, fishing, and mining and quarrying. Its share in the total GSDP steeply declined from 40.1 percent in 1993-94 to 20.5 percent in 2006-07.

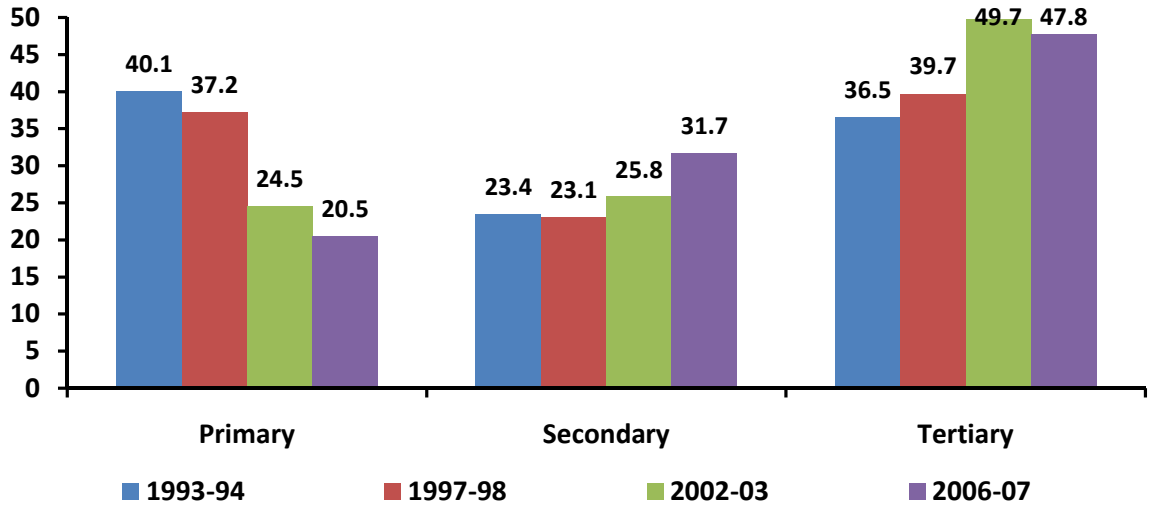

Figure 2: Trends in Sectoral Composition (%) of Real GSDP at Factor Cost, Uttarakhand, 1993-94 to 2006-07

The share of agriculture, including horticulture and livestock, has declined from 33.8 percent in 1993 to 17.8 percent in 2006-07. Secondary sector consists of manufacturing, construction, and electricity, gas and water supply. The contribution of this sector went up from 23.4 percent in 1993-94 to 31.7 percent in 2006-07. It is significant to note that the percentage share of manufacturing sector in the total GSDP has actually declined from 14.2 percent in 1993-94 to 12.4 percent in 2006-07. This implies that the increase in the share of secondary sector is due to the increase in the share of construction and electricity, gas and water supply. Although contribution of tertiary sector has increased from 36.5 percent in 1993-94 to 47.8 percent in 2006-07, there has been some decline in its share after 2001-02 (refer Appendix).

Figure 3 shows the occupational distribution of main workers according to 2011 Population Census. It is evident from the figure that more than 58 percent (farmers + agricultural workers) of main workforce directly depends on agriculture for their livelihood. The proportion of such workers is much higher in the hill region (61.8 %) than the plain region (48.7 %). As compared to Census 2001, there is a noticeable change in the proportion of workforce dependent on agriculture between these two regions. A growth of nearly 38 percent in the proportion of workforce directly dependent on agriculture was observed in plain region compared to a decline of 8 percent in hill region during 2001-2011.

It might be observed that the proportion of agricultural labour is almost negligible in hill region (3.3%) while it is about 22 percent in the plain region. Contrary to this, percentage share of farmers in the total workface is much higher (58.5%) in hill region than in plain region (26.4%). This implies that due to inadequate livelihood options available to the people of the hill regions, a majority of them depend on their small size of land holdings for the survival whereas in plain region, apart from developed agriculture, there are lots of other livelihood alternatives.

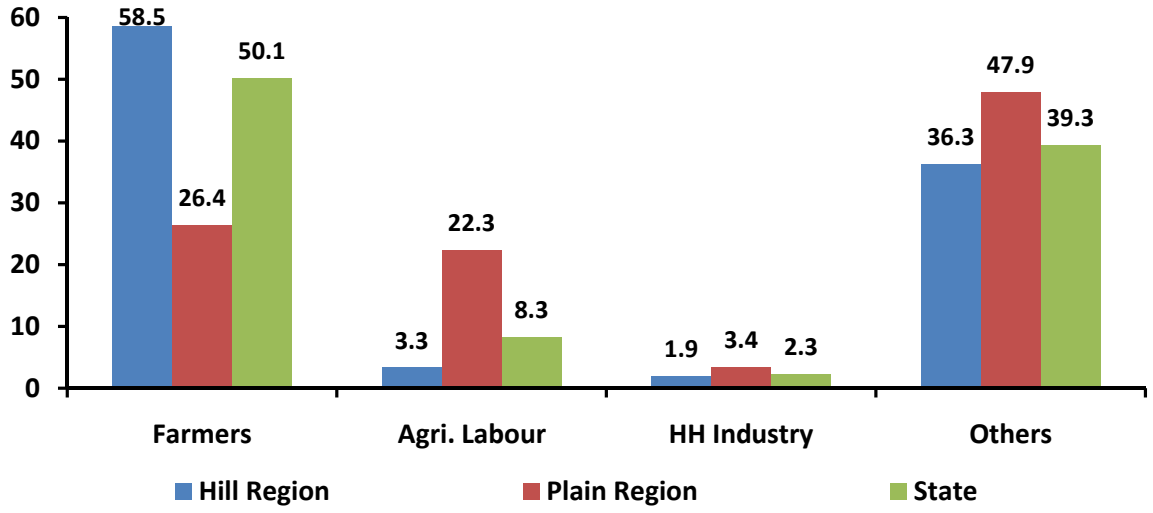

Figure 3: Proportion (%) of Main Workers by Occupational Category, Uttarakhand, 2011

This is also evident from the share of other workers in the total main workers, which is higher in plain region (47.9%) compared to the hill region (36.3%). However, at the state level, a decline of nearly 14 percent has been observed in the proportion of workforce in this category (others), compared to an increase of more than four times (63%) in the proportion of agricultural labour and 8 percent growth in the proportion of farmers during 2001-2011.Thus, the data suggests that although the income trajectory has gradually shifted from agriculture and allied activities to non-farm activities, there has not been a commensurate decline in the dependence of workers on agriculture. Consequently, the livelihood of people engaged in the agriculture has been marginalized vis-à-vis those engaged in secondary and tertiary sector.

4. Trends in Land Use Pattern

There may hardly be any remarkable change observed in the land use pattern of Uttarakhand during last 20 years. However, some changes can be noticed after 2000-01, when the northern hilly region of then Uttar Pradesh emerged as an independent state of Uttarakhand. As Figure 4 shows, there is a sharp change in the proportion of land used under different categories, which might be attributed largely to the inclusion of Haridwar in Uttarakhand.

Consequently, the land under agriculture (i.e. net sown area) grew by 10 percent, declining the proportion of forestland up to 7 percent from the level during 1995-96 to the level during 2000-01. During the same period, growth of nearly 16 percent in the proportion of land under non-agricultural use is also observed, which in subsequent periods appears to have declined again to the level as low as 4 percent during 2008-09. Area under forest and agriculture has especially remained same at 60 and 13-14% respectively during last 10 years in the state. The cultivable wasteland and the fallow land share a proportion of 1 to 2 percent in total reported area of the state, and record hardly any noticeable change during 2000-01 to 2008-09.

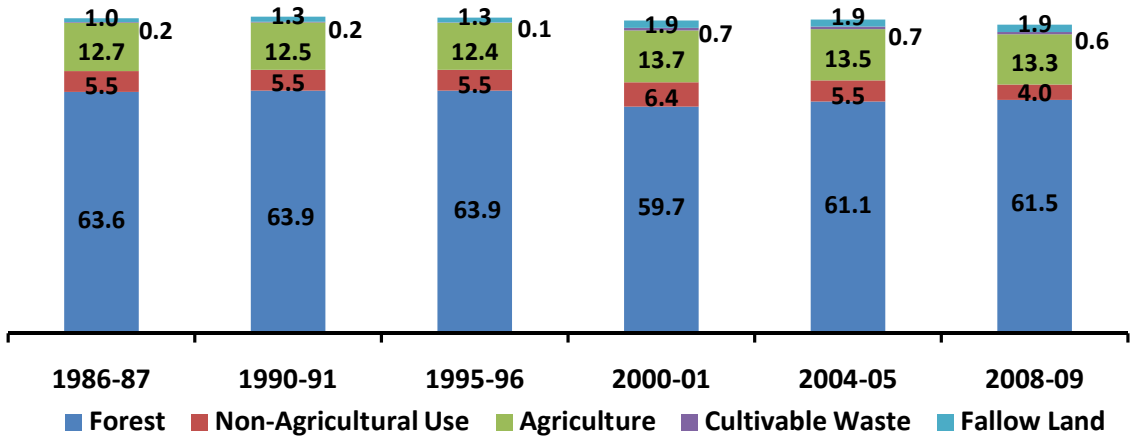

Figure 4: Land use pattern (%), Uttarakhand, 1986-87 to 2008-09

4.1. Area Under Forest

As observed from the data presented in Figure 4, the state has maintained a higher proportion (60% and above) of its land under forest since a long period. To a great extent, this is because of hilly terrain, where deforestation may cause serious threat to the day-to-day livelihoods. In addition, by losing vegetation, the people might not even assure to a better remuneration in terms of expanding agricultural lands, or using it for other purposes, as the development of land itself would be too costly to manage for them, if there is no government intervention. However, after the creation of the new state, all possible efforts were made to alterthe limited land area, as a result of which the forest cover of the relatively plain areas of the state were changed to accelerate agricultural growth.

Like other northern and eastern states of the country, the cultivation has been the main source of livelihoods in this region too. This is the reason that the districts of Haridwar and Udham Singh Nagar have almost half the forest cover of the state average (Figure 5). Other few districts that have the forest cover below state average are Almora, Bageshwar, Champawat, Dehradun, Garhwal, and Pithoragarh. Uttarkashi has maintained its area under forest cover as high as 89 percent since 1986-87 and even earlier.

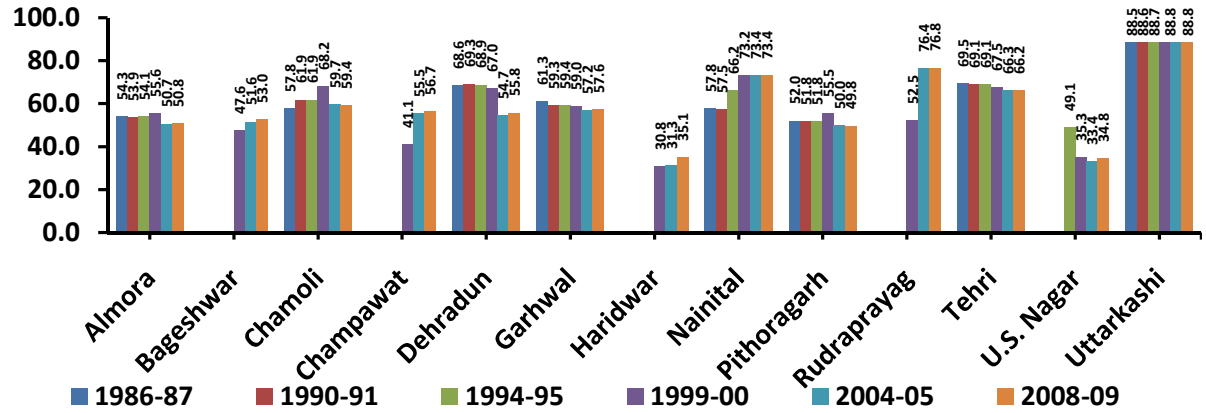

Figure 5: Area under Forest cover (%) by Districts of Uttarakhand, 1986-87 to 2008-09

The forest cover plays a vital role in maintaining the ecosystem and congenial climate of the region. As the state is full of highly steep river streams, which rapidly change the geomorphology of the area with large-scale weathering, erosion, landslides, etc., the role of vegetation becomes significant. Its importance is also well accounted for the sustenance of the rain-fed agriculture widely practiced in the hilly regions of the state.

4.2. Area Under Agriculture (Net Sown Area)

Haridwar and Udham Singh Nagar are the two districts in the plain region of the state, which share almost half of their total land area under agricultural use. Figure 6 shows the proportion of NSA across different districts of the state. As only 13 percent of the total reported land area of the state are sown (net), there are a very few districts in the state, apart from Haridwar and Udham Singh Nagar, where the proportion of the NSA exceeds the state average. Only Dehradun and Almora are the districts from the hill regions that operated 21 and 18 percent of their area under agricultural use (above state average) during 2008-09 respectively (Figure 6).

In the last decade, during 2004-05 to 2008-09, a decline of about 43 and 12 percent in the proportion of NSA was observed in districts of Garhwal and Pithoragarh respectively. However, in the plain region too, Udham Singh Nagar and Haridwar appear to reduce their land under agriculture by 9 and 3 percent respectively during 2008-09 compared to the level during 2004-05.

The issue for concern is that the NSA in Uttarakhand has been steadily decreasing over the years. Studies show that the already very small portion of NSA of this hilly state is reducing further, as most of the districts show a declining trend of the area. The increasing trend of all other major land use categories of the state is mainly contributing towards the decline of NSA as a whole. In a study by Rao and Nandi (2001), it was shown that while for Uttarakhand as a whole the decline was of the order of 3.7 percent during 1974-94, the district level figures varied between 24 to 2 percent[3].

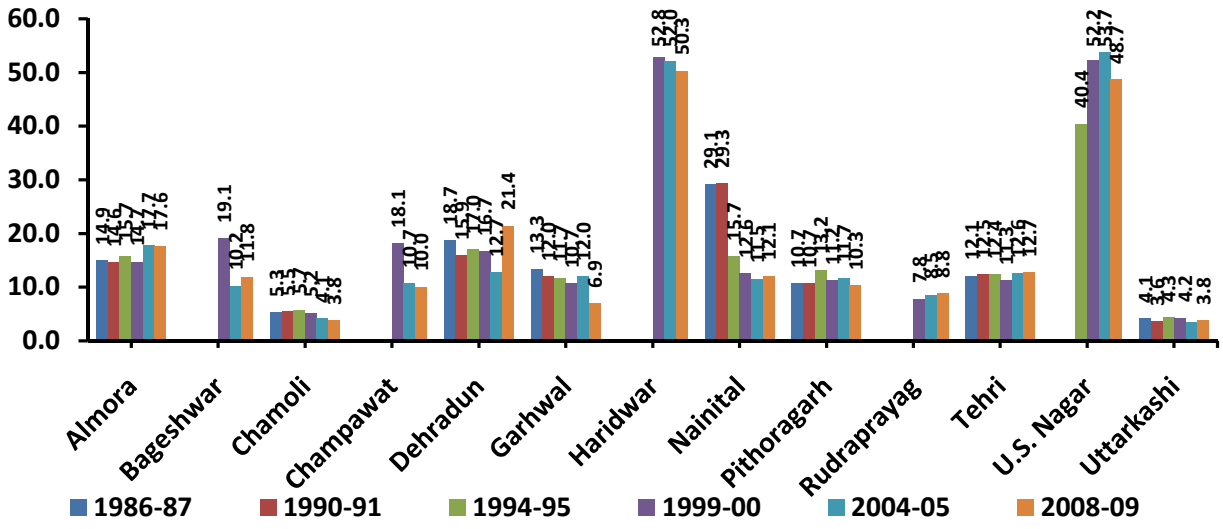

Figure 6: Net sown area (%) by Districts of Uttarakhand, 1986-87 to 2008-09

4.3. Area Under Non-Agriculture Use

The decline in the proportion of NSA in some of the districts (as mentioned earlier) is to some extent compensated with an increase in the proportion of land under non-agricultural use, although the data for the entire state does not corroborate this. Figure 7 illustrates the trend in the proportion of area under non-agricultural use across districts of Uttarakhand during 1986-87 to 2008-09. During 2004-05 to 2008-09, Chamoli has registered a sharp increase in the proportion of area under non-agricultural use from the level of just 1 percent to 7 percent. This may be, as the data suggests, due to a reduction of about 55 percent in the barren and uncultivable land area of the district. Chamoli has been the attraction for setting up hydroelectric and thermal-power plants as well as among the most sought places for tourism development during the recent past by the state govt.

Similarly, Udham Singh Nagar district shares a substantial proportion in gross state domestic product (GSDP) with both agricultural and non-agricultural activities. Due to abundant plain areas, transportation and market development in the district, people get benefitted in both agricultural and non-agricultural activities. This is the reason that Udham Singh Nagar district has been diverting its land under non-agricultural use considerably, as the proportion of area under non-agricultural use increased from the level of only 5 percent during 1994-95 to 11 percent during 2008-09. During 2004-05 to 2008-09, an increase of about 26 percent in the proportion of area under non-agricultural use was registered in the district. Haridwar also has a substantial proportion of non-agricultural land, although, during 2004-05 to 2008-09, the district showed decline in its share by 9 percent (Figure 7).

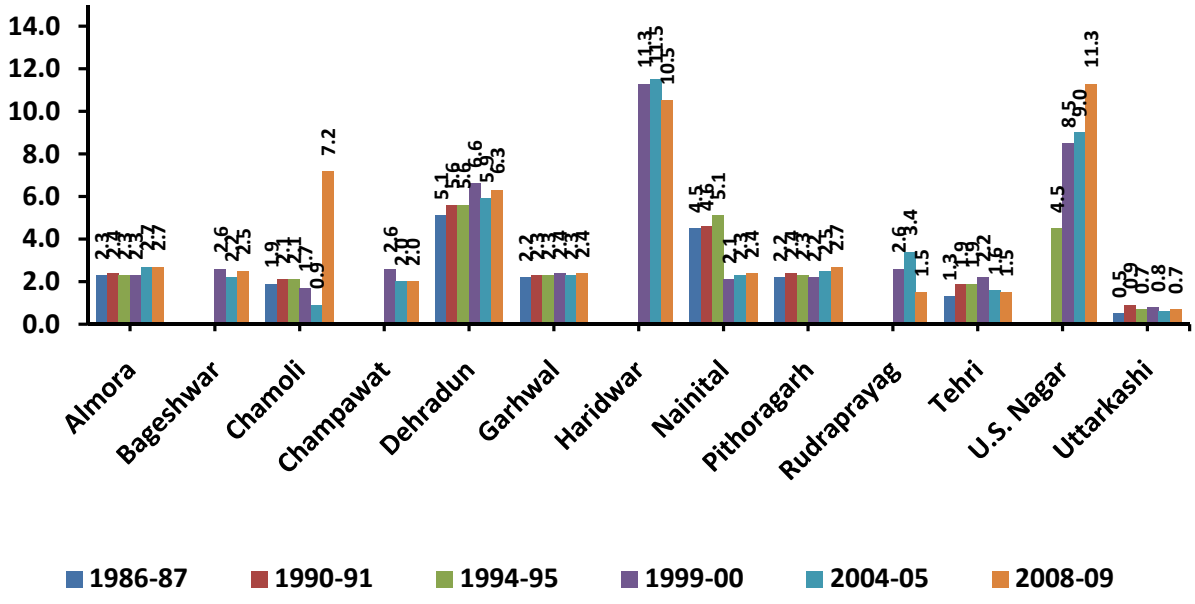

Figure 7: Area under non-agricultural use (%) by Districts of Uttarakhand, 1986-87 to 2008-09

5. Operational Holdings

Operational holding refers to the size of farm, which was operated for the agricultural purpose. It is broadly divided into five groups, namely marginal (less than 1 ha), small (1-2 ha), semi-medium (2-4 ha), medium (4-10 ha), and large land holding (more than 10 ha). This might be an indirect indicator to evaluate the intensity and productivity of agriculture in any particular area. More the smaller and fragmented agricultural farms, lesser will be the productivity in the area in general.

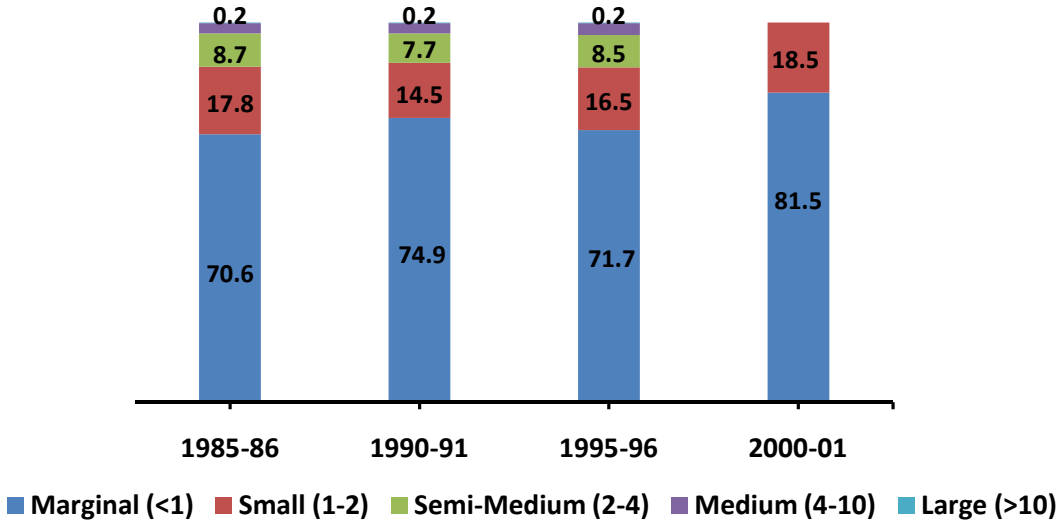

Figure 8: Proportion of operational holdings (%) by size class (ha) of agricultural land, Uttarakhand, 1985-86 to 2000-01

As shown in Figure 8,during the period 1985-86 to 2000-01 more than 70 percent of agricultural holdings are marginal (of size less than 1 ha). After becoming an independent state in 2000, the proportion of marginal holdings increased to about 81.5 percent and the remaining (18.5%) were small holdings (1-2 ha). This is a typical characteristic of agricultural lands in hilly areas, where terrace farming are performed, and due to paucity of extension of the land, small fragmented lands are managed to be developed for the agricultural purpose at different altitudes.

5.1. Number of Operational Holdings across Districts

This section presents a trend in the proportion of operational holdings (number) across the districts of Uttarakhand during 1985-86 to 2000-01. As Figure 9 illustrates, most of the hilly districts of the state like Almora, Bageshwar, Champawat, Pithoragarh, and Rudraprayag register the proportion of marginal holdings ranging between 75 and 80 percent, and even more. The lowest proportion of marginal holding during 2000-01, was recorded by Garhwal (51%), followed by Udham Singh Nagar (53%), Nainital (66%), and Haridwar, Chamoli, Uttarkashi (each with 68 percent of marginal holdings). Pauri Garhwal (28%) recorded the highest proportion of small (1-2 ha) land holdings during 2000-01, followed by Tehri Garhwal (22%), Udham Singh Nagar (20%), and Chamoli (20%). Other districts in the state

had below 20 percent of small size land holdings. The proportion of medium size holdings was recorded the highest in Udham Singh Nagar (10%), followed by Nainital (5%), Garhwal and Haridwar (4% each), and Uttarkashi (3%) during 2000-01.

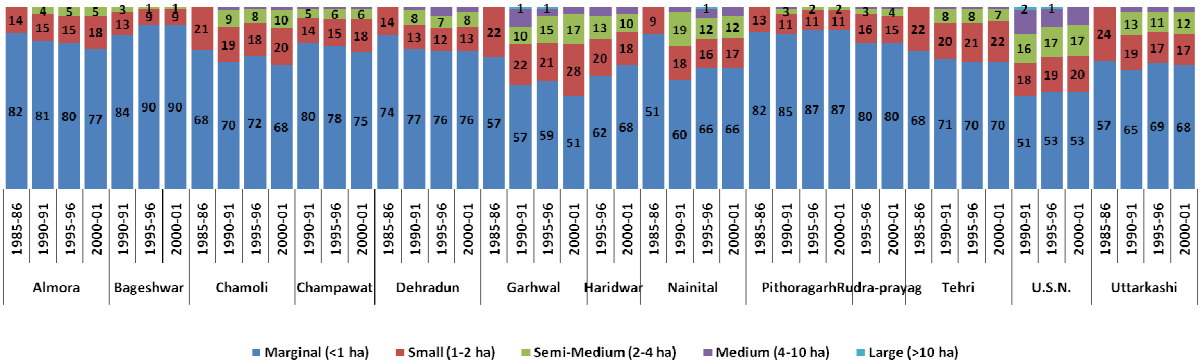

Figure 9: Operational holdings (%) by size class (ha) across districts of Uttarakhand, 1985-86 to 2000-01

5.2. Area of Operational Holdings across Districts

There are two different indicators to assess the proportion of operational holdings. In terms of number of operational holdings, most of the districts register their higher proportion of holdings in the marginal category, since the marginal holdings are very small (in size) but abundant in number in hilly areas. On the contrary, the large size holdings are larger in terms of area, but less in number. Figure 10 illustrates (differently from the Figure 9) that in the districts of plain region, in general, the proportion of area under medium and large holdings is higher than that under marginal and small size holdings. Udham Singh Nagar had only 13 and 16 percent area under marginal and small land holdings compared to 30 percent area under medium holdings and the highest proportion of area under large size holdings (14%) in the state during 2000-01. Other districts where the proportion of area under medium and large size holdings observed relatively higher were Nainital, Haridwar, and Dehradun during 2000-01. Bageshwar registered the highest proportion (66%) of area under marginal holdings during 2000-01, followed by Pithoragarh (59%), Almora (46%) and Champawat (39%).

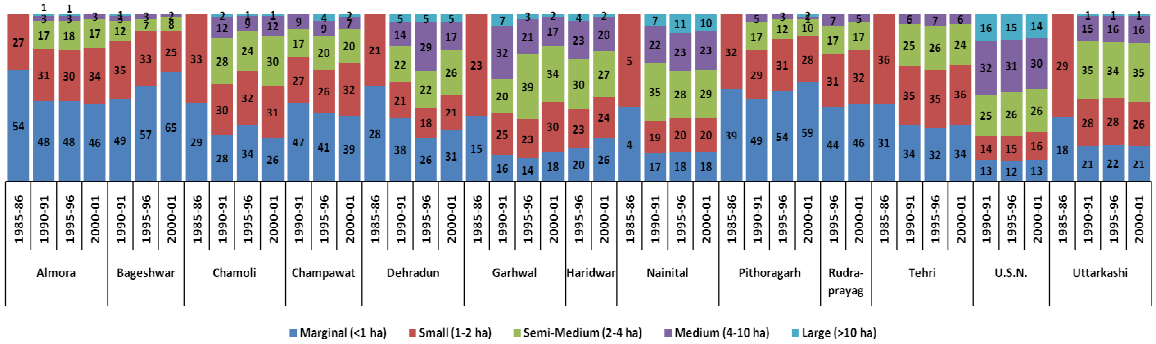

Figure 10: Area of operational holdings (%) by size class (ha) across districts of Uttarakhand, 1985-86 to 2000-01

6. Trends in Irrigation Pattern

Uttarakhand recorded an area of 3,40,129 ha under irrigation during 2008-09, which was about 45 percent of the total NSA (7,53,711 ha). Gross irrigated area (GIA) during the same period was recorded 569 thousand ha, which was 49 percent of the GCA (11.6 lakh ha). Figure 11 presents the proportion of GIA area to the GCA as well as the proportion of total irrigated area by major sources of irrigation in Uttarakhand during 1986-87 to 2008-09. However, it would be relevant to compare the datasince 2000-01 to avoid the influence of boundary changes in the state. During the period 2000-01 to 2008-09, an increase of about 9 percent has been observed in the proportion of GIA.

The share of tube-wells (about 60%) in total irrigated area has been the highest among other sources of irrigation. However, the contribution of UpperGangaCanal and other canals is also substantial, 28 percent (a decline of 3% from the level of 2000-01) of total irrigated area shared by canals irrigation during 2008-09. Since olden days, the main source of irrigation in this hill state has been the natural streams routing from mountain cleavages. Evenpresently, at least 10 percent of the total irrigation is done by stream water collected in ponds or other such mechanisms. Irrigation is done by conveying the water from streams through kuchha channels locally called Guhls to different terraces using the natural gravitational flow of water. The state constructed canals operate on the same principle, except in some situations electricity driven lift systems, pump sets, and hydraulic rams are installed. These, however, are limited to foothills and valleys. Thus, most of the crops in hills are raised under rain-fed conditions.

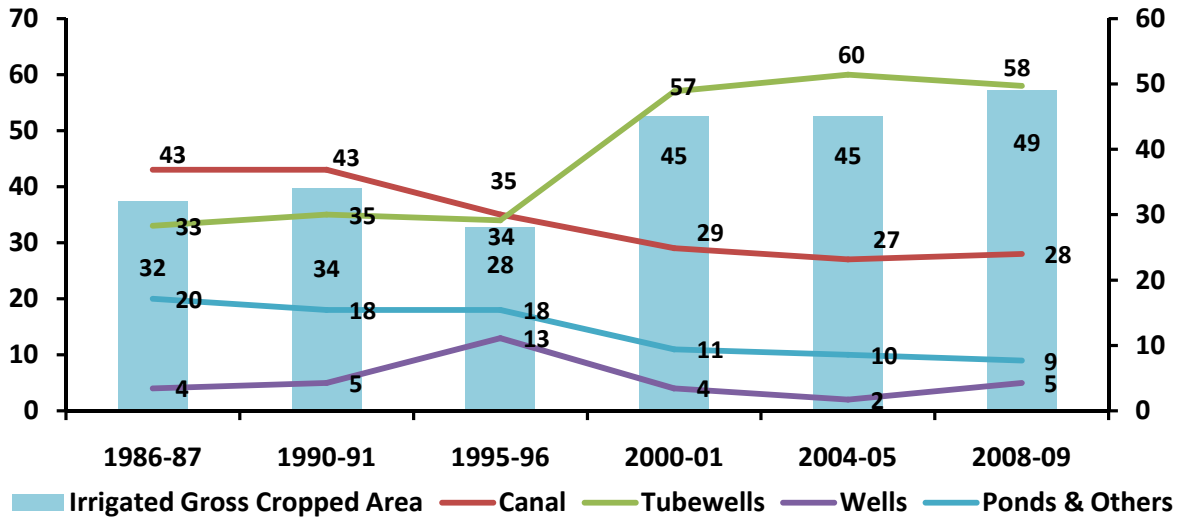

Figure 11: Total (Gross) Irrigated Area by source (%), Uttarakhand, 1986-87 to 2008-09

6.1. Irrigated Gross Cropped Area across Districts

Modern irrigation facilities are limited to the districts of plain region in the state. During 2008-09, a gross area of 2.59 ha (1.42 lakh ha net irrigated) was irrigated in Haridwar, which was 97 percent of the GCA and the highest among the districts of Uttarakhand (Figure 12). It

was followed by the district of Udham Singh Nagar, which recorded about 91 percent of its agricultural land irrigated. Except these two districts of the plain region, only Nainital district (52%) is reported to have the proportion of gross irrigated area above the state average (49%) during 2008-09. Pauri Garhwal recorded a tremendous growth in the proportion of GIA during 2004-05 to 2008-09, while during the same period, a decline of around 72 percent was observed in the irrigated proportion of Dehradun. However, the fact is that Dehradun reported an increase of 69 percent in the NSA during this period, while the irrigation facilities could not be managed proportionately. In Almora, Chamoli, and Pithoragarh districts less than 10 percent agricultural land was recorded to beirrigated during 2008-09.

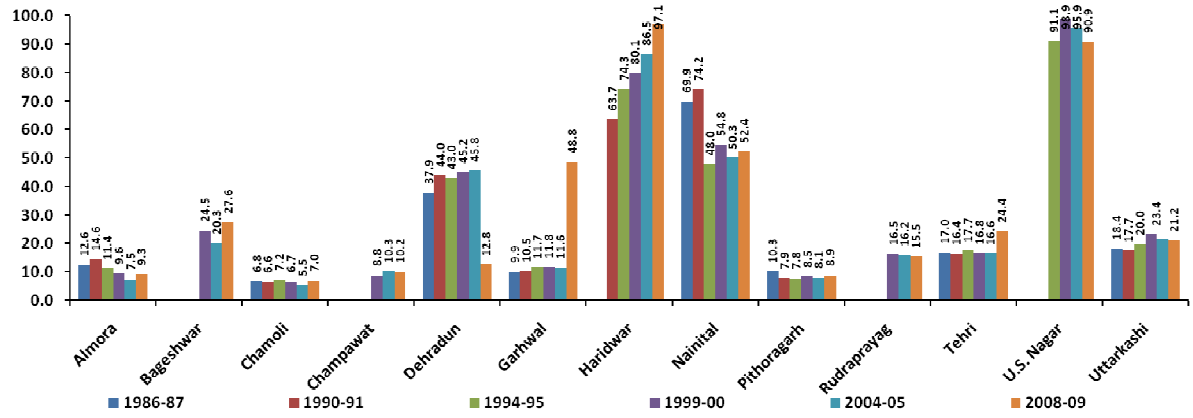

Figure 12: Total (Gross) Irrigated Area by Districts of Uttarakhand, 1986-87 to 2008-09

6.2. Sources of Irrigation

The major sources of irrigation in Uttarakhand are the canal system, tube wells, lift irrigation, guhls (hill channels), water-harvesting tanks (hauzas), hydrams, shallow tube wells, and deep tube wells in the Tarai belt. In most of the districts, especially in hilly region of the state, the main source of irrigation is natural streams. To irrigate the land on the hill slopes, water has traditionally been brought into the fields from rivers/rivulets by means of channels called 'guhls' cut along the contour line of the hills. The diversion work since earlier times has consisted of brushwood obstruction laid across the stream by which water is diverted into 'guhls' constructed at considerable effort and expense (Walton, 1928, Gazetteer, Almora, cited in U. C. Pandey, "Status of Irrigation in U. P. Hills- Past and Present", 1987). The Upper Ganga Canal system has also contributed a lot in the irrigation facilities in the state, especially in Haridwar. The canal system irrigates nearly 9,000 $km^2$of fertile agricultural land in ten districts of Uttar Pradesh and Uttarakhand. It starts at the Bhimgoda Barrage near Har ki Pauri at Haridwar, traverses to Meerut and Bulandshahr, and continues to Nanu in Aligarh district, where it bifurcates into the Kanpur and Etawah branches[4]. In the plain region, irrigation is also substantially performed by tubewells and wells using pumping sets.

6.2.1. Area Irrigated by Canals

Figure 13 illustrates that the hill districts of Bageshwar (86%), Nainital (83%), and Rudraprayag (74%) had more than two-third of the irrigation performed by canals. However, these canals are not to be confused by the long articulated canal systems like Ganga Canal system. In most of the hilly districts, these canals are locally administered narrow and short length channels diverted through several natural streams. Other districts, which recorded the higher proportion compared to the state average (28%) of irrigated area by canals during 2008-09 were Dehradun (64%), Almora (62%), and Uttarkashi (60%).

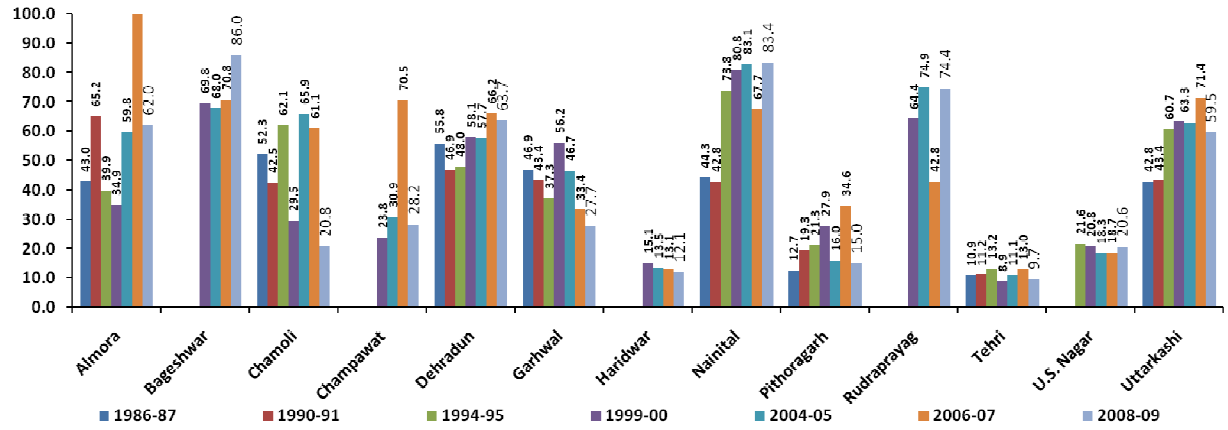

Figure 13: Area Irrigated by Canals (%) across Districts of Uttarakhand, 1986-87 to 2008-09

Up to a length of 1341 km, canals serve the agricultural land in Nainital, which is the longest coverage in the district compared to other districts in the state (Figure14). Udham Singh Nagar (925), Dehradun (864), and Pauri Garhwal (836) closely follow the Naintal district in terms of length of the canal in the district. The lowest length of canal serving agricultural fields was recorded in Champawat (224). Other districts are benefited by the canals up to even less than 500 km, except Tehri Garhwal, Uttarkashi, and Almora, where the length of the canals in the district was approximately706, 655, and 546 km respectively.

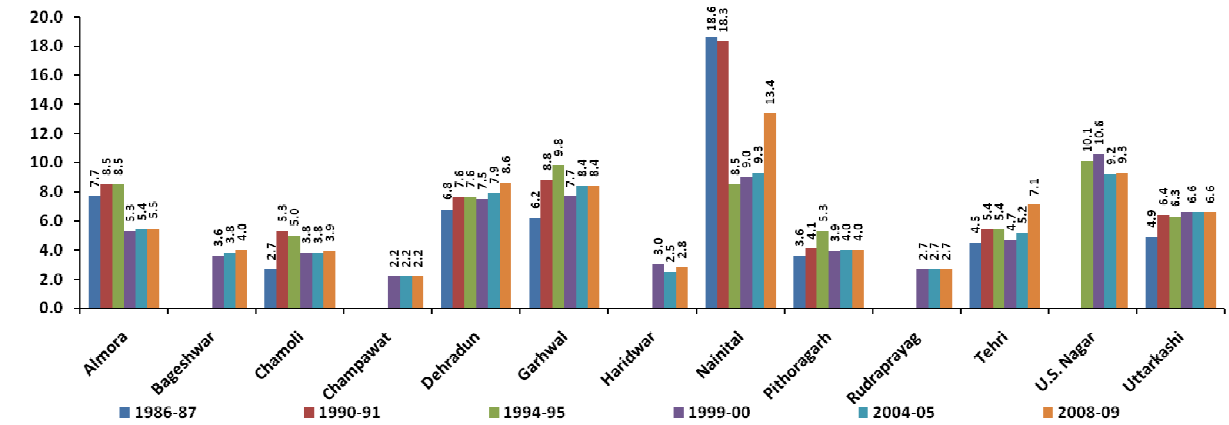

Figure 14: Length of Canals (in '00 kms) across Districts of Uttarakhand, 1987-88 to 2007-08

6.2.2. Area Irrigated by Tubewells/Wells

Compared to Figure 13, one can easily observe in Figure 15, that the tubewell/well irrigation is complementary to the canal irrigation system, and inversely proportionate to each other. As expected, the use of tubewell/well irrigation is very much popular in the districts of plain region in the state. Farmers in Haridwar and Udham Singh Nagar are the large beneficiaries of the tubewell/well irrigation. Almost 86 and 69 percent of total irrigation was performed by tubewells/wells in the districts of Haridwar and Udham Singh Nagar during 2008-09. The hill districts of Champawat in Kumaon region also appears to have nearly 72 percent of the agricultural land irrigated by tubewells/wells, which is a tremendous increase in the proportion compared to earlier years.

Since the declaration of this hill region as an independent state in 2000, the proportion of tubewell/well irrigation has been contributing as the main source of irrigation in the state as a whole. However, on an average over the entire state (58-60%) is primarily affected by the higher proportion of such irrigation in the districts of plain region. After all, these districts share nearly four-fifth of the total irrigated agricultural land in the district. Dehradun and Nainital districts too recorded 16 and 11 percent of total agricultural land irrigated by tube-wells/wells during 2008-09 respectively. Similarly, the Pauri Garhwal district had 8 percent of its agricultural land irrigated by tube-wells/wells during the same period.

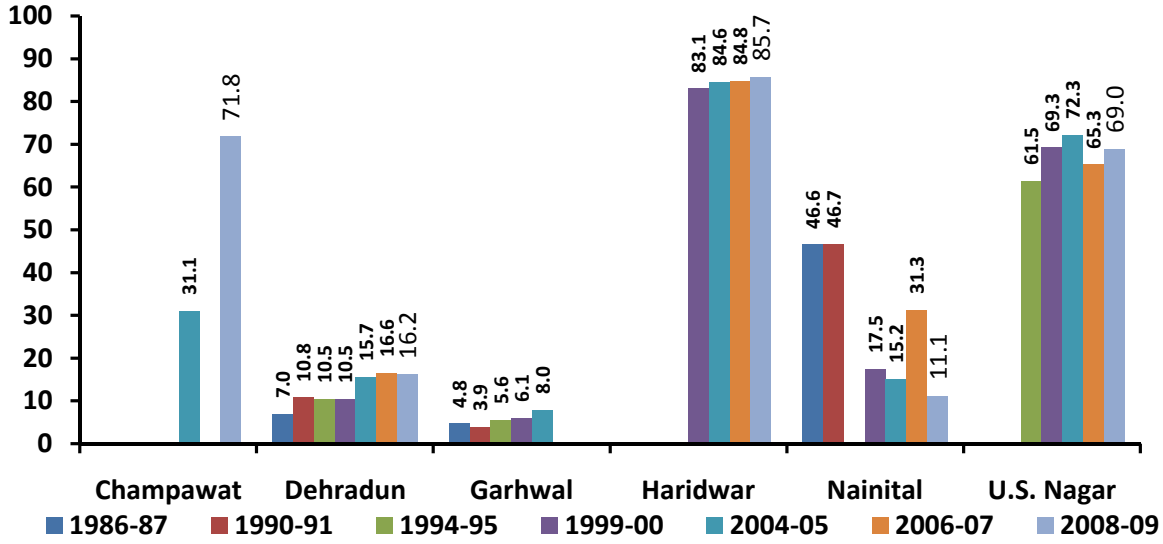

Figure 15: Area Irrigated by Tubewells/Wells (%) across Districts of Uttarakhand, 1986-87 to 2008-09

6.2.3. Area Irrigated by Other Sources

Apart from these two main sources (canal and the tubewell/well irrigation systems), a substantial proportion of agricultural land in hill region is irrigated by other sources managed by the local community. These mainly include guhl, hauz, hydrams, etc. Tehri Garhwal (90%), Pithoragarh (85%), and Chamoli (76%) districts in the hill region of the state

has recorded almost three-fourth of the total irrigation contributed by other sources (Figure 16).

A traditional but effective canal irrigation system (guhls) is used to irrigate the fields using gravitational force, which brings water from a long distance (of the order of many kilometer). These guhls were maintained by the local beneficiaries until they were taken up by the minor irrigation department of the state government. Another traditional irrigation method, which is prominent in Uttarakhand, is water mills. The water mills, known as gharats in Uttarakhand, have traditionally been used for milling grain and extracting oil. The estimated number of water mills varies from 3,500[5] to 70,000. These water mills, with little technological upgradation, can also be employed for hydropower generation[6].

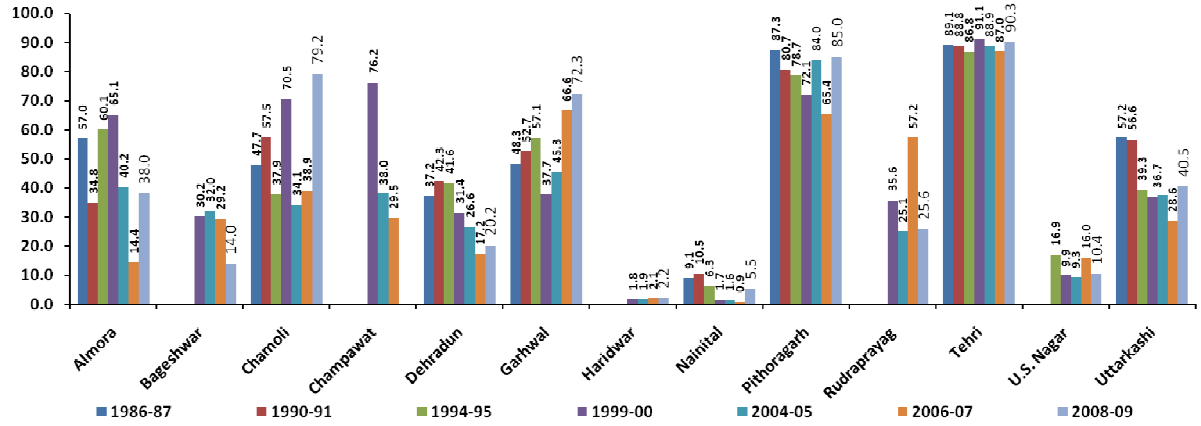

Figure 16: Area Irrigated by other sources (%) across Districts of Uttarakhand, 1986-87 to 2008-09

Figure 17 shows the number of guhls (hill channels) and water-harvesting tanks (hauzas) in thousand across districts of Uttarakhand. Tehri Garhwal district had the highest number of such tanks and channels (10,000) in the state during 2008-09, followed by Pauri Garhwal, Almora, Uttarkashi, Pithoragarh, and Chamoli. In the hill regions, the irrigation infrastructure is very poor. A large portion of the agricultural area is situated above rivers, with the result that they cannot be irrigated using the gravity system (surface water system) and can only be irrigated through lift irrigation. The lift irrigation technique is sophisticated and cost-effective; it is implemented through an automatic pumping device known as a hydraulic ram pump or hydram. Hydrams, which do not use any external energy or power such as diesel or petrol, work on the principle of the water hammer and convert the available static head to kinetic energy. Water can be carried to a height of 30 times above the available head. However, to make more water available for irrigation and to reduce the wear and tear on the plant, for the time being the irrigation department is trying to lift water only up to 15 times the available head. The lift irrigation technique can act as an important tool to improve the status of irrigation in Uttarakhand, in particular the hill districts. The advantage is that the land below the supply channel (guhls) can be irrigated directly from the supply channel; in addition, by increasing the scale of the supply channel, water mills for grinding wheat and other cereals can be driven. Consequently, dependence on power and diesel will be reduced, new employment opportunities will be created, the nutritional value of the

cereals will remain intact. In addition, the maintenance expense is minimal and has no adverse impact on the environment (Mittal *et al*., 2008).

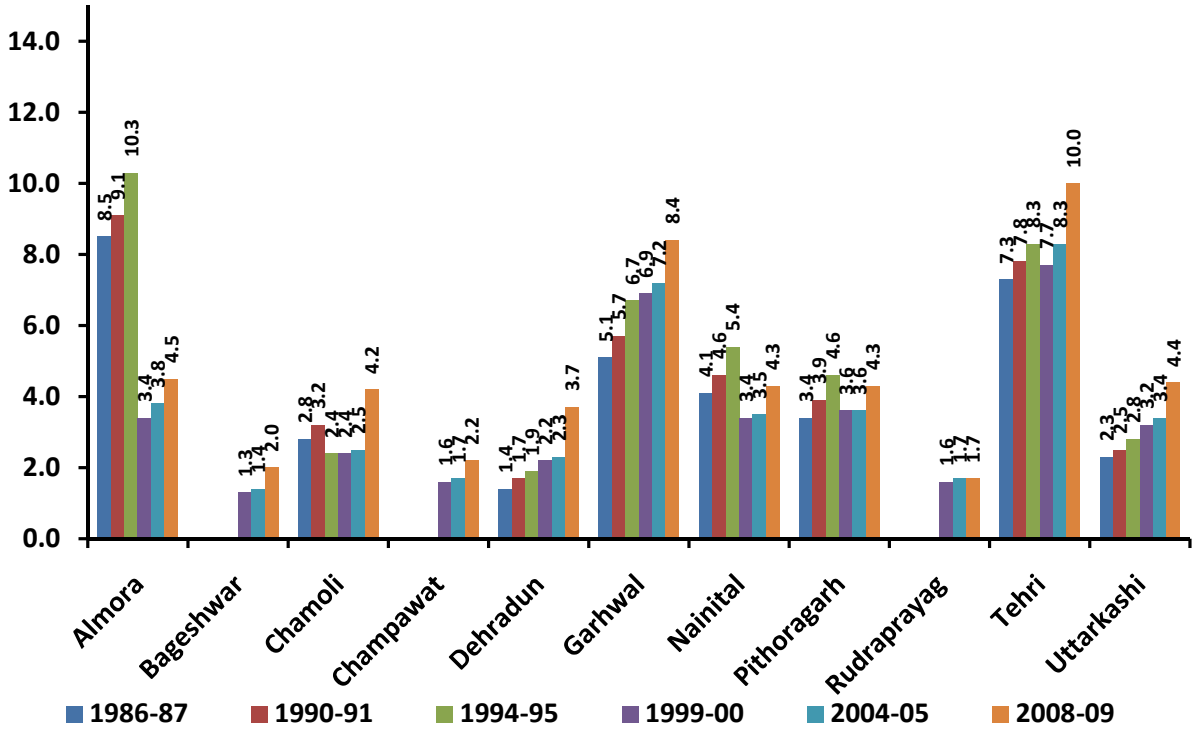

Figure 17: Number of Hauz & Guhl (in '000) across Districts of Uttarakhand, 1987-88 to 2007-08

6.2.4. Area Irrigated under Major Crops

Figure 18 illustrates the proportion of gross irrigated area under major crops, which indicates that more than 70 percent of the irrigated area is under traditional crops i.e. wheat and rice. About one fifth of the total irrigated area is under sugarcane, and the rest is shared by pulses, oilseeds, potato, and other crops. However, only 65 percent of agricultural land under rice and fifty percent area under wheat appeared to be irrigated during 2004-05 and 2006-07 (Figure 19). In addition, only 10 percent area under pulses was irrigated. Irrigation pattern in the agricultural land under oilseeds appears to show a declining trend, as compared to the level of 36 percent during 2004-05, the irrigated area under oilseeds has declined to 21 percent during 2006-07. However, during this period, the proportion of irrigated area under potato has increased. The irrigated area under sugarcane has been increasing substantially, and more than 95 percent of the area under sugarcane was observed irrigated.

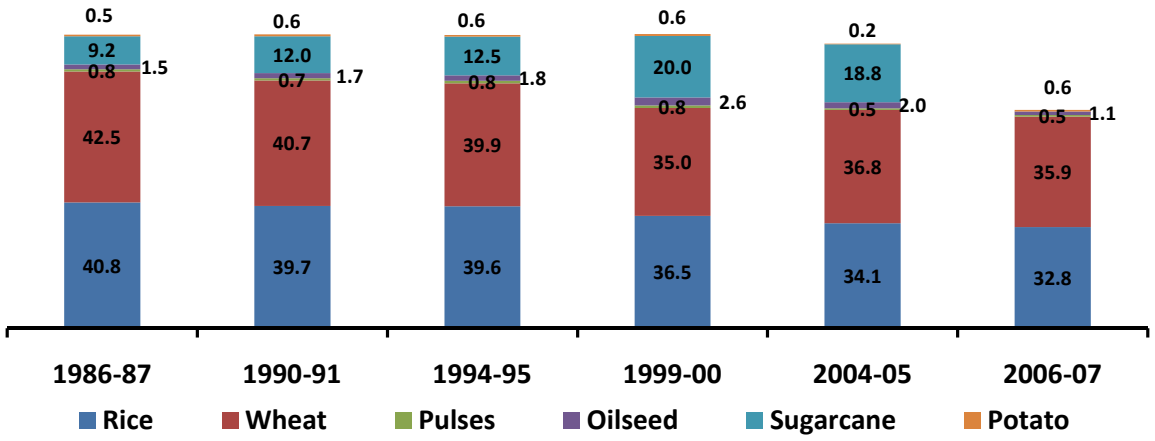

Figure 18: Proportion (%) of Gross Irrigated Area under Major Crops Uttarakhand, 1986-87 to 2006-07

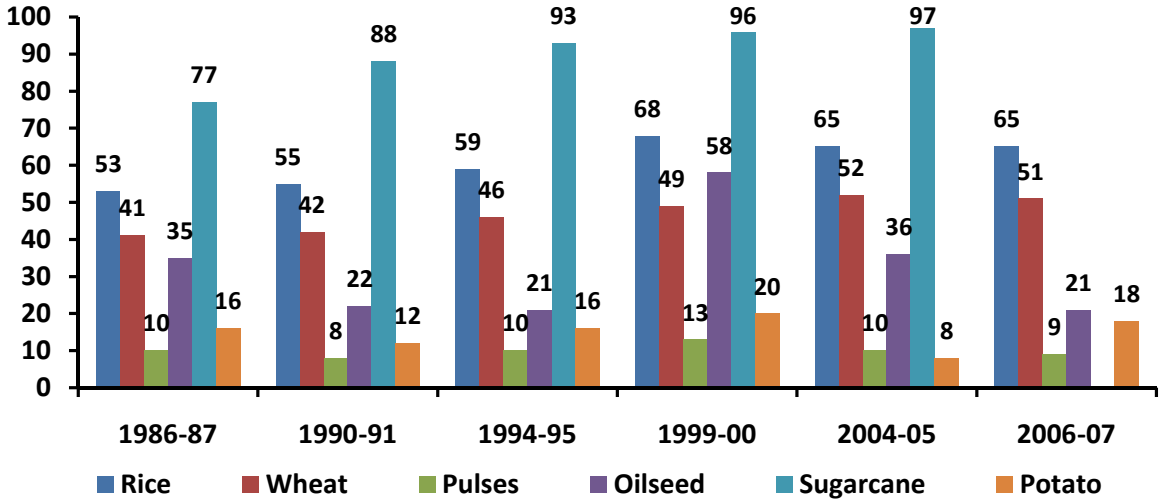

Figure 19: Irrigated Area (%) by Major Crops Uttarakhand, 1986-87 to 2006-07

6.2.5. Area Irrigated under Rice across Districts

Figure 20 illustrates the proportion of agricultural land under rice, which was irrigated across districts of Uttarakhand. As expected, the plain region districts like Udham Singh Nagar and Haridwar recorded almost hundred percent of the agricultural land under rice irrigated during 2006-07. Nainital (92%) and Dehradun (90%) districts too closely follow the plain districts in the state. However, other districts in Uttarakhand recorded a very less average of irrigated land under rice during the period, which was even less than the state average of 65 percent.

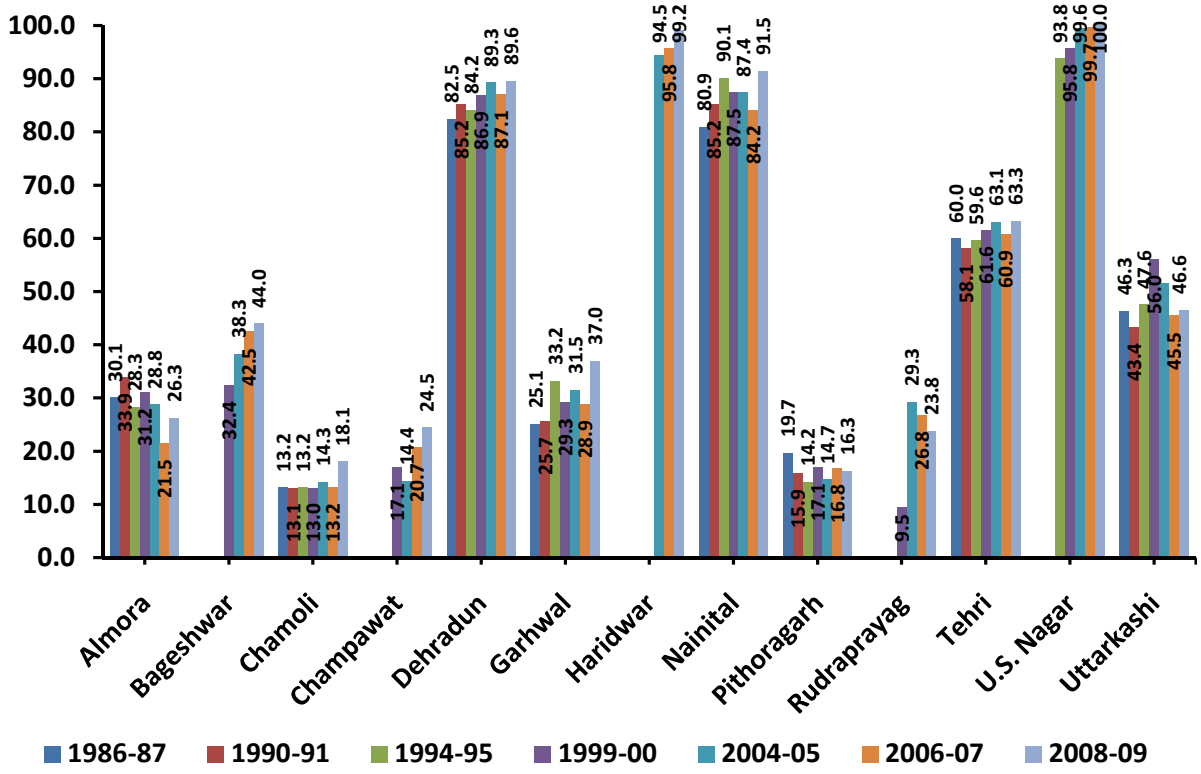

Figure 20: Irrigated Area (%) under Rice across districts of Uttarakhand, 1986-87 to 2006-07

6.2.6. Area Irrigated under Wheat across Districts

The irrigation pattern in the agricultural field under wheat (Figure 21) also emphasize the higher share of districts in the plain region i.e. Udham Singh Nagar and Haridwar with their 99.8 and 90.8 percent irrigated agricultural land under wheat cultivation. These districts are only closely followed by the district of Nainital with nearly 74 percent of irrigated land under wheat. Other districts recorded even less than 50 percent of their irrigated land under wheat cultivation, which is the state average.

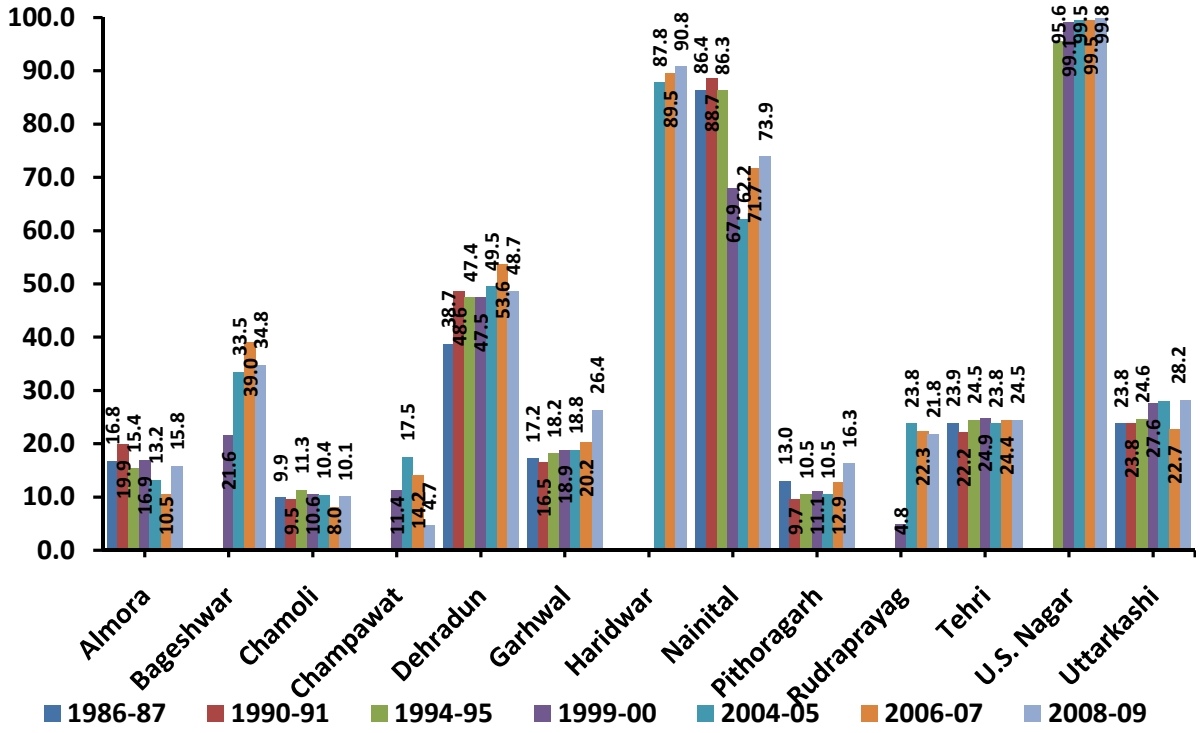

Figure 21: Irrigated Area (%) under Wheat across districts of Uttarakhand, 1986-87 to 2006-07

6.2.7. Area Irrigated under Pulses across Districts

A total of 31,941 ha agricultural land was operated for the cultivation of pulses (which include Urad, Moong, Gram, Lentil, Arhar, Pea, Moth etc.) in the state during 2006-07, of which only 2,863 ha was irrigated.

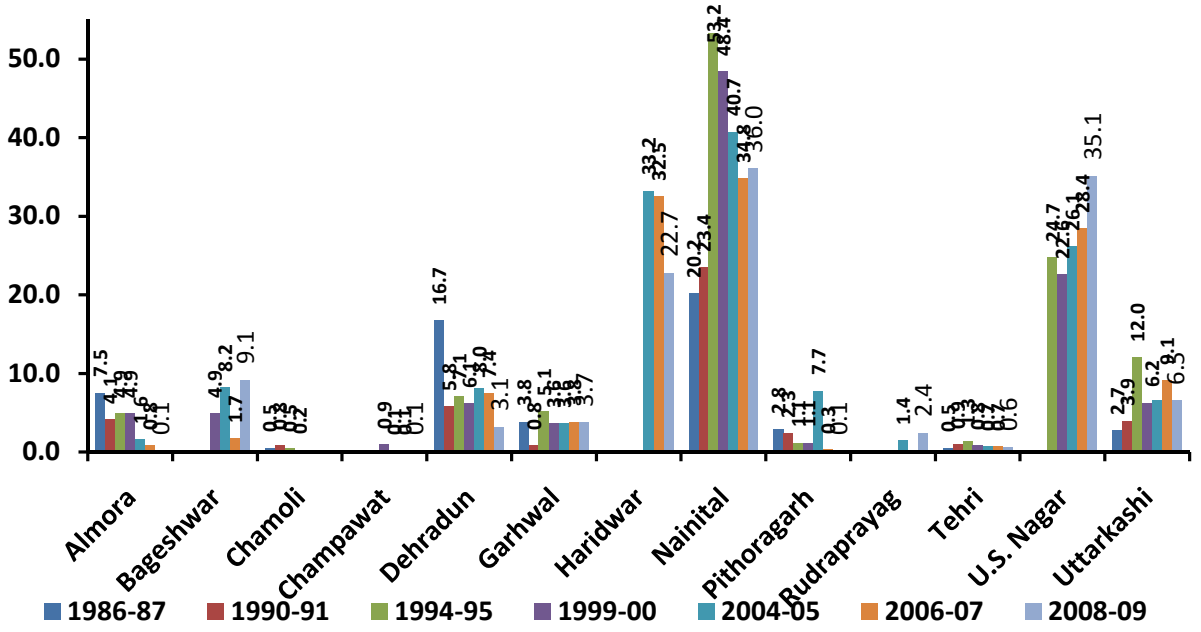

Figure 22: Irrigated Area (%) under Pulses across districts of Uttarakhand, 1986-87 to 2006-07

In absolute term, the larger area under pulses was irrigated in the district of Udham Singh Nagar (1202 ha), while it was only 35 percent of the total area cultivated for the production of pulses (Figure 22). Nainital (36%) recorded the highest proportion of irrigated land under pulses, while Haridwar, the other plain district had only 23 percent of irrigated land under pulses during 2006-07. Among rest of the districts, except Bageshwar, which recorded the proportion equal to the state average (9%), most of the districts had even less than 5 percent of irrigated land under pulses.

6.2.8. Area Irrigated under Oilseeds across Districts

A range of oilseeds like mustard, soybean, til, sunflower, groundnut, alsi etc. is produced in Uttarkhand. However, the dominant oilseed, which is cultivated throughout the state, is lahi/mustard with a total agricultural area of 15,925 ha (2006-07), of which only one-third area (5,931 ha) was irrigated. Other main oilseeds of the states like soybean and til recorded a total area of 8,504 and 2,065 ha under cultivation during 2006-07 respectively, but cultivation of both these oilseeds was largely rain-fed. The highest proportion of irrigated agricultural land under oilseeds was recorded in the district of Udham Singh Nagar (49%), closely followed by Dehradun (43%), and Nainital (31%) during 2006-07 (Figure 23). Most of the other districts except Haridwar (24%) were recorded with lesser proportion of irrigated land under oilseeds than that of the state average (21%) during 2006-07.

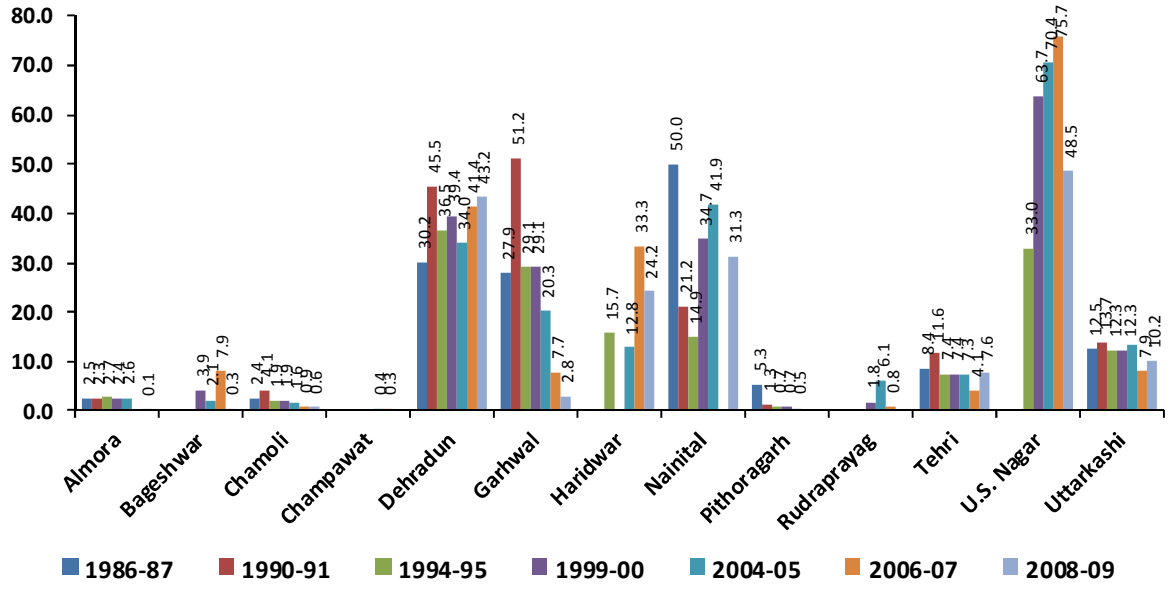

Figure 23: Irrigated Area (%) under Oilseeds across districts of Uttarakhand, 1986-87 to 2006-07

7. Consumption of Fertilizers and Pesticides

Uttarakhand is the part of Indo-Gangetic Plain, which constitutes mainly the alluvial soils (fluvisols). The latter are derived from the deposition of silts by numerous river systems. These soils are deficient in nitrogen (N), phosphorus, and organic matter. Generally, alluvial soils range from near neutral to slightly alkaline in reaction. The hill region has always been

dependent upon the natural manures and organic farming, but to increase the agricultural production and to meet the requirements of the expanding population, it became imperative for the state to change the traditional methodologies, especially during the green revolution. Animal husbandry, once an integral and valued part of agriculture, is relegated to secondary importance, as chemical fertilizers replace dung, compost, mulch, etc.

The trend of fertilizer usage started in the late 60s with the green revolution. In Uttarakhand, the plain areas of Bhabhar and Tarai caught up fast with the trend of using high yielding varieties and agrochemical usage. However, the hills did not start using them in a big way. The use of fertilizers still is not very high in magnitude in the cereals but as far as vegetables are concerned, the usage of various agrochemicals is fast catching up with that of the plains[7]. The crop wise per hectare consumption of chemical fertilizers in the hill districts like Bageshwar, Pauri Garhwal, Uttarkashi, Nainital etc. are as high as 406 kg/ha in tomato, 365 kg/ha in sugarcane, 334 kg/ha in cabbage, 242 kg/ha in potato, 193 kg/ha in capsicum, 162-168 kg/ha in beans and pea etc. However, proportionately lower consumption of fertilizer was observed in the cultivation of paddy (97 kg/ha) and wheat (141 kg/ha).

The excessive use of chemical fertilizer, as more than 100 thousand tons of chemical fertilizer were consumed annually by the state during 1980's, contributed in the reduction of natural fertility of the soil, as well as the destruction of soil structure, aeration and water holding capacity. It also contributed in the indiscriminate killing of useful insects, microorganisms, and predators that naturally check excess crop damage by insects and pests; poisoning the food with high toxic pesticide residues; and the change in the natural taste of the produce. Figure 24 shows the level of fertilizer consumption and proportion of its constituent during 1980-81 to 2007-08. The graph clearly indicates that there has been a tremendous increase in the consumption of chemical fertilizer in the state from a level of only 37 thousand tons during 1980-81 to about 125 thousand tons during 2007-08. The contribution of nitrogenous among other compositions of the fertilizer has always been higher (more than 65%).

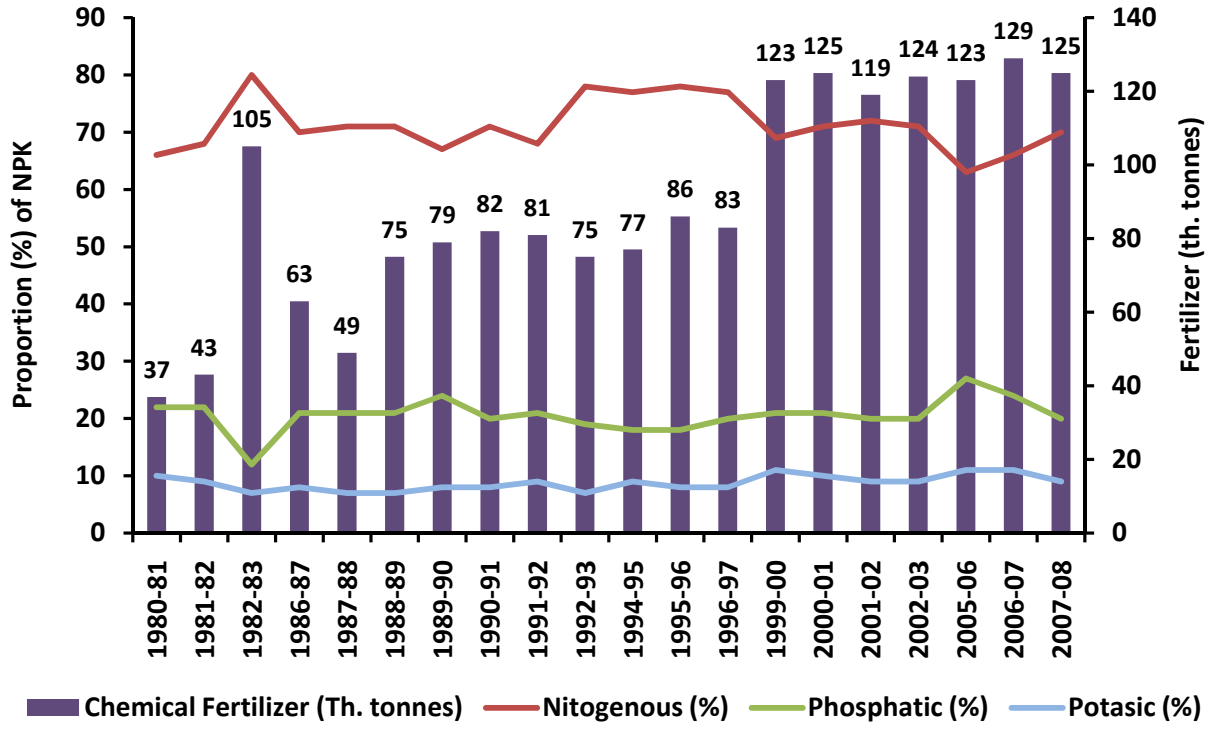

Figure 24: Consumption of Chemical Fertilizer, Uttarakhand, 1980-81 to 2007-08

Although, the level of pestiside consumption is very low compared to fertilizer and compared to other adjoining states during 2004-05, around 132 tonnes of pesticides were consumed by the state in total, compared to 310 tones in Himachal Pradesh[8]. Figure 25 shows the consumption of pesticides in g/100 ha of gross cropped area in Uttarakhand during 2000-01 to 2004-05. The consumption of pesticides in the state during 2002-03 and 2004-05, has been approximately 11g/100 ha of gross cropped area.

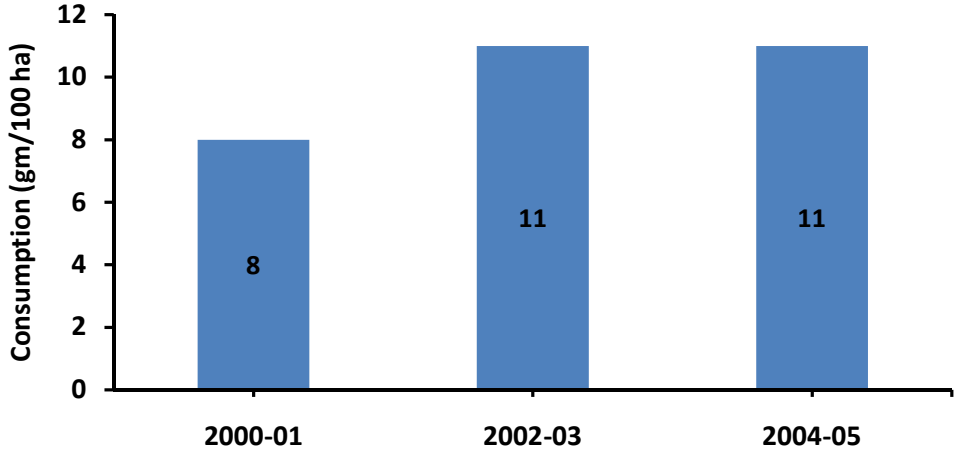

Figure 25: Consumption of Pesticides (gm/100 ha of GCA), Uttarakhand, 2000-01 to 2004-05

7.1. Consumption of Fertilizers across Districts

Figures 26a and 26b show the proportion of three main chemical fertilizers i.e. nitrogenous, phosphorous, and potasic consumed across the districts of Garhwal region and Kumaon region respectively. The highest proportion of nitrogenous fertilizer was consumed in Haridwar (76%) during 2007-08, closely followed by Pauri Garhwal (74%), Dehradun (73%), Udham Singh Nagar and Almora (70% each). However, the larger proportion of phosphorous fertilizer in total chemical fertilizer was consumed in Uttarkashi (55%) during 2007-08, followed by Chamoli (44%), Tehri Garhwal (38%), and Rudraprayag (35%). Potasic fertilizer was reportedto be consumed mostly in Champawat (12%), followed by Udham Singh Nagar (11%), Uttarkashi (10%), Nainital (9%), and Pithoragarh (7%).

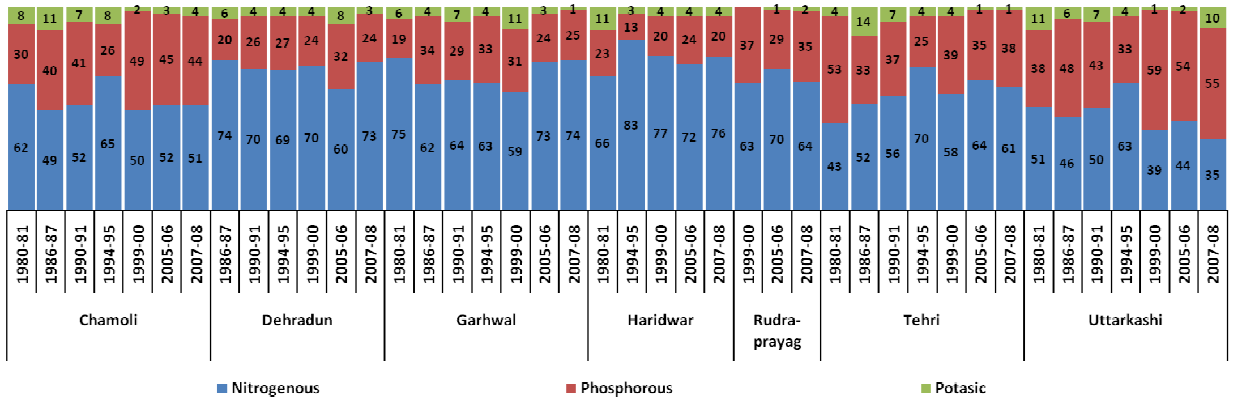

Figure 26a: Fertilizer consumption (%) across Districts of Uttarakhand (Garhwal Region), 1980-81 to 2007-08

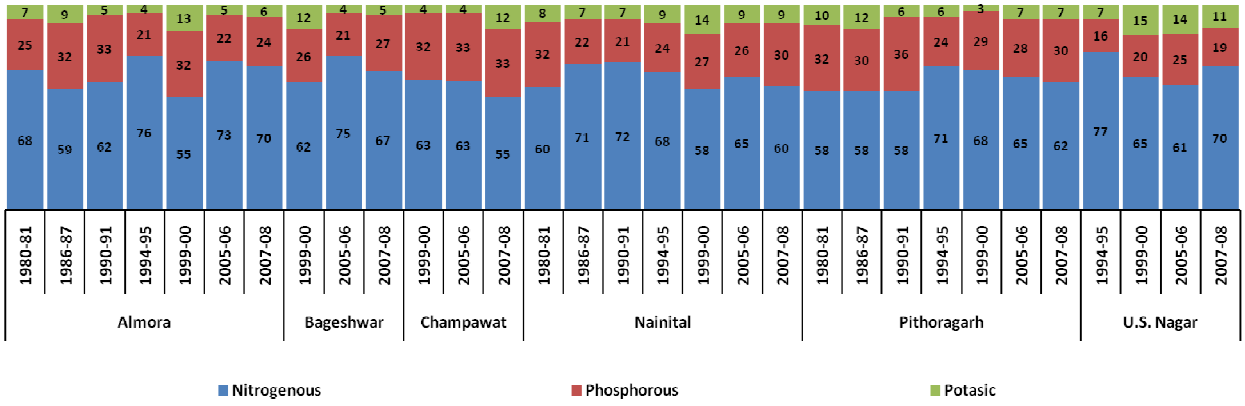

Figure 26b: Fertilizer consumption (%) across Districts of Uttarakhand (Kumaon Region), to 2007-08

8. Mechanization and Power Resources

Quinquennial census of agricultural equipments and other farm machines (Figure 27) suggest that there has been a continuing growth in the number of tractors and sprayers per thousand ha of gross cropped area.

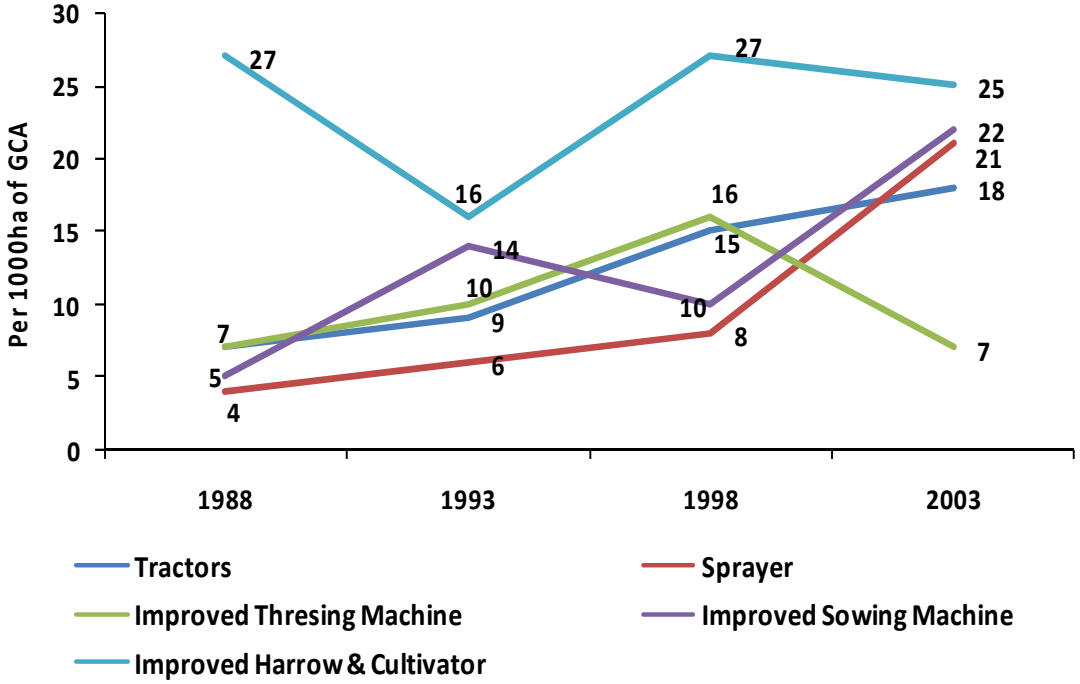

Figure 27: Use of Tractors, Sprayers & Improved Farming Machines, Uttarakhand, 1988-2003

Figure 28 shows the use of pump-sets and tube-wells per 1000 ha of gross cropped area in Uttarakhand. The graph suggests a tremendous increase in the level of boring pump-sets per 1000 ha in the state. It grew from a level of 18 per 1000 ha during 1987-88 to 40 per 1000 ha during 2007-08. However, the number of tube-wells and pumping sets per 1000 ha has been growing almost steadily, barring a few exceptions. The number of tube-wells per 1000 ha has been nearly 6 to 7, while the data for pumping sets indicate that it has been maintaining with 1 pumping set per 1000 ha of gross cropped area in the state since 1991-92.

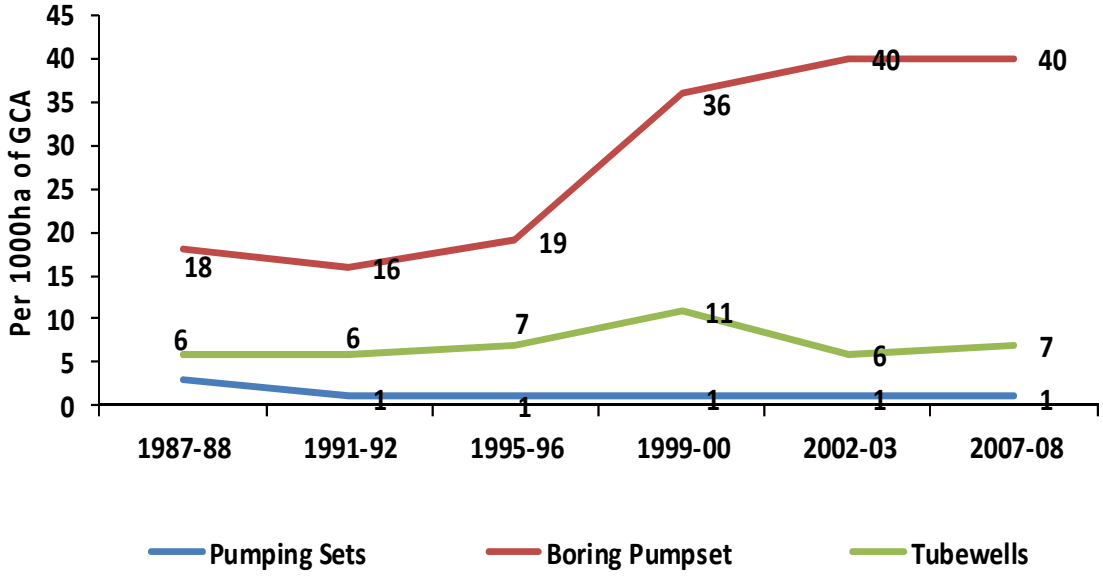

Figure 28: Use of Pump-sets & Tube-wells, Uttarakhand, 1987-88 to 2007-08

8.1. Operation of Tube-wells

As the higher proportion of tube-well irrigation in the districts of plain region has been reported, Udham Singh Nagar with the highest number of tube-wells operated during the cultivation confirm the same. Figure 29 illustrates that the district of Udham Singh Nagar has continuously been recording more than seven thousand of tube-wells operated during each agricultural season compared to a very low number observed in the other districts of the states. Only Nainital and Dehradun seem to be closely following the level of Udham Singh Nagar with approximately 500and 300 numbers respectively.

Although the data for Haridwar could not be shown in the graph due to lack ofdata for all selected years, nonetheless, the district has also approximately 500 tube-wells operating in the recent agricultural seasons. While Tehri Garhwal has a steady rate of growth in the number of tube-wells operated during each agricultural season, Champawat and Pauri Garhwal districts appear to show an increasing trend in the use of tube-wells.

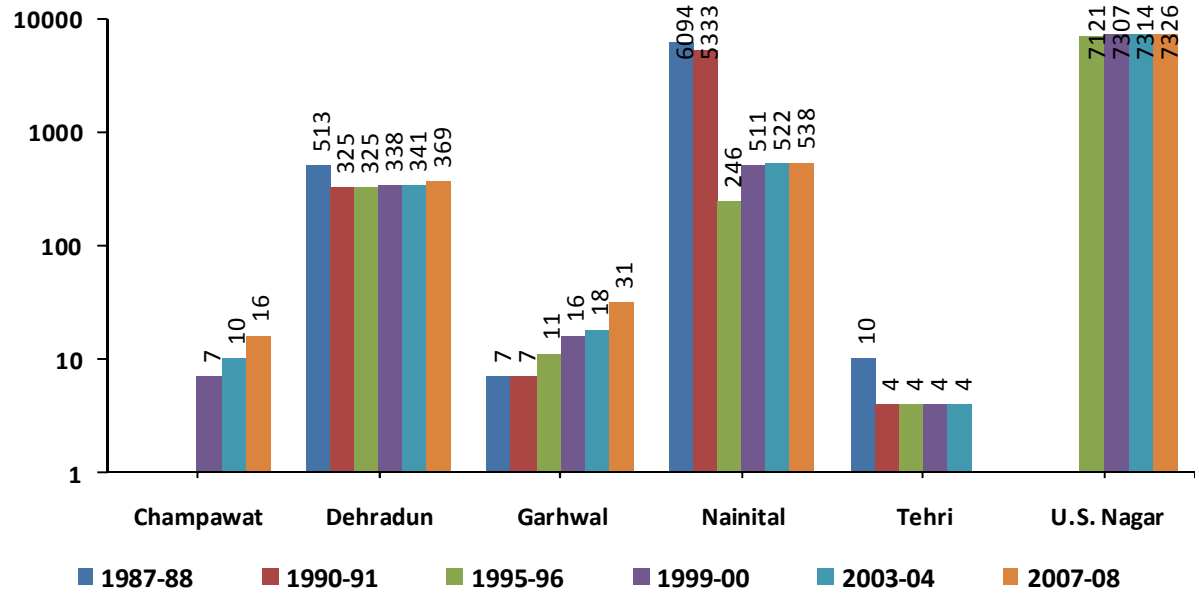

Figure 29: Tube-wells operated (No.) across Districts of Uttarakhand, 1987-88 to 2007-08

8.2. Operation of Pumping Sets

Figure 30 shows the number of boring or pumping sets operated in each agricultural season across districts of Uttarakhand. Haridwar leads with almost 26,593 pumping sets during 2007-08, closely followed by Udham Singh Nagar with 20,655 pumping sets. Other districts with more than 500 pumping sets operated during the agricultural season 2007-08 were Nainital (891) and Dehradun (632). However, as per the trends (Figure 30), the growth in number of pumping sets has been very small over the period with no apparent change since the level of 1995-96.

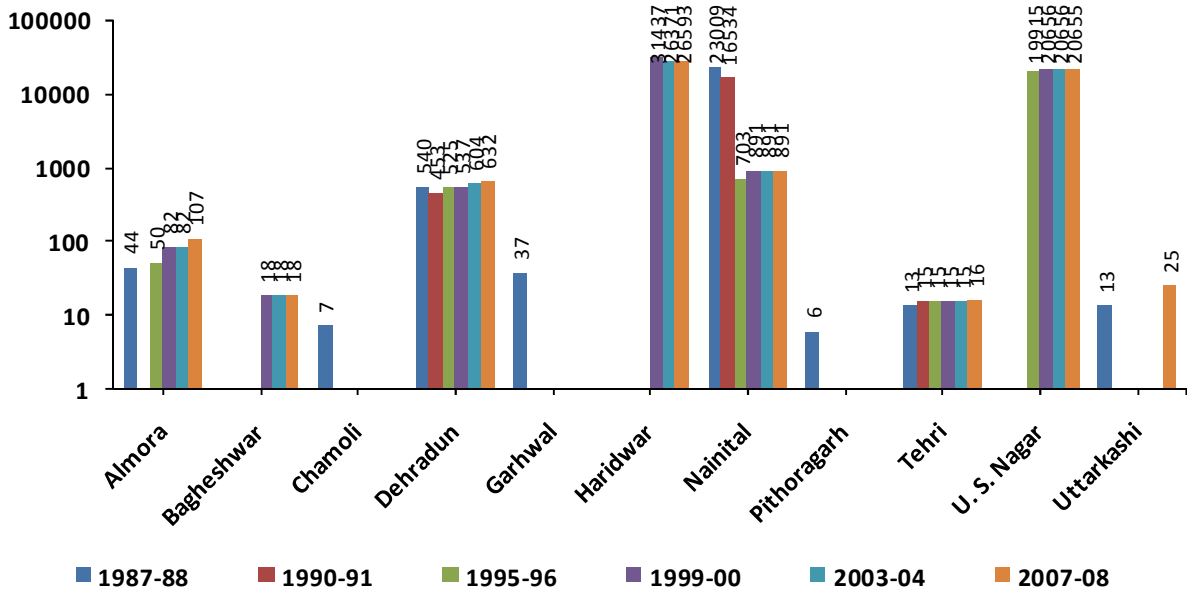

Figure 30: **Boring Pumpsets/Pumping sets operated (No.) across Districts of Uttarakhand, 1987-88 to 2007-08**

9. Crop Output

Cropping intensity is an indicator of intensive use of agricultural land. Figure 31 suggests that the cropping intensity in general, even in hilly region of the state, is very high. More than one crop is sown in an agricultural field in a season. Pithoragarh recorded the highest crop intensity of 184 percent during 2003-05, followed by Bageshwar (180), Udham Singh Nagar (171), and Nainital (169). It is important to note that Haridwar, even being the district in the plain region, had the lowest cropping intensity of only 144 percent compared to other districts in the state. This is due to the fact that the district has a significant area under sugarcane, and sugarcane is an annual crop, which is harvested once in a year.

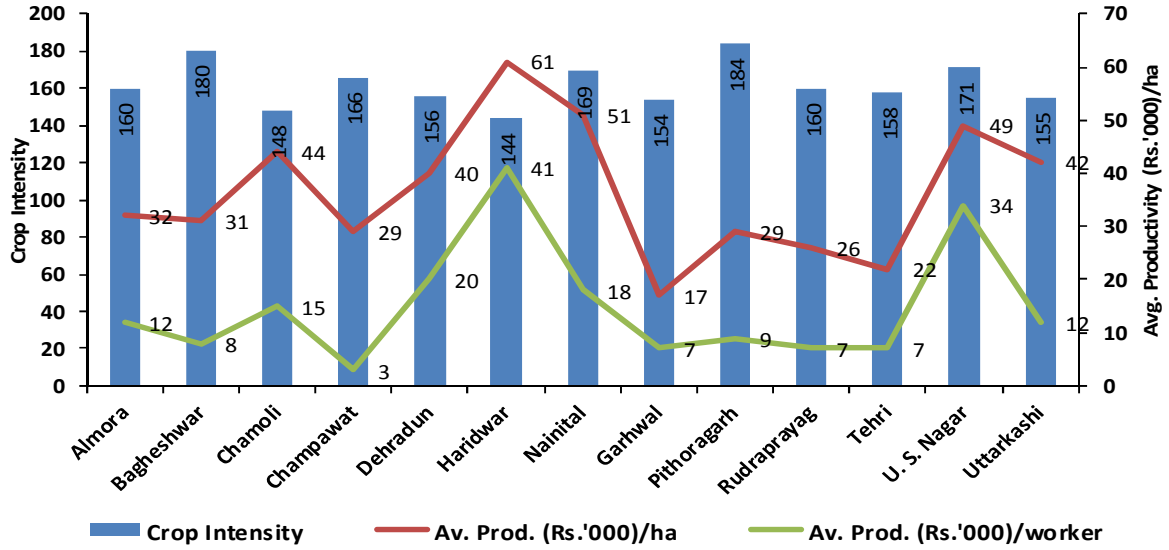

Figure 31: **Crop Intensity and Average Productivity across Districts of Uttarakhand, 2003-05**

Figure 31 also illustrates the average productivity across districts of Uttarakhand in terms of monetary gain with respect to agricultural area and the agricultural workers involved during the agricultural season 2003-05. Haridwar stood out among the other districts of the state with an average productivity of Rs 61,000 per hectare and Rs 41,000 per worker during 2003-05, closely followed by Udham Singh Nagar with an average productivity of Rs 49,000 per hectare and Rs 34,000 per worker.

The crop output may, to some extent, be correlated with the crop intensity. However, thisis not the case instances. Productivity of the crop not only depends upon the use of agricultural fields to produce the crop, but also depends upon various factors like soil fertility, use of fertilizer, variety of seeds, irrigation facilities, etc. The yield of the crop is a direct indicator of crop productivity. Figure 32a shows the average yield of different crops in the state during 1986-87 to 2009-10. The trend suggests that the productivity of the two main and traditional crops of the state i.e. rice and wheat has the highest productivity among major food grains and crops over the years. During 2009-10, the average yield of wheat was recorded 2,140 kg/ha, compared to 2,090 kg/ha of rice. Other two major food grains barley and maize had an average yield of 1,100 and 1,400 kg/ha respectively. Pulses was recorded with lowest average yield of 700 kg/ha, while the oilseeds recorded around 1,100 kg/ha during the same period.

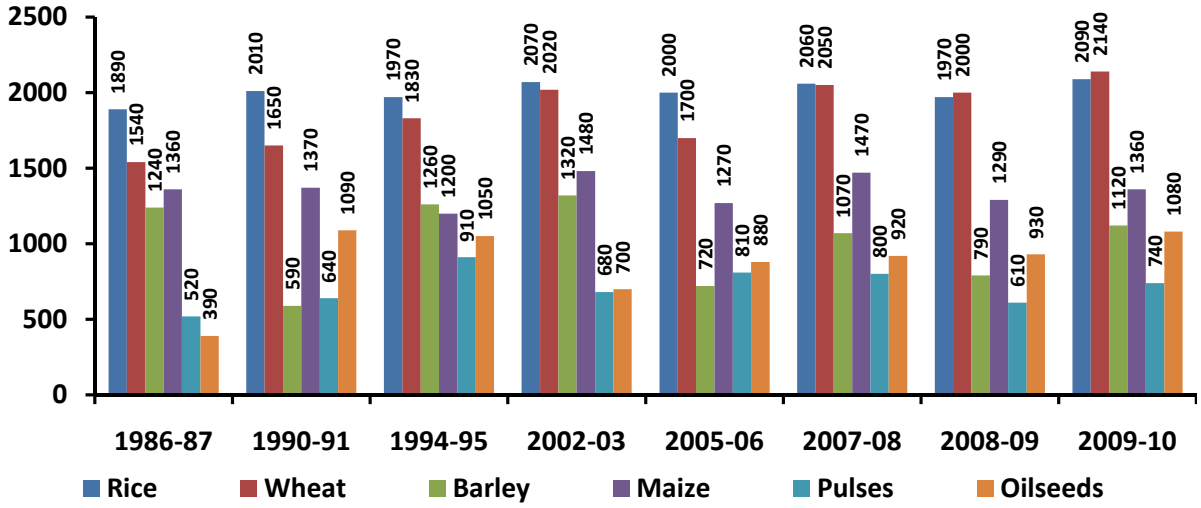

Figure 32a: Average yield (kg/ha) of major crops, Uttarakhand, 1986-87 to 2009-10

The most productive crop in the state, which has generated impressive monetary benefits to the farmers of the plain region in the state, is no doubt, the sugarcane. Figure 32b shows the average yield of sugarcane in the state during 1986-87 to 2009-10, and the datasuggests that the sugarcane has been recording an average yield of more than 50,000kg/ha over the period. The production of sugarcane, however, is limited to a few districts in the state like Haridwar, Udham Singh Nagar, Nainital, Dehradun, Pauri Garhwal, etc. Although, the recent data for the other very productive crop or vegetable i.e. potato was not available, the average yield of potato has been around 15,000kg/ha in the state, and grown almost in all the districts of the state.

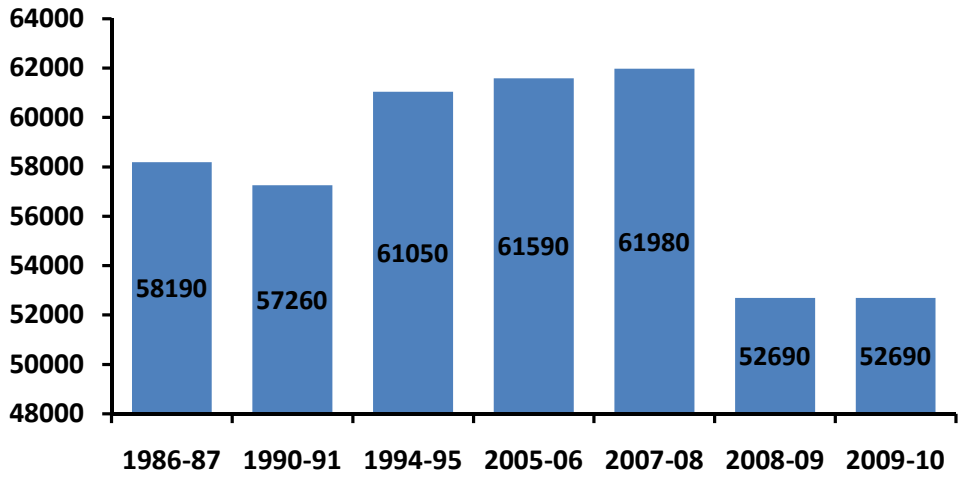

Figure 32b: Average yield (kg/ha) of Sugarcane, Uttarakhand, 1986-87 to 2009-10

9.1. Rice

Figures 33a and 33b represent the average yield of rice (kg/ha) across districts of the Kumaon and the Garhwal region of Uttarakhand during 1986-87 to 2005-06 respectively. However, there is no specific reason in presenting the yield of rice for districts by two separate regions (and the other crops too in succeeding sections), except the separation would provide a more clear picture and trend. During 2005-06, the highest average yield of rice was recorded by Udham Singh Nagar (2,800 kg/ha), closely followed by Nainital (2,700 kg/ha), and Dehradun (2,100kg/ha). Among the rest, except Haridwar (1,800 kg/ha) which was somewhat closer to the state average (2,000kg/ha), all other districts were quite below the average yield level of rice in the state. While, most of the districts show not a clear trend over the years with highs and lows, Haridwar stands out with continuously decreasing average yield of rice in the state.

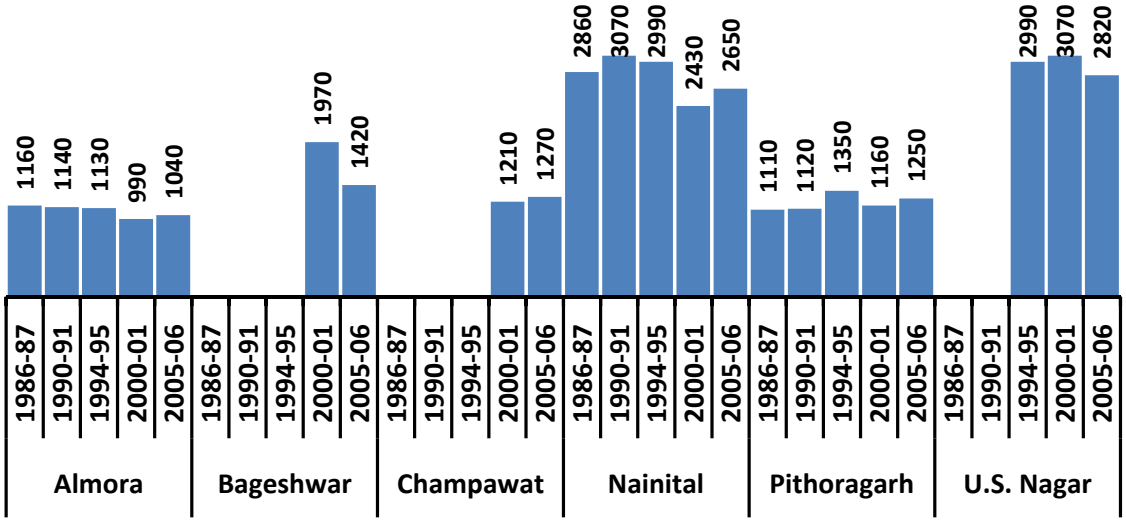

Figure 33a: Average yield of Rice in kg/ha across Districts of Uttarakhand (Kumaon Region), 1986-87 to 2005-06

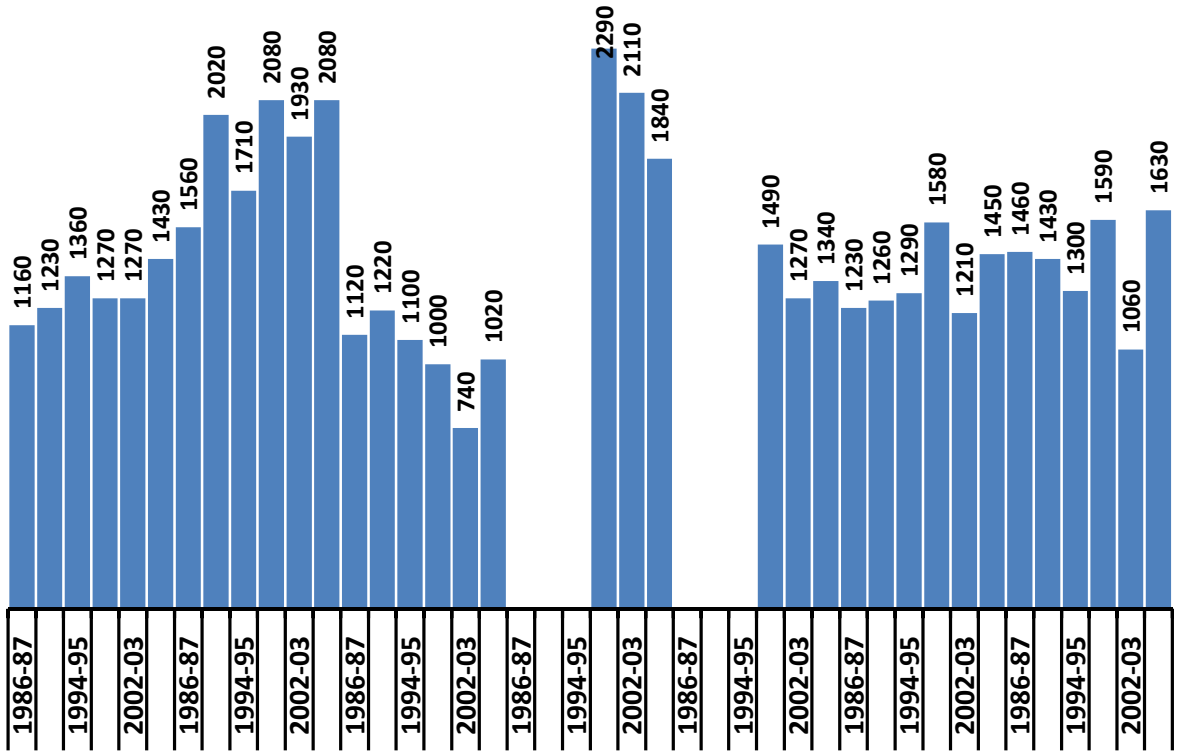

Figure 33b: Average yield of Rice in kg/ha across Districts of Uttarakhand (Garhwal Region), 1986-87 to 2005-06

9.2. Wheat

There were only three districts in the state namely Udham Singh Nagar, Haridwar, and Nainital, which recorded an average yield of wheat more than the state average of 1,700kg/ha. These districts in order recorded an average yield of wheat as 3,000 kg/ha, 2,400 kg/ha, and 2,200 kg/ha respectively. Other districts which recorded more than the average yield of 1,000 kg/ha, were Dehradun with 1,500 kg/ha, Champawat and Pithoragarh with 1,200kg/ha each, Uttarkashi (1,100 kg/ha), Tehri Garhwal and Rudraprayag with 1,000 kg/ha each.

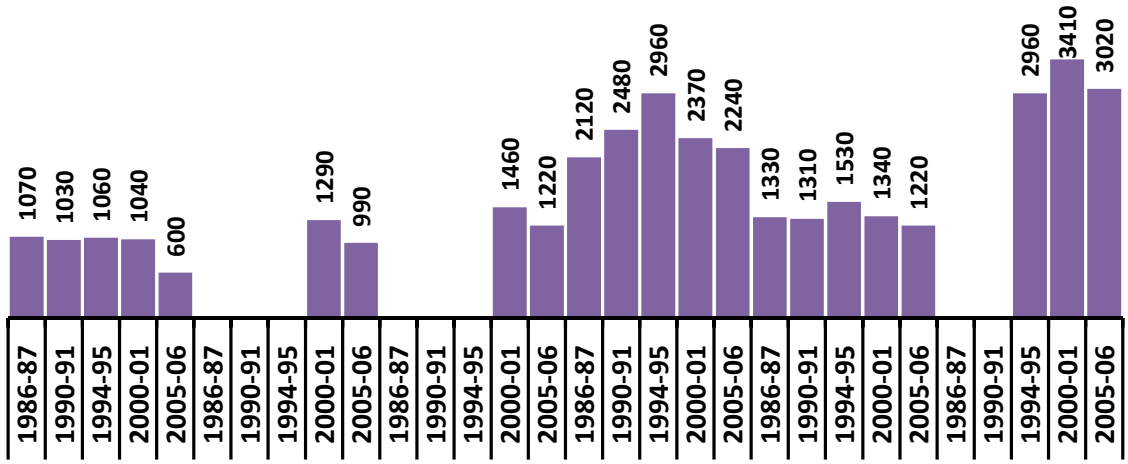

Figure 34a: Average yield of Wheat in kg/ha across Districts of Uttarakhand (Kumaon Region), 1986-87 to 2005-06

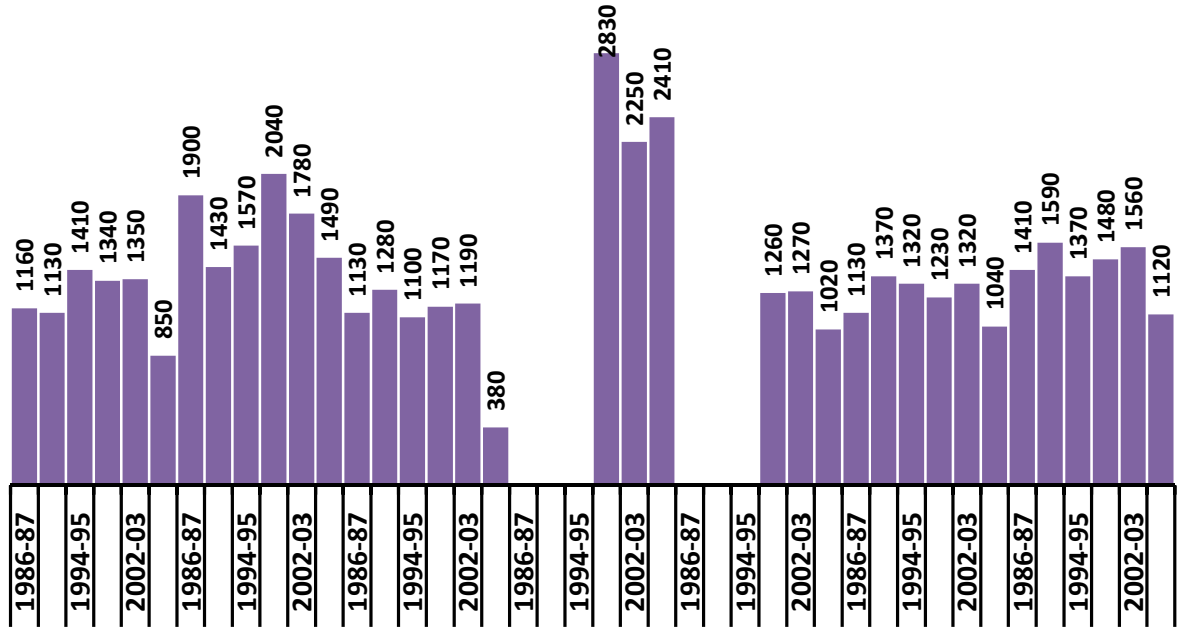

Figure 34b: Average yield of Wheat in kg/ha across Districts of Uttarakhand (Garhwal Region), 1986-87 to 2005-06

9.3. Pulses

During 2005-06, the only district, which managed to make an increase in the state average yield of pulses, was Tehri Garhwal with a tremendous increase in the productivity of pulses with an average yield of 2,700kg/ha. Other districts had a very low yield compared to the state average (800kg/ha).

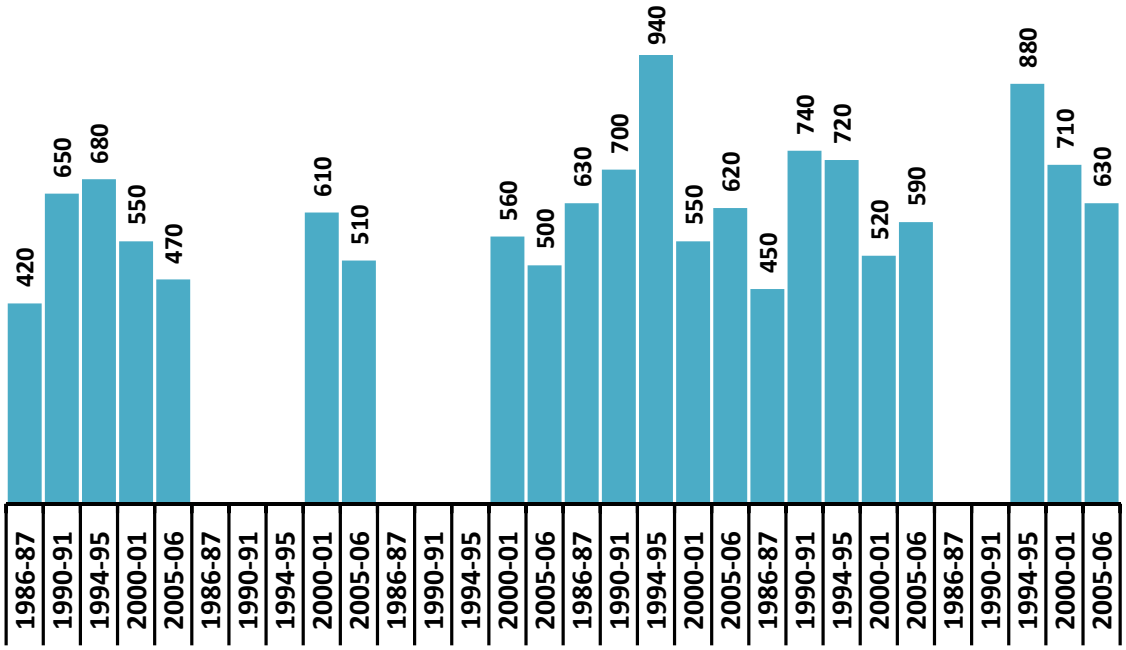

Figure 35a: Average yield of Pulses in kg/ha across Districts of Uttarakhand (Kumaon Region), 1986-87 to 2005-06

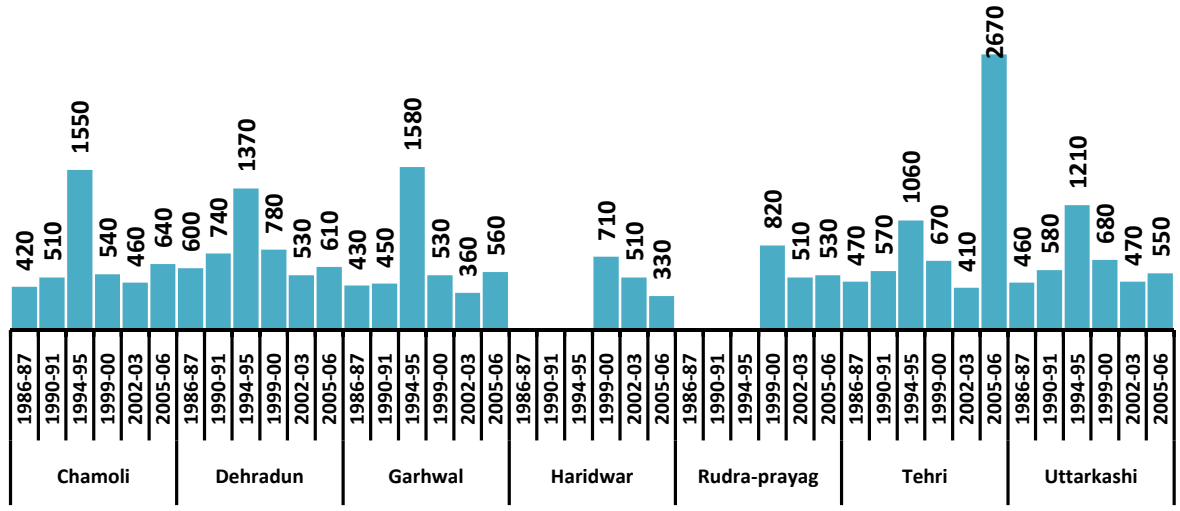

Figure 35b: Average yield of Pulses in kg/ha across Districts of Uttarakhand (Garhwal Region), 1986-87 to 2005-06

9.4. Oilseeds

The highest average yield of oilseeds was observed in the district of Pithoragarh in Uttarakhand during 2005-06, which was around 1,400kg/ha. Other districts which were close to this yield were Tehri Garhwal and Nainital districts with around 1,200 kg/ha each. Rest of the districts in the state appeared to record an average yield lower than the state average of nearly 900 kg/ha (see Figure 36a and 36b).

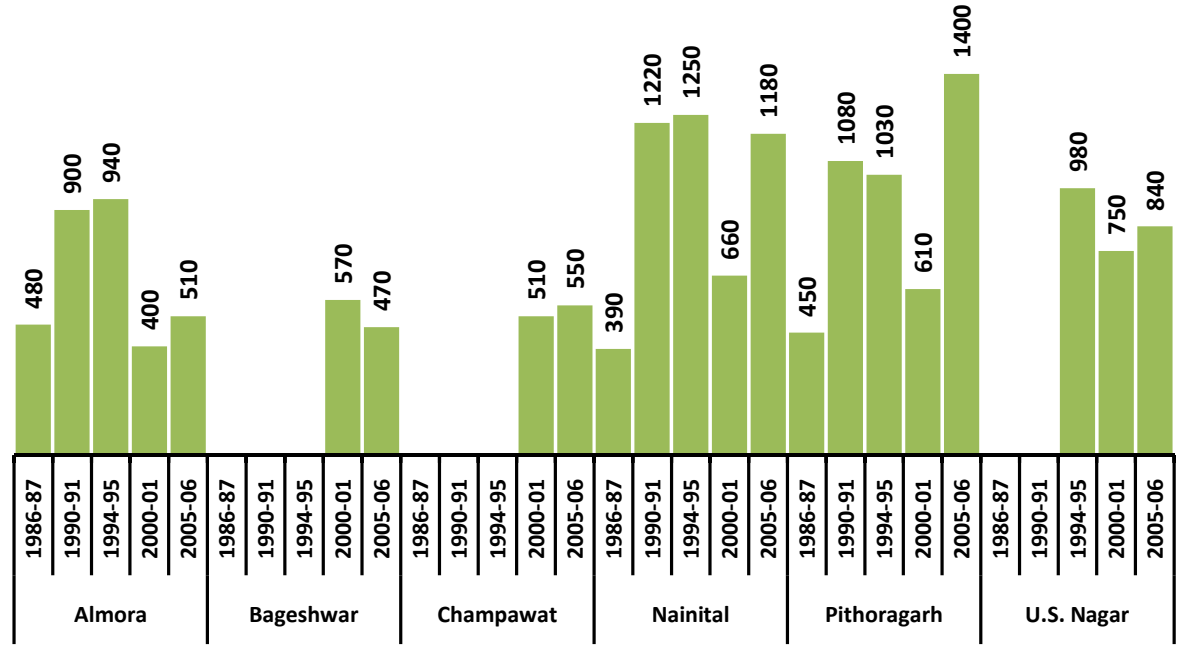

Figure 36a: Average yield of Oilseeds in kg/ha across Districts of Uttarakhand (Kumaon Region), 1986-87 to 2005-06

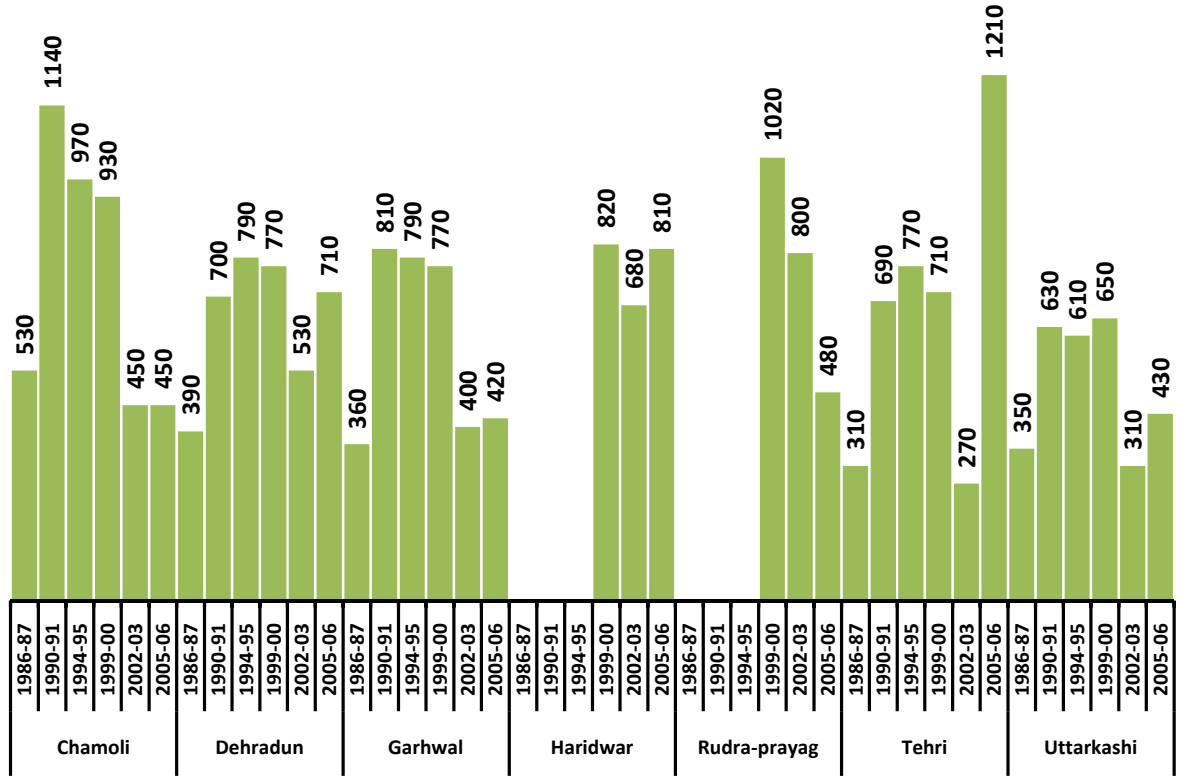

Figure 36b: Average yield of Oilseeds in kg/ha across Districts of Uttarakhand (Garhwal Region), 1986-87 to 2005-06

9.5. Sugarcane

The highest productivity among all crops grown in the state is considered to be of sugarcane. However, the cultivation of sugarcane is limited to only half of the districts in the state as shown in Figure 37. The average yield of sugarcane in the state is around 60,000kg/ha, which does not differ largely across the state. As per Figure 37, the highest average yield of sugarcane was recorded by Dehradun (65,800 kg/ha) during 2005-06, closely followed by Haridwar (62,200kg/ha) and Pauri Garhwal (61,000kg/ha). During the same period, Udham Singh Nagar and Nainital observed an average yield of 59,600kg/ha each.

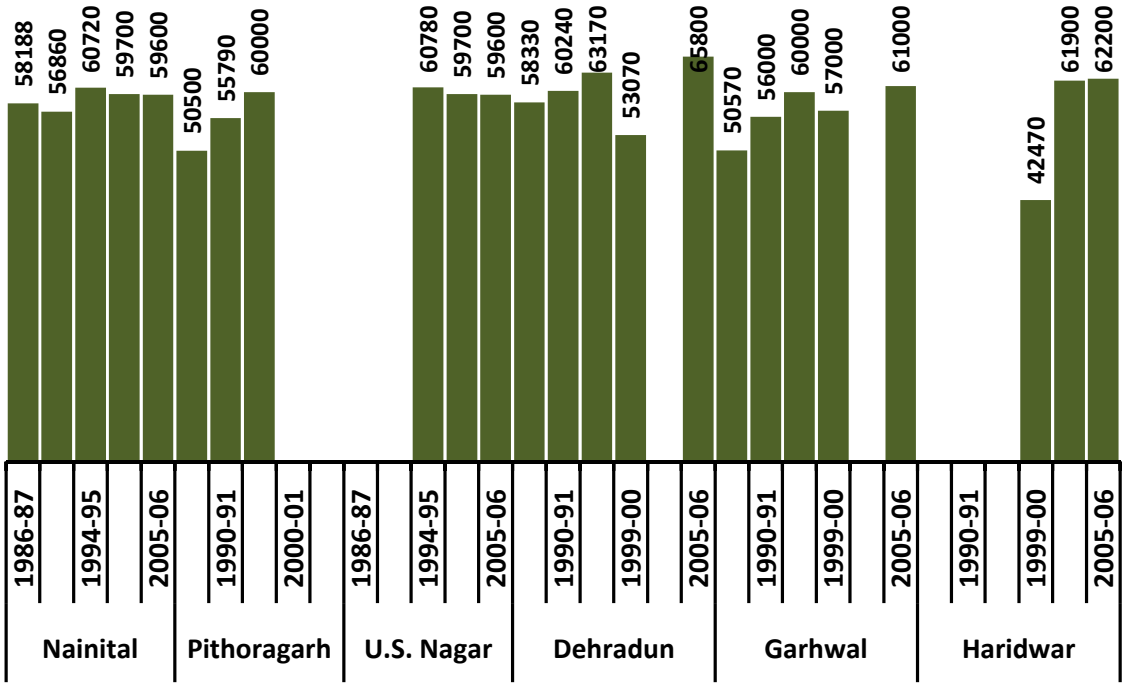

Figure 37: Average yield of Sugarcanein kg/ha across Districts of Uttarakhand, 1986-87 to 2005-06

9.6. Potato

Figures 38a and 38b represent the average yield of potato across the districts of Kumaon and Garhwal region during 1986-87 to 2005-06 respectively. The highest average yield of potato in the state was recorded by the district of Chamoli (19,000 kg/ha) during 2005-06, followed by Haridwar, Udham Singh Nagar, and Pauri Garhwal with 17,500kg/ha each.

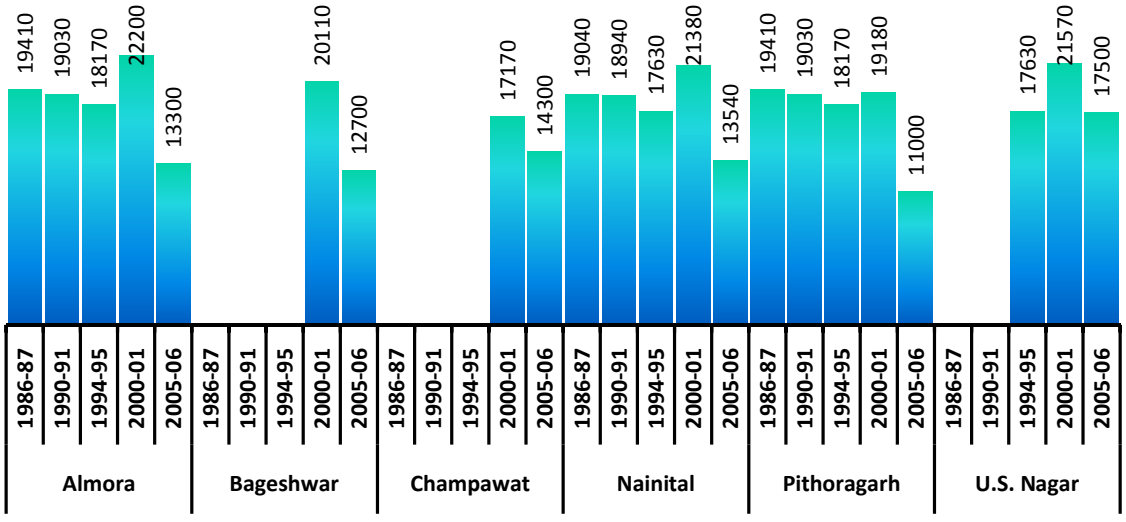

Figure 38a: Average yield of Potato in kg/ha across Districts of Uttarakhand (Kumaon Region), 1986-87 to 2005-06

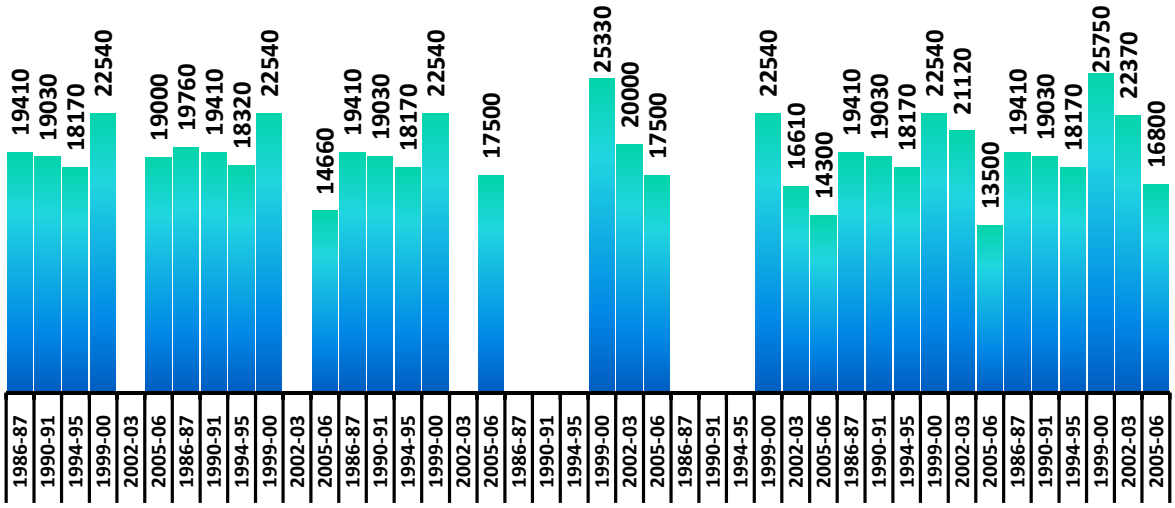

Figure 38b: Average yield of Potato in kg/ha across Districts of Uttarakhand (Garhwal Region), 1986-87 to 2005-06

10. Cost and Returns in Major Crops

In this section, data, information and analysis on costs and returns in major crops, fertilizer consumption, human labour and draught power utilization are presented. The main intent is to arrive at the most profitable crop (cropping pattern) from the point of view of farmers and sustainable agriculture. Data for this purpose are collected from www.indiastat.com.

10.1. Economics of Sugarcane Cultivation

Sugarcane is one of the most important crops grown by the farmers in the plain region of the state. It is grown on irrigated land and requires relatively more number of irrigation cycles as compared to other competitive crops. Availability of ground and surface water in the Ganga canal command and sugarcane price policy motivate the farmers to bring more cultivated areas under sugarcane crops. Apart from a number of small-scale units of sugarcane processing, there are about 11 sugar mills working in the state. Table 1 shows the cost and returns in the sugarcane crops for the last 5 years. As the table reveals, both per hectare value of sugarcane output (main product + by-product) and per hectare cost (C) in nominal term have significantly increased over the period. The trend in the net income indicates that cultivation of sugarcane in the basin area has remained profitable to the farmers. Net returns from the crop have increased from Rs 21,173 in 2002-03 to Rs 33,234 in 2006-07. However, the increase was mainly due to rise in sugarcane prices, as per hectare yield of sugarcane has actually declined during the period. During 2007-08, per hectare yield has significantly increased over the preceding year, but net income declined mainly due to decline in the per unit price. The ratio of value of output (VOP) to C is calculated to know the returns on investment. The ratio was found to be lowest (1.69) during 2002-03 and the highest (2.01) during 2005-06. A ratio of 2.01 indicates that if a farmer spends Rs 1 on the cultivation of sugarcane, he/she gets Rs 2.01.

Table 1: Costs and Returns in Sugarcane, Uttarakhand (Rs /ha)

Year	Value of Output (VOP)	Cost of Cultivation (C), Rs	Net Income,Rs	Ratio of VOP to C	Yield, kg./ha	Chemical Fertilizer, kg/ha	Human labour, hours/ha	Draught power, hours/ha
2002-03	52,018	30,845	21,173	1.69	57,900	264	1159	-
2003-04	52,093	25,164	26,928	2.07	59,200	134	991	-
2004-05	57,079	29,568	27,511	1.93	50,400	315	1145	-
2005-06	62,343	30,995	31,349	2.01	49,100	134	1009	3
2006-07	63,421	33,234	30,187	1.91	46,100	192	1051	-
2007-08	61,629	32,716	28,913	1.88	52,600	87	727	0.51

Consumption of chemical fertilizer in sugarcane crop varies across years. It was found to be the lowest (87 kg/ha) in 2007-08 and the highest (315 kgs/ha) during 2004-05. On an average, one hectare of sugarcane cultivation absorbs about 1,014 human hours of labour, which is equivalent to 127 man-days. The labour absorption was observed to be the lowest (727 hrs/ha) during 2007-08 and the highest (1,159 hrs/ha) during 2002-03.

10.2. Economics of Wheat Cultivation

Wheat is another important crop grown in the area. It is grown in the entire state. Table 2 shows the cost and returns from the wheat cultivation. As is evident from the table, VOP has been greater than the cost of production only in three out of the five years. Net income is negative during 2002-03 and 2004-05. The ratio of VOP to C indicates that except for the last three years, the farmers growing wheat did not get any profit from wheat crop. The loss was observed to be the highest during 2002-03. Per hectare yield was quite low. It ranges from 2,200 kg/ha to 2,600 kg/ha. Fertilizer consumption was also found low as is obvious from Table 2. Human labour absorption does not show any trend. The number of labour hours was recorded the highest (496 hrs/ha) during 2003-04 and the lowest (423 hrs/ha) during 2005-06. On an average, one hectare of wheat cultivation provides about 58 days of employment. Draught power use in the wheat cultivation was the highest during 2003-04 and the lowest during 2005-06.

Table 2: Costs and Returns in Wheat, Uttarakhand (Rs /ha)

Year	Value of Output (VOP)	Cost of cultivation (C), Rs	Net income, Rs	Ratio of VOP to C	Yield, kg/ha	Chemical Fertilizer, (kg/ha)	Human labour (hours/ha)	Draught power (hours/ha)
2002-03	17,681	18,923	-1242	0.93	2,200	56	484	122
2003-04	18,710	18,644	66	1	2,400	51	496	123
2004-05	20,824	20,,934	-110	0.99	2,600	77	478	114
2005-06	21,041	20,114	927	1.05	2,300	48	423	58
2006-07	25,854	24,998	856	1.03	2,500	49	445	72
2007-08	31,573	25,152	6421	1.26	2,600	43	470	60

10.3. Economics of Paddy Cultivation

Table 3 shows cost and returns in paddy cultivation. The paddy cultivation recorded negative profit in the first two years and then generated profit in the subsequent years. The ratio of VOP to C was observed to be the lowest during 2002-03 (0.97) and the highest (1.34) during 1997-98. Per hectare yield of paddy ranges from 2,800 kg/ha to 3,800 kg/ha. Per hectare use of chemical fertilizer in paddy varies from 55 kg/ha to 91 kg/ha. On an average, one hectare of paddy cultivation provides about 88 days of employment. Animal labour (a pair of bullocks) use in paddy shows variation across years. It shows rise and fall over the period.

Table 3: Costs and Returns in Paddy, Uttarakhand (Rs /ha)

Year	Value of Output (VOP)	Cost of cultivation (C)	Net income, Rs	Ratio of VOP to C	Yield kg/ha	Chemical Fertilizer (kg/ha)	Human labour (hours/ha)	Draught power (hours/ha)
2002-03	17,201	17,690	-489	0.97	2,800	80	778	114
2003-04	18,144	18,560	-417	0.98	3,100	91	790	95
2004-05	19,855	18,553	1302	1.07	3,100	62	691	90
2005-06	22,557	21,308	1249	1.06	3,500	79	659	52
2006-07	26,134	21,896	4238	1.19	3,800	66	672	37
2007-08	26629	19811	6818	1.34	33	55	632	44

10.4. Economics of Barley Cultivation

Table 4 shows the cost and returns from the barley crops. Farmers growing barley crops incurred heavy losses during 2003-04 and 2004-05, as value of output was much lower than the cost of cultivation during both the periods. The ratio of VOP to C was as low as 0.47 during 2003-04. This indicates that if a farmer spends Rs 1 for growing barley, he/she gets only Rs 0.47 as value of output. Low productivity (1,200 to 1,400kg/ha) and lack of remunerative prices are the main reasons for the negative profitability in barley cultivation. Labour absorption in the cultivation of barley ranges between 682 hours/ha to 698 hours/ha. Animal power utilization is relatively higher in barley than that in wheat.

Table 4: Costs and Returns in Barley, Uttarakhand (Rs /ha)

Year	Value of Output (VOP)	Cost of cultivation (C)	Net income, Rs	Ratio of VOP to C	Yield, kg/ha	Chemical Fertilizer, kg/ha	Human labour, hours/ha	Draught power, hours/ha
2003-04	8,780	18,806	-10,026	0.47	1,200	Not Available	682	280
2004-05	11,819	19,248	-7,428	0.61	1,400	Not Available	698	200

10.5. Economics of Mustard Cultivation

Costs and returns from mustard (oilseed) crop are shown in Table 5. As is evident from the data presented in the table, VOP from mustard crop has been higher than C during 2002-03, 2003-04 and 2007-08. As a result, farmers growing this crop during these two years earned

profit. However, the farmers growing this crop during 2004-05 incurred losses, as VOP was much lower than C. The ratio of VOP to C varies significantly across years, indicating to the volatility in the net income of farmers from the crop. Yield of mustard ranges between 500kg/ha to 1,100kg/ha. Low yield during 2004-05 is the main reason for the negative profitability. Fertilizer consumption was also much lower during 2007-08 than during 2002-03. Human labour and animal labour use in mustard varies across years.

Table 5: Costs and Returns in Mustard, Uttarakhand (Rs /ha)

Year	Value of Output (VOP)	Cost of cultivation (C)	Net income, Rs	Ratio of VOP to C	Yield kg/ha	Chemical Fertilizer, kg/ha	Human labour, hours/ha	Draught power, hours/ha
2002-03	26,169	10,955	15,214	2.39	1,000	61	353	63
2003-04	11,456	10,898	558	1.05	600	-	666	20
2004-05	7,955	11,819	-3,864	0.67	500	32	309	65
2007-08	23,840	14,661	9,179	1.63	1,100	11	279	6

10.6. Economics of Gram Cultivation

Gram is mostly grown on rain-fed farms. Table 6 shows that per hectare VOP declined from Rs 15,258 during 2003-04 to Rs 15,022 during 2004-05. Similarly, C declined from Rs 12,114 to Rs 11,893. Consequently, net returns remain almost the same. Profitability and yield of the crop remained the same during both the periods. However, labour utilization slightly declined and animal labour slightly increased during 2004-05 over the preceding years.

Table 6: Costs and Returns in Gram, Uttarakhand (Rs /ha)

Year	Value of Output (VOP)	Cost of cultivation (C)	Net income, Rs	Ratio of VOP to C	Yield kg/ha	Chemical Fertilizer, kg/ha	Human labour, hours/ha	Draught power, hours/ha
2003-04	15,258	12,114	3,145	1.26	900	Not Available	343	5
2004-05	15,022	11,893	3,129	1.26	900	Not Available		8

10.7. Economics of Maize Cultivation

Maize cultivation is not found profitable for the farmers. As Table 7 indicates, in all the years under study, there has been net loss to the farmers. The cost has remained much higher than the returns. The ratio of VOP to C was estimated the lowest (0.51) during 2003-04 and 2004-05. It was estimated the highest (0.85) during 2005-06, followed by 2007-08. The yield of maize ranges between 1,200kg/ha to 1,600kg/ha which is quite low. The data presented in the table suggest that both cost and returns in the maize cultivation are much lower than that are in wheat and paddy crops. However, the returns remained much lower than the cost and consequently farmers growing maize incurred heavy losses. Average consumption of chemical fertilizer in maize is worked out to be about 55 kg/ha. On an average, one

hectare of maize cultivation provides about 80 days of works. Use of animal labour varies from 55 hours/ha to 78 hours/ha.

Table 7: Costs and Returns in Maize, Uttarakhand (Rs /ha)

Year	Value of Output (VOP)	Cost of cultivation (C)	Net income, Rs	Ratio of VOP to C	Yield,kg/ha	ChemicalFertilizer, kg/ha	Human labour, hours/ha	Draught power, hours/ha
2002-03	7,033	13,714	-6,681	0.51	1,339	67.64	821.90	61.34
2003-04	7,635	13,245	-5,610	0.58	1,307	71.81	809.74	64.24
2004-05	6,276	12,262	-5,986	0.51	1,206	58.44	596.62	55.06
2005-06	10,650	12,814	-2,164	0.83	1,419	41.34	557.85	62.19
2006-07	11,602	14,803	-3,201	0.78	1,641	42.18	500.00	62.21
2007-08	13,584	16,551	-2,967	0.82	1,502	50.12	470.00	77.93

11. Organic Farming

Uttarakhand is the first State of India to be declared an organic state. The Uttarakhand Organic Commodity Board (UOCB) has been constituted to promote organic farming in the state. About 10,000 hectare of land is under organic farming, covering about 15,000 farmers and 45 crops[9]. The state has ideal conditions for the organic farming, especially in the hill regions where chemical fertilizer consumption in various traditional cereal crops such as millets, barley, pulses, etc. is quite low due to various constraints. Promotion of organic farming is desirable for maintaining soil fertility, checking the groundwater degradation, protecting human health, reducing water requirement of crops, and finally decreasing the non-point sources of pollution of rivers. The major challenge before the state is to improve the livelihood of the people without losing out its biodiversity and other natural resources, including water resources. In this context, organic farming could be a viable option if the state encourages and supports the farmers by protecting their farm income, developing marketing infrastructure, putting in place the institution of certification, quality check branding, and training of farmers. It is observed that when a farmer shifts from conventional farming to organic farming, the initial level of productivity declines. However, later on, the productivity increases. In order to encourage farmers to adopt this alternative system of farming, their net income should be insured at least for two to three years either though providing subsidized inputs or through direct transfer of subsidies. This transfer could be much lower than the environmental and health costs that the society bears due to chemicalization of agriculture. In this section, an attempt is made to examine the cost and returns from organic as well as conventional farming in the state. The analysis is based on the data compiled from the studies conducted by the other researchers.

Table 8: Economics of Organic vs. Conventional Farming in Uttarakhand, 2008-09

Crop	Yield, kg/acre		Farm gate Price, Rs /kg		Value of Output, Rs /acre		Cost, Rs /acre		Net Return	
	OF	CF	OF	CF	OF	CF	OF	CF	OF	CF
Basmati	900	1,050	34.0	30.0	30,600	31,500	7,690	8,390	22,910	23,110
Non-basmati	1,620	1,800	8.5	8.5	13,770	15,300	7,600	7,800	6,170	7,500
Wheat	1,140	1,380	11.0	10.50	12,540	14,490	6,500	7,400	6,040	7,090
Finger millet	1,050	1,000	7.0	6.85	7,350	6,850	2,800	3,150	4,550	3,700
Maize	1,800	1,700	6.0	5.9	10,800	10,030	3,800	4,200	7,000	5,830
Barley	730	600	8.0	7.7	5,840	4,620	3,320	3,600	2,520	1,020
Sugarcane	28,700	30,000	1.5	1.4	43,050	42,000	13,740	14,500	29,310	27,500
Peas	3,600	3,800	18.0	17.0	64,800	64,600	10,870	10,070	53,930	54,530
Tomato	4,100	4,500	4.75	4.5	19,475	20,250	9,400	9,400	10,075	10,850
Potato	4,500	4,200	10.0	9.9	45,000	41,580	8,200	8,500	36,800	33,080
Cauliflower	4,200	4,400	4.50	4.3	18,900	18,920	9,980	9,180	8,920	9,740
Ginger/Turmeric	2,700	2,500	3000	28.0	81,000	70,000	5,500	5,400	75,500	64,600
Chilli green/red	2,500	2,800	7.0	6.5	17,500	18,200	7,800	8,600	9,700	9,600
Tulsi green	2,000	2,000	7.0	7.0	14,000	14,000	3,700	3,700	10,300	10,300
Coriander green*	2,800	2,500	20.0	19.0	56,000	47,500	7,800	8,350	48,200	39,150
French beans	3,000	2,750	9.0	8.5	27,000	23,375	4,000	4,500	23,000	18,875
Soybean	500	400	21.0	20.0	10,500	8,000	4,000	4,500	6,500	3,500
Rajma	550	500	54.0	52.0	29,700	26,000	4,000	4,500	25,700	21,500
Arbi	3,000	2,700	8.0	8.0	24,000	21,600	5,700	5,900	18,300	15,700
Mustard	600	650	20.0	18.0	12,000	11,700	4,500	4,200	7,500	7,500
Onion	11,000	10,500	5.5	5.5	60,500	57,750	8,450	8,350	52,050	49,400
Avaregae	3,857	38,920	14.0	13.29	28,777	27,060	6,636	6,866	22,142	20,194

Source: Prepared from Singh J. (2009), Impact Assessment study of Center of Organic Farming I &II, Uttarakhand State http://www.srtt.org/institutional_grants/pdf/COF.pdf

* Typically this year the price of coriander green was exceptionally high.

Singh (2009)[10] conducted a study on organic versus conventional farming in Uttarakhand. The study was based on a sample survey of 310 farmers collected from 13 development blocks, namely, Gadarpur, Bajpur, Kashipur, and Jaspur in Udham Singh Nagar district; Raipur, Kalsi, Sahaspur, and Vikasnagar in Dehradun district; Doiwala and Narsan in Hardwar district; Betalghat and Ramgarh in Nainital district; and Tarikhet in Almora district. Table 8 shows the comparison of costs and returns in organic and conventional farming among 21 crops. Per acre yield, farm gate prices, total value of output per acre, cost per acre and finally net income per acre are examined in case of these crops. A perusal of Table 8 reveals that out of 21 crops, nine crops have slightly lower yield per acre from organic farming compared to conventional farming. These crops are paddy (both basmati and non-basmati), wheat, sugarcane, peas, tomato, cauliflower, chili, and mustard. Millet, barley, maize, potato, ginger, coriander, French beans, soybean, rajma, arbi, and onion achieved higher yield under organic farming than that in conventional farming. There were no differences observed in the yield of rest of the crops.

As far as farm gate prices of various crops are concerned, it was observed that prices of 18 commodities were higher under organic farming than the conventional farming. This shows that the premium prices were received by the farmers growing organic products. However, the difference is insignificant in case of most of the crops as is evident from the data shown in Table 8. Per acre cost of cultivation is higher in conventional farming than that in organic farming in case of most of the crops as shown in Table 8. Thus, higher market prices and lower cost of cultivation of organic crops are the major advantages of the organic farming. However, net returns in some of the crops are lower under organic farming than conventional farming mainly due to yield differences. On an average, one acre of land under organic farming provides net income of Rs 22,142, whereas the corresponding net income from conventional farming is Rs 20,194. This implies that in spite of lower average productivity of land under organic farming, the net returns are higher because of lower cost and premium prices.

Singh andSingh (2006)[11] compared the costs and returns in paddy and wheat crops under organic farming vis-à-vis non-organic farming in Kashipur block of Udhamsingh Nagar district of Uttarakhand. The study was based on primary data collected from 90 farmers (45 organic and 45 non-organic) during 2004-05. The costs and returns from these two crops are shown in Table 7. The yields from organic and non-organic paddy have been found as 2,686 kg/ha and 3,274 kg/ha, respectively. However, farmers could realize relatively higher prices for organic (Rs 13.80/ kg) produce than non-organic (Rs 11.61/kg.). Net returns over cost C have been found higher in organic farming than in non-organic farming mainly because of lower C and higher premium prices of organic paddy. In case of wheat, per hectare yield was much lower (1,985 kg/ha) in organic farming than in non-organic farming (2,812 kg/ha). Cost C in organic wheat was lower (Rs 16,138/ha) than that in non-organic wheat (Rs 20,847/ha). However, the price per kgof organic wheat has been higher (Rs 8.75/kg) than that in non-organic wheat (Rs 7.80/kg). Although per hectare cost of cultivation of organic wheat was lower than that of non-organic, the high yield difference between the two makes the organic wheat farming non-profitable for the farmers.

12. Conclusions

- Net Sown Area as percentage of the total area has declined in the recent years. This is a matter of concern from the point of view of food security and sustainability of livelihood of people.
- At the State level, area under non-agricultural uses has increased significantly, especially in the plain districts of the state.

- There has been marginalization of agricultural holdings in the State. Percentage of number of marginal holdings has remarkably increased whereas number of all other categories of holdings has declined.
- Percentage of GIA to GCA has also significantly increased, with highest percentage of GIA shared by the groundwater resources in the plain districts of the State.
- Sugarcane, wheat and rice together comprise the largest share in the GIA. These crops consume the maximum quantity of available water. Huge quantity of water could be saved by changing the cropping pattern from these crops to the less water consuming crops. Further, technological improvement and change in the agricultural practices in general, and irrigation practices in particular, could also help to reduce the water use in rice, wheat and sugarcane crops.
- The use of chemical fertilizer in agriculture has increased significantly. Further, fertilizer consumption was found much higher in the plain districts than that in the hill districts.
- Number of pump sets per 1000 ha of GCA has increased over the period, particularly in the plain districts. The rapid growth of number of pump sets in the basin area has some implications for the sustainability of groundwater. The flat rate electricity tariff system prevailing in the State encourages extraction of more groundwater for irrigation as marginal cost of drawing extra unit of water is almost zero for farmers.
- The trend in cropping pattern indicates that the cropping pattern is dominated by sugarcane, wheat, and rice in the plain districts of the state, while in the hill regions most of the farmers grow traditional food crop, soybean, medicinal plants, and vegetables.
- Productivities of most of the crops including wheat, rice and sugarcane were observed to be the higher in the plain areas than that in the hill areas.

13. Suggestions

- Scope of modern input-intensive agriculture in the hill districts of the state is quite limited due to physical, environmental and economic reasons. Farmers of hill regions have natural advantage of cultivation of organic farming. Organic farming should be promoted in the state, including the plain areas through state support. Since, in case of most of the crops net returns from organic farming is lower than the non-organic farming. Farmers willing to adopt organic farming system must be compensated initially either through input-subsidization or through direct transfer.
- Training and capacity building infrastructure at the block level should be created to enhance the knowledge and skills of farmers through effective training programmes related to organic farming, composting techniques, bio-pesticides and bio-fertilizer, value addition techniques, group-farming and organizational skills.

- While restrictions on the number of private tube wells in the river basin may improve groundwater table, there is also need to revive and renovate the traditional water bodies in the basin area. Efforts are required to be made to create a network of ponds, even on the private land. These ponds, if planed properly, would help not only in the development of fisheries but also serve the purpose of storing rainwater and recharging groundwater.
- The electricity tariff system in agriculture should be shifted from flat-tariff to meter-tariff, initially in the over-exploited blocks. However, farmers should be compensated by providing subsidy on procurement of modern water saving technology, such as, sprinkler and drip irrigation in these blocks.
- Possibility of horizontal expansion of area under cultivation is quite low. Most promising options to augment farm income and employment are diversification of agriculture and efficient use of scarce land and water resources. Rice-wheat-sugarcane system of farming being adopted in plains of the Ganga basin would not be environmentally sustainable for a longer period. Price signals and market conditions are main determinants of diversification which can be influenced through appropriate agricultural price policy.
- Horticulture and agro-forestay have the potential to generate additional livelihood opportunities to the rural households. There is need to converge the scheme of NHM with the activities of MGNREGS. Annual Action plans and labour budget prepared for the MGNREGS should be prepared by integrating the schemes of district line departments, such as agriculture, irrigation, forest, horticulture etc, so that livelihood component be effectively integrated in the plan with other components such as development, environment, water and soil conservation, regeneration of natural capital, etc.
- Apart from horticulture and agro-forestry, dairy, poultry and fishing are other alternative livelihood options within the agriculture and allied sector that could be included as components in the overall basin management plan. There is need to construct a network of ponds, even on the private land, especially in the agriculturally developed plain districts of the state. These ponds, if planed properly, would help not only in development of fisheries but also serve the purpose of storing rainwater and recharging groundwater. Recently, the Government of India extended the scope of MGNREGS works to the small and marginal farmers land. This provides an ample opportunity to plan and execute works related to horticulture, minor irrigation, land development, construction of ponds, etc. on the private land too. Field surveys carried out in five districts of the states, namely, Chamoli, Champawat, Tehri, Udhamsingh Nagar and Haridwar district to review the systems and assess the

impact of MGNREGS revealed that there is scope for development of horticulture and fishery in the state through effective dovetailing and convergence of MGNREGS with other schemes.

- District-wise land-use pattern reveals that the area under pastureland has been shrinking and not adequate for supporting the livestock of the state. It is necessary to initiate for development programme at large scale in the hill districts to grow more fodder on forest land (both under panchayat and forest department) and on waste and barren land. Community participation through PRIs is required to manage and share the benefit of fodder development programme.
- Transportation of agricultural commodities from the remote hill villages to the market places is the major problem. It is therefore, necessary to diversify the hill agriculture from traditional crops to high value and low volume products, such as herbal and medicinal plants, aromatic plants, mushroom, spices, soybean and pulses, off-season vegetables and fruits. Primary processing of some of the above mentioned products can be done in the village itself and secondary and tertiary processing may be done in the industrial clusters. This would not only help in reducing the volume but also make value addition to the growers. Self-help groups (SHGs) could be formed and trained to do the primary processing.

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Appendix

Table A1: Trend in sectoral distribution of GSDP product at factor cost and constant prices

Year	Agriculture (%)	Forestry (%)	Primary (%)	Manufacturing (%)	Secondary (%)	Tertiary (%)	GSDP (Rs Lacs)
				At 1993-94 Prices			
1993-94	33.84	4.72	40.1	14.19	23.36	36.54	568557
1994-95	32.82	4.07	38.59	18.46	26.97	34.44	618735
1995-96	35.24	4.46	41.21	12.36	22.24	36.54	617420
1996-97	33.37	3.44	37.86	15.34	24.77	37.38	657128
1997-98	32.6	3.75	37.22	12.63	23.1	39.67	668874
1998-99	32.82	4.61	38.67	9.19	21.46	39.86	679984
				At 1999-00 Prices			
1999-00	27.09	2.72	30.99	9.18	18.55	50.46	1278613
2000-01	26.21	1.97	28.89	11.33	21.62	49.5	1427911
2001-02	23.36	1.94	26.09	9.87	23.24	50.66	1505644
2002-03	21.88	1.92	24.5	11.96	25.76	49.73	1648873
2003-04	21.51	1.83	24.84	12.01	25.26	49.9	1776023
2004-05R	20.44	1.76	23.43	12.38	27.04	49.53	1954003
2005-06P	19.04	1.5	22.01	12.08	29.47	48.51	2137194
2006-07Q	17.83	1.44	20.52	12.39	31.65	47.83	2330396

Table A2: Land use pattern and irrigated area, Uttarakhand, 1986-87 to 2008-09

Year	Reported Area[1]	Forest	Cultivable Barren Land	Current Fallow	Other Fallow	Barren & Uncultivable land	Non-Agri-cultural Land	Grazing Land	Miscellane-ous[2]	Net Sown Area	Area sown more than once	Gross Cropped Area	Land pre-pared for Sugarcane	Net Irrigated Area	Gross Irrigated Area
1986-87	5404114	3435922	318809	11818	44900	298917	124432	272275	208097	688891	223274	1150309	309	226055	362457
1987-88	5376163	3424218	319289	11513	45094	298659	125225	272260	208594	671308	215115	1102772	480	247917	359020
1988-89	5384093	3424218	319867	11042	45925	298477	125669	272247	208364	678280	428450	1106730	99	223085	363976
1989-90	5372625	3438767	301781	7537	60553	284628	131035	211586	204891	731769	167975	1188398	117	344673	383274
1990-91	5358595	3424857	317014	8198	63423	295518	136497	227393	216588	669107	171002	1099306	285	228610	373304
1991-92	5358704	3424725	315905	9445	63615	297953	135791	227989	218542	664739	166561	1088833	152	224305	374317
1992-93	5458847	3426526	315900	8394	64317	296671	136977	227498	219936	662629	436870	1099498	48	209497	389148
1994-95	5369589	3435513	312158	7918	62968	290644	135076	218998	214059	692255	449379	1141635	29	245064	395152
1995-96	5361708	3428633	316407	7764	63896	294935	137156	229113	217974	665830	418165	1083995	26	225210	389469
1996-97	5362433	3428810	317786	7491	64407	297497	137578	227305	218084	663475	413409	1076834	56	238476	391051
1997-98	5387231	5309588	321908		64574	298033	138722	230696	221559	661215	408807	1069165	52	229752	391397
1998-99	5592361	3498447	324443	11257	67044	294756	166324	228940	217033	784117	475272	1248651	1413	342283	551054
1999-00	5614332	3514954	321871	13738	69153	293520	166256	221979	216452	797571	460533	1247583	3883	347813	546758
2000-01	5627061	3356895	314827	37339	70853	362200	227234	234060	251512	772141	453250	1211881	1838	343556	538896
2002-03	8415909	5080752	496859	47188	110421	558052	227957	232636	253783	758720	451433	1201691	3166	340944	532832
2004-05	5670120	3465057	308473	41683	68432	311817	229995	228944	248979	766737	467809	1234546	981	345224	549545
2006-07	5666878	3465057	366713	44064	64068	311849	160649	220286	250140	765150	447159	1212314	1600	345020	554013
2008-09	5672568	3485797	303144	35161	70967	224480	216534	198737	383987	753711	407451	1161162	—	340129	569719

[1]Total reported Area for land utilization

[2] Land under miscellaneous trees, crops, grooves etc. not included in net area sown

Table A3: Land use pattern and irrigated area across districts of Uttarakhand, 1999-2000

S. No.	Districts	Reported Area1	Forest	Cultivable Waste	Current Fallow	Other Fallow	Barren & Uncultivable land	Non-Agricultural Land	Grazing Land	Miscellane-ous2	Net Sown Area	Area Sown than Once	Gross Cropped Area	Net Irrigated Area	Gross Irrigated Area
1	Almora	589478	327733	46797	503	6079	25031	13573	47226	36158	86378	51850	138228	6915	13252
2	Bageshwar	139221	66236	12381	133	1609	6623	3590	12495	9566	26588	18684	45272	6070	11111
3	Chamoli	643957	438982	20767	57	1006	102716	11269	13593	22023	33544	17500	51044	1782	3406
4	Champawat	160419	65965	15057	314	3514	7243	4232	22772	12330	28992	15402	44394	2553	3914
5	Dehradun	316135	211691	13889	4373	5957	2076	21010	32	4440	52667	25420	78087	24246	35298
6	Garhwal	752364	443977	46127	151	18541	35584	18182	44998	63987	80817	44490	125307	7667	14837
7	Haridwar	230296	70873	2075	3702	3361	1989	26035	63	522	121676	58814	180490	101400	144581
8	Nainital	413394	302474	25502	997	4196	2853	8691	1147	15467	52067	32824	83038	29655	45475
9	Pithoragarh	476781	264385	36547	763	8530	17579	10274	55275	29928	53500	35751	89251	4662	7559
10	Rudraprayag	242708	127340	11670	32	656	57715	6332	7638	13375	19041	10020	29061	2413	4787
11	Tehri Garhwal	545240	367897	78515	61	9145	13179	11847	3074	24	61569	35547	97118	8506	16272
12	U. S. Nagar	286708	101111	3633	2609	2767	1196	24463	18	1154	149757	96432	237519	145703	234867
13	Uttarkashi	817631	726290	8911	43	3792	19736	6758	13648	7478	30975	17799	48774	6241	11399

[1]Total reported Area for land utilization

[2] Land under miscellaneous trees, crops, grooves etc. not included in net area sown

Table A4: Land use pattern and irrigated area across districts of Uttarakhand, 2004-05

S. No.	Districts	Reported Area1	Forest	Cultivable Waste	Current Fallow	Other Fallow	Barren & Uncultivable land	Non-Agricultural Land	Grazing Land	Miscellane-ous2	Net Sown Area	Area Sown than Once	Gross Croppe d Area	Net Irrigated Area	Gross Irrigated Area
1	Almora	465858	236179	42411	948	7783	25635	12625	30461	27211	82605	48659	131264	4988	9832
2	Bageshwar	213542	110160	16874	1954	3133	6829	4717	27486	20671	21718	17462	39180	4003	7943
3	Chamoli	847580	506100	48115	491	1096	158580	8021	49808	40500	34869	17896	52765	1585	2928
4	Champawat	238378	132337	15200	2917	6773	5426	4704	19078	26543	25400	16358	41758	2381	4283
5	Dehradun	368996	201831	64027	7720	7530	3638	21815	329	15131	46972	26537	73509	20864	33660
6	Garhwal	672852	385099	38453	7832	18246	35838	15472	35179	56056	80677	42832	123509	7707	14271
7	Haridwar	231117	72431	2061	2601	3905	2488	26656	51	758	120166	53473	173639	107164	150269
8	Nainital	406433	298336	26801	3338	3018	1251	9277		17828	46584	33307	79891	28016	40153
9	Pithoragarh	410692	205239	40599	1275	4363	20848	10079	53326	26891	48072	39517	87589	3962	7056
10	Rudrapryag	235421	179895	3004	686	680	7257	8008	4308	11600	19983	11457	31440	2617	5100
11	Tehri Garhwal	485766	322051	5304	7056	5776	5469	7812	593	146	61256	37987	99243	8519	16496
12	U. S. Nagar	281070	93738	3285	2512	2894	986	25275	46	1262	151072	107944	259016	148358	248470
13	Uttarkashi	812415	721661	2339	2353	3235	37572	5231	8279	4382	27363	14380	41743	5060	9084

[1]Total reported Area for land utilization
[2] Land under miscellaneous trees, crops, grooves etc. not included in net area sown

Table A5: Land use pattern and irrigated area across districts of Uttarakhand, 2008-09

S. No.	Districts	Reported Area[1]	Forest	Cultivable waste	Current Fallow	Other Fallow	Barren & Uncultivable land	Non-Agricultural Land	Grazing Land	Miscellaneous[2]	Net Sown Area	Area Sown than Once	Gross Cropped Area	Net Irrigated Area	Gross Irrigated Area
1	Almora	464942	236184	38269	1529	6950	25235	12527	28319	33989	81940	40097	122037	5759	11351
2	Bageshwar	207902	110160	14024	1902	1530	6267	5129	19801	24635	24454	17871	42325	5866	11689
3	Chamoli	851764	506100	10302	308	697	71116	61209	27865	141500	32667	14424	47091	1692	3286
4	Champawat	233225	132337	13516	2690	9301	6173	4589	17395	23997	23227	13323	36550	2012	3720
5	Dehradun	364830	203659	44870	8684	21945	3975	22868	34310	59469	78220	32587	110807	7368	14152
6	Garhwal	669055	385044	32078	5770	8092	33330	15925	14753	14596	46247	20117	66364	19382	32374
7	Haridwar	286495	100648	3056	2941	3368	1573	30079	30	814	143986	123210	267196	141533	259446
8	Nainital	406308	298236	22280	1681	2066	1569	9683	118	21606	49069	27694	76763	28045	40214
9	Pithoragarh	411883	205299	39588	2430	5262	20573	11016	45673	39477	42565	30756	73321	3597	6506
10	Rudraprayag	234796	180365	2578	195	367	6876	3460	4623	15677	20655	12841	33496	2608	5205
11	Tehri Garhwal	485517	321564	78007	3536	5670	5568	7181	477	1970	61544	8089	69633	8824	17009
12	U. S. Nagar	243162	84537	1716	2761	3780	2773	27395	68	1756	118376	52488	170864	108241	155272
13	Uttar Kashi	812689	721664	2860	734	1939	39452	5473	5305	4501	30761	13954	44715	5202	9495

[1] Total reported Area for land utilization

[2] Land under miscellaneous trees, crops, grooves etc. not included in net area sown

Table A6: Number and area of operational holdings by size class (ha.) of agricultural land, Uttarakhand, 1985-86 to 2000-01

Year	Marginal Holdings (Less than 0.5 ha.)		Marginal Holdings (0.5 to 1 ha.)		Marginal Holdings (Less than 1 ha.)		Small Holdings (1-2 ha.)		Semi-Medium Holdings (2-3 ha.)		Semi-Medium Holdings (2-4 ha.)	
	Number	Area	Number	Area	Number	Area	Number	Area	Number	Area	Number	Area
1985-86	—	—	—	—	519874	180029	117711	161230	45941	112648	—	—
1990-91	399234	100627	184392	114264	583626	214891	133942	187211	25484	61189	69013	170635
1995-96	591487	97600	199417	136167	790904	233767	152701	213899	—	—	81402	229992
2000-01	420877	95945	206990	146477	627867	242422	158402	220727	—	—	77415	212385

Table A7: Number and area of operational holdings by size class (ha.) of agricultural land, Uttarakhand, 1985-86 to 2000-01 (contd.)

	Holdings (3-5 ha.)		More than 5 ha.		Medium Holdings (4-10 ha.)		Large Holdings (More than 10 ha.)		All Holdings	
Year	Number	Area	Number	Area	Number	Area	Number	Area	Number	Area
1985-86	32082	121699	30653	329219	—	—	—	—	745261	904823
1990-91	15693	58629	5509	39990	25127	126392	1893	37788	807661	737880
1995-96	—	—	—	—	28813	158624	1840	43850	928480	880132
2000-01	—	—	—	—	24163	132199	1421	35628	890667	1026631

Table A8: Number and area of operational holdings by size class (ha.) of agricultural land across districts of Uttarakhand, 2000-01

S. No	Districts	Marginal Holdings (Less than 1 ha.)		Small Holdings (1-2 ha.)		Semi-Medium Holdings (2-4 ha.)		Medium Holdings (4-10 ha.)		Large Holdings (More than 10 ha.)		All Holdings	
		Number	Area	Number	Area	Number	Area	Number	Area	Number	Area	Number	Area
1	Almora	94273	39424	21798	29646	5734	14610	501	2561	16	385	122322	86626
2	Bageshwar	49798	16400	4673	6137	761	1970	68	379	3	41	55303	24927
3	Chamoli	26399	8944	7607	10881	3848	10364	810	4222	19	395	38683	34806
4	Champawat	26890	10736	6444	8777	2106	5486	371	1954	27	466	35838	27419
5	Dehradun	50419	17287	8460	12085	5226	14430	1740	9535	140	2999	65984	56336
6	Garhwal	43839	20440	24412	34965	14627	39356	3552	19111	129	1773	86559	115645
7	Haridwar	78690	31609	20981	28637	12034	33193	4462	24347	177	2929	116344	120715
8	Nainital	32733	10626	8362	11903	6196	17091	2371	13516	261	5604	49923	58739
9	Pithoragarh	75256	27420	9663	12947	1898	4839	164	856	14	276	86995	46338
10	Rudraprayag	25493	9352	4726	6539	1347	3481	168	919	6	79	31713	20369
11	Tehri Garhwal	56053	23471	17927	24897	5206	16426	875	4522	18	269	80079	69575
12	U.S. Nagar	43908	19333	17055	24236	14014	39008	8009	44718	584	20078	83570	147373
13	Uttarkashi	24543	7381	6294	9078	4418	12131	1072	5559	27	334	36354	34483

Table A9: Total agricultural area and irrigated area (ha) under major crops, Uttarakhand, 1986-87 to 2006-07

Year	Rice		Wheat		Barley		Maize		Madua		Sawa		Total Food grains	
	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated
1986-87	277985	147841	376465	154095	35122	996	34777	736	—	—	—	—	442975	75275
1987-88	261265	141439	362227	149775	32346	1239	32078	952	—	—	—	—	397098	72191
1988-89	261041	141771	362221	152247	30624	882	35186	1310	—	—	—	—	412690	77194
1989-90	283108	151192	391186	161600	34405	1114	34204	453	—	—	—	—	1318937	74487
1990-91	267646	148233	359053	152111	27367	884	29892	482	—	—	—	—	392616	71201
1991-92	252273	142556	353481	153809	29798	990	34283	564	—	—	—	—	—	—
1992-93	259440	150923	358378	162079	27686	1072	29162	631	—	—	—	—	379063	73281
1993-94	260649	154274	362587	165514	27416	829	31850	528	145309	1182	22026	0	898063	322328
1994-95	280470	160024	371392	160347	28407	837	31681	529	145482	111	77613	8	935055	321856
1995-96	261414	154133	341822	155573	29725	880	28781	466	139867	184	71876	6	873493	311242
1996-97	259699	153988	339778	151467	26968	652	30981	664	137150	20	71838	5	866426	306796
1997-98	267018	162123	337573	144973	26978	380	33259	607	131617	68	67492	6	863944	308722
1998-99	305053	199934	386697	191094	27100	656	35683	325	283094	39	72040	28	961006	392085
1999-00	295106	199742	387807	191638	18172	629	34096	924	137190	58	68035	42	945744	392653
2002-03	275409	174429	374802	191058	25664	496	12378	158	74071	16	34642	0	868679	359900
2004-05	288987	187663	387102	202353	24180	536	29575	482	131006	39	67272	1	917416	388550
2006-07	281181	181865	391345	198734	25597	581	31552	965	108999	0	67854	14	1003061	382117

Table A10: Total agricultural area and irrigated area (ha) under major crops, Uttarakhand, 1986-87 to 2006-07 (contd.)

Year	Urad		Moong		Lentil		Gram		Pea (Matar)		Arhar		Total Pulses	
	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated
1986-87	7758	61	213	8	16789	1097	2760	865	1940	800	1673	5	31123	3060
1987-88	7846	90	191	8	16134	1046	2489	786	1673	808	1707	7	30042	2899
1988-89	7827	101	179	9	16253	1079	2116	842	1226	513	1722	1	27395	2697
1989-90	7283	318	4	0	15848	910	1871	753	1439	475	267	4	18443	2201
1990-91	7063	0	4	0	15920	988	1905	706	1722	607	1680	0	31360	2536
1991-92	6921	67	72	0	15084	980	1765	824	2160	793	1530	13	30729	2972
1992-93	6873	68	0	0	14484	952	1566	844	1628	615	1509	12	29425	2744
1993-94	9978	163	195	117	14235	1004	1560	801	1626	496	1627	134	29275	2715
1994-95	9347	194	163	101	15226	869	1770	1064	2322	828	1744	8	24008	2962
1995-96	9420	174	202	143	15284	852	1568	849	2528	920	1735	28	30781	2966
1996-97	9590	214	205	120	15273	801	1410	678	2212	995	1748	8	30837	2816
1997-98	9343	163	85	82	14414	792	1146	553	2234	1021	1763	10	28987	2620
1998-99	10571	1422	161	144	16677	807	1179	527	2385	1118	1801	18	32776	4036
1999-00	10194	1227	165	141	15829	1060	1073	511	3019	1257	1769	3	32022	4199
2002-03	10606	1040	124	72	14451	439	954	465	3550	1305	1793	3	32719	3324
2004-05	11237	253	20	16	11803	487	823	536	3848	1662	1833	3	29879	2957
2006-07	12129	275	3	3	13518	513	879	675	3541	1397	1794	1	31941	2863

Table A11: Total agricultural area and irrigated area (ha) under major crops, Uttarakhand, 1986-87 to 2006-07 (contd.)

Year	Total Foodgrains		Laahi/Sarson		Aalsi		Til Pure		Groundnut		Sunflower		Soyabean	
	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated
1986-87	975821	304653	11553	5281	306	21	3559	135	147	0	—	—	9987	0
1987-88	922773	294380	11532	5723	225	10	2886	129	170	0	—	—	10666	0
1988-89	936527	296995	11674	5878	194	3	2742	127	160	0	—	—	10419	0
1989-90	579553	240080	8496	4015	163	8	334	5	47	0	—	—	13031	36
1990-91	910511	302133	12913	6152	146	6	2736	240	239	0	—	—	12985	44
1991-92	894663	298449	15117	7309	125	1	2775	239	278	3	147	117	14461	91
1992-93	901430	315179	11687	5776	56	2	2794	263	51	1	0	0	15773	139
1993-94	927304	570210	11505	5980	25	4	2903	283	37	0	209	190	16950	253
1994-95	959063	324818	12885	6125	22	2	2590	110	257	0	211	185	18685	252
1995-96	904274	314208	13180	6226	27	4	2241	118	45	1	554	298	17488	233
1996-97	897263	131392	13573	6971	27	6	2228	112	30	0	500	230	13268	228
1997-98	892932	311342	13546	7252	18	3	2462	115	299	15	402	353	6875	283
1998-99	993873	396121	13454	7808	35	6	3001	113	3356	29	1994	397	3757	190
1999-00	987766	397852	13309	6870	14	0	3128	127	3855	29	273	236	4684	123
2002-03	901399	363185	11423	5291	189	78	2125	49	1179	21	86	28	9975	73
2004-05	958251	394031	14820	7627	21	14	2035	86	1625	97	205	204	11347	227
2006-07	965000	384981	15925	5931	0	0	2065	1	1491	0	38	38	8504	1

Table A12: Total agricultural area and irrigated area (ha) under major crops, Uttarakhand, 1986-87 to 2006-07 (contd.)

Year	Total Oilseeds		Sugarcane		Potato		Tobacco		Total Rabi Fodder		Total Kharif Fodder		Total Jayad Fodder	
	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated
1986-87	15565	5437	43610	33409	11342	1864	319	76	5019	4482	6493	125	3195	2938
1987-88	14813	5862	49671	39110	11494	1768	319	76	4930	4692	6250	219	3196	2997
1988-89	14770	6008	51083	41362	11579	2090	434	129	4691	4301	6122	142	3539	3343
1989-90	22076	4064	43780	36898	6531	1162	128	13	4614	4154	6505	136	3540	3376
1990-91	29020	6442	51061	44725	13039	2077	236	55	6469	5670	7387	207	3742	3509
1991-92	32898	7760	53127	47214	13104	2153	236	55	6582	6194	8438	902	3657	3432
1992-93	15469	6328	51445	46257	13038	2147	235	55	7373	5633	7461	1835	3562	3402
1993-94	32256	6690	44188	39364	13017	2159	236	55	6904	6462	8735	901	3740	3611
1994-95	34652	6675	47913	43489	14418	2309	129	32	6790	6352	8438	827	3714	3587
1995-96	33535	6880	52530	48597	14611	2298	129	32	6171	5735	8955	946	3722	3595
1996-97	29626	7547	55867	52444	14595	2431	129	32	6317	5834	8647	1231	3590	3406
1997-98	23603	8028	51988	49069	14380	2250	129	37	6026	5503	7922	1194	3566	3517
1998-99	25598	14623	112459	107858	15120	3073	216	119	10976	10106	21809	1993	8473	8213
1999-00	24263	14190	114059	109525	15284	3036	250	110	11031	10195	22378	2410	8272	8077
2002-03	24656	12674	122453	117050	7352	824	5	0	1771	1435	2002	274	524	428
2004-05	29973	10774	106267	103256	13388	1081	31	20	25135	13665	28590	11218	445	402
2006-07	28068	5997	120939	0	17194	3110	3	1	24790	605	659	178	445	402

Table A13: Total agricultural area and irrigated area (ha) under major crops across districts of Uttarakhand, 1999-2000

S. No	Districts	Rice		Wheat		Barley		Maize		Madua		Sawa		Urad		Lentil	
		Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated
1	Almora	23583	6783	44956	5953	2998	50	2211		36053	26	16538	7	948	3	1328	26
2	Bageshwar	15535	5946	14623	4905	2384	38	515	25	7557	5	934				1108	93
3	Chamoli	12341	1764	15311	1589	1218	1	194		10888		2327		419		62	
4	Champawat	9426	1359	14456	2531	2152	15	1213		8212		1697				984	1
5	Dehradun	13621	12158	24191	11983	1327	39	11463	55	2822	4	1069	1	530	16	940	76
6	Garhwal	21217	6687	36548	6887	981	104	2122		27096	3	18503		3160	90	645	16
7	Haridwar	25099	23721	47012	41265	81	71	2545	385					1096	1037	2452	64
8	Nainital	15507	13549	29374	18270	900	81	7958	50	3500	20	615	2	617	24	636	264
9	Pithoragarh	28174	4135	26331	2757	3537	40	2680	58	12889		1212		1127	5	4442	428
10	Rudraprayag	8203	2401	9770	2321	81	41	233	132	5989		1993				142	2
11	Tehri Garhwal	13333	8414	30395	7223	2232	87	1710	197	16693		20824	32	1422		961	19
12	U.S. Nagar	108017	107636	83029	82651	69	44	704	22					172	49	1759	46
13	Uttarkhashi	10050	5189	11811	3303	212	18	548		5491		2323		703	3	370	25

Table A14: Total agricultural area and irrigated area (ha) under major crops across districts of Uttarakhand, 1999-2000 (contd.)

S. No	Districts	Gram		Pea		Total Pulses		Total Foodgrains		Laahi/Sarson		Total Oilseeds		Sugarcane		Potato	
		Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated
1	Almora	13		38	9	2339	38	128678	12857	504	13	1041	27			1653	230
2	Bageshwar	10		12		1130	93	42678	11012	141	3	141	3			297	47
3	Chamoli			9		607		42886	3354	542	11	706	11			3080	16
4	Champawat	36		59		1079	1	38235	3906	357	1	357	1			808	2
5	Dehradun	156	23	243	34	1972	158	56501	25544	1120	622	1907	649	6296	5753	1256	828
6	Garhwal	82	47	26	6	4439	159	116375	13895	506	54	871	177	1	1	461	56
7	Haridwar	88	17	236	128	3990	1324	78743	66513	488	463	3773	482	63094	59869	554	552
8	Nainital	461	416	448	181	2178	887	60032	32859	1882	1674	4007	1677	6565	6565	1837	192
9	Pithoragarh	14		61	1	5650	434	80473	7424	404	3	1912	10	5		1205	21
10	Rudraprayag					142	2	27236	4765	179	11	179	11			117	1
11	Tehri Garhwal	6	1	242	3	3303	23	88482	15779	789	115	1611	117			1384	150
12	U.S. Nagar	202	7	1484	829	3771	986	195590	191339	5411	3646	5859	4122	38098	37337	733	685
13	Uttarkhashi	5		161	66	1422	94	31857	8605	986	254	1899	256			1899	256

Table A15: Total agricultural area and irrigated area (ha) under major crops across districts of Uttarakhand, 2002-03

S. No	Districts	Rice		Wheat		Barley		Maize		Madua		Sawa		Urad		Lentil	
		Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated
1	Almora	23828	5132	45193	4749	3402	5	1917	4	34578	16	14134		839	1	1265	17
2	Bageshwar	13348	5679	14306	5585	2070	24	573	10	5770		504		101		986	19
3	Chamoli	11321	1500	14750	1187	1467	2							277		49	
4	Champawat	8625	1783	10351	1466	1372	10	778	24	4879		750		243	1	1172	
5	Dehradun	13106	11419	23295	12496	1256	99							704	52	785	32
6	Garhwal	24263	7006	34679	6989	7233	65							3112	106	972	3
7	Haridwar	16208	15523	41267	36936	31	20							792	735	1613	56
8	Nainital	12040	10135	26423	18951	1149	38	3903	70	5079		875		938	18	445	224
9	Pithoragarh	23911	4012	27462	3553	3518	19	3290	25	9135		891		699		4369	14
10	Rudraprayag	8675	2324	9579	2140	1236	8							230		29	
11	Tehri Garhwal	12742	7764	26962	6567	2620	137	1641		14630		17488		1524		960	33
12	U.S. Nagar	98291	98035	88050	87604	60	49	276	25					554	127	1461	31
13	Uttarkashi	9051	4117	12485	2835	250	20							593		345	10

Table A16: Total agricultural area and irrigated area (ha) under major crops across districts of Uttarakhand, 2002-03 (contd.)

S. No	Districts	Gram		Pea		Total Pulses		Total Foodgrains		Laahi/Sarson		Total Oilseeds		Sugarcane		Potato	
		Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated
1	Almora	31		40		2175	18	125227	9924	390		853				1120	189
2	Bageshwar			14		1101	19	37672	11311	99		191	15			674	
3	Chamoli			6		400		40818	2689	502	7	803	7				
4	Champawat	63		14		1492	1	29025	3308	399		1500				719	8
5	Dehradun	109	8	540	79	2299	171	56400	24354	1252	724	1990	823	6071	5097	986	
6	Garhwal	66	63	3		4510	172	121815	14289	382	17	767	59				
7	Haridwar	78	7	229	67	2739	890	61507	53565	545	513	1613	537	72498	68874	422	414
8	Nainital	431	375	148	87	2027	706	51496	29900	641	551	7464	604	6403	6401	2420	212
9	Pithoragarh	70		116		5254	14	73461	7623	321							
10	Rudraprayag			2		310		29183	4472	213	2	256	2			196	1
11	Tehri Garhwal	26		206	2	4843	35	52010	7766	820	86	2097	86				
12	U.S. Nagar	76	12	1890	947	4105	1165	190785	186879	4806	3245	5279	3994	37481	36678	815	
13	Uttarkashi	4		342	123	1464	133	32000	7105	1053	146	1837	146				

Table A17: Total agricultural area and irrigated area (ha) under major crops across districts of Uttarakhand, 2006-07

S. No	Districts	Rice		Wheat		Barley		Maize		Madua		Sawa		Urad		Lentil	
		Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated
1	Almora	24133	6336	50601	7990	3028	50	2041	0	37887	0	16802	0	1029	0	1006	3
2	Bagheshwar	15439	6788	16794	5837	2485	45	384		5382		466		69		1375	136
3	Chamoli	13490	2443	16927	1707	1547	9	18474	1716	13730		3789		356		75	
4	Champawat	9379	2299	11915	560	1792	0	876	0	7703	0	1289	0	514	0	1162	1
5	Dehradun	12170	10899	22660	11027	867	29	23527	11056	2196		580		642		559	23
6	Garhwal	24261	8977	37608	9941	7019	92	44627	10033	2066		19043		3544		1087	37
7	Haridwar	11654	11555	41888	38030	12	8	41900	38038					382	262	1137	81
8	Nainital	12381	11327	24715	18270	775	72	5306	0	2949	0	771	0	948	0	339	183
9	Pithoragarh	21022	3432	24981	2622	3501	4	3898	0	9470	0	1273	0	989	0	4686	8
10	Rudraprayag	10394	2477	10882	2370	1235	41	12117	2411	6111		2477		214	10	21	
11	Tehri	12820	8112	29412	7203	2940	148	32352	7351	14430		19012	14	1921	3	1173	11
12	U.S. Nagar	101292	101284	89532	89386	1	0	1168	0	0	0	0	0	688	0	508	14
13	Uttarkhashi	12746	5936	13430	3791	395	83	13825	3874	7075		2352		833		390	16

Table A18: Total agricultural area and irrigated area (ha) under major crops across districts of Uttarakhand, 2006-07 (contd.)

S. No	Districts	Gram		Pea		Total Pulses		Total Foodgrains		Laahi/Sarson		Total Oilseeds		Sugarcane		Potato	
		Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated
1	Almora	0	0	6	0	2043	3	136535	14379	532	1	1017	1			775	201
2	Bagheshwar	17	1	54	1	1516	138	42466	12808	555	2	766	2			403	21
3	Chamoli			27	1	551		50330	4160	885	11	1894	11			4095	
4	Champawat	18	0	68	0	1762	1	34716	2860	1331	1	2400	1	8		772	0
5	Dehradun	44	3	206	23	1558	49	50695	22004	1112	595	1376	595	4417		1064	945
6	Garhwal	153	151	41		5062	188	123895	19198	424	28	1001	28			456	51
7	Haridwar	10	1	1	1	1533	348	56373	50847	619	561	2319	561	76636		300	300
8	Nainital	579	518	180	61	2118	762	49015	30431	1017	918	2936	918	6038		2191	55
9	Pithoragarh	18	0	130	0	5834	8	69979	6066	699	1	2123	1			1063	2
10	Rudraprayag			7		418	10	31697	4914	231		358				99	
11	Tehri	25	0	104	10	4141	25	85504	15503	1146	142	2237	170			1411	36
12	U.S. Nagar	13	0	2212	1188	3421	1202	195414	191872	6133	3414	7123	3452	33840		1209	1205
13	Uttarkhashi	2	1	505	112	1984	129	38381	9939	1241	257	2518	257			3356	294

Table A19:Area irrigated (ha) by sources of irrigation, Uttarakhand, 1986-87 to 2008-09

Year	Canal	Public Tubewells	Pvt Tubewells	Total Tubewells	Wells	Ponds	Others
1986-87	97815	74422	—	74422	8385	25	45408
1987-88	93747	2912	—	75230	10940	23	57977
1988-89	95342	2555	—	76068	13907	157	37611
1989-90	97671	15841	58031	73872	10383	364	45796
1990-91	99440	19475	61572	81047	11828	154	41139
1991-92	88320	21562	63042	84604	11696	115	39570
1992-93	78468	13429	64070	77499	15278	174	38078
1994-95	81904	17742	81029	98771	21819	5051	37494
1995-96	79341	17179	58618	75797	29176	104	40792
1996-97	100307	23964	151572	175536	19618	75	44533
2000-01	98395	23682	168325	192007	12136	513	35234
2002-03	98799	23477	172055	195532	12338	551	37027
2003-04	92704	25509	182274	207783	10577	1239	36203
2004-05	94799	23906	182943	206849	7528	1001	35047
2006-07	95205	26593	172895	199488	18389	254	31801
2008-09	95922	—	—	198193	15587	770	29657

Table A20: Area irrigated (ha) by sources of irrigation across districts of Uttarakhand, 2000-01

S.No.	Districts	Canal	Public Tube-wells	Pvt Tube-wells	Total Tube-wells	Wells	Ponds	Others	Total
1	Almora	2560						2344	4904
2	Bageshwar	1458						2635	4093
3	Chamoli	425						1225	1650
4	Champawat	759	728		728		488	196	2171
5	Dehradun	11459	2899	378	3277	37		7432	22205
6	Garhwal	4756	591		591		5	2373	7725
7	Haridwar	15633	4965	80747	85712			1006	102351
8	Nainital	23963	3600	1598	5198			494	29655
9	Pithoragarh	1762						2881	4643
10	Rudraprayag	1555						858	2413
11	Tehri Garhwal	1164						5490	6654
12	U.S. Nagar	30224	10899	85602	96501	12099	20	6582	145426
13	Uttarkashi	2677						1718	4395

Table A21:Area irrigated (ha) by sources of irrigation across districts of Uttarakhand, 2004-05

S.No.	Districts	Canal	Public Tubewells	Pvt Tubewells	Total Tubewells	Wells	Ponds	Others	Total
1	Almora	2982						2006	4988
2	Bageshwar	2724						1279	4003
3	Chamoli	1044					118	423	1585
4	Champawat	736	740		740		401.4	503.6	2381
5	Dehradun	12038	2889	377	3266		325	5235	20864
6	Garhwal	3602	613		613			3492	7707
7	Haridwar	14476	4581	86086	90667		96	1925	107164
8	Nainital	23292	2965	1297	4262			462	28016
9	Pithoragarh	633						3329	3962
10	Rudraprayag	1961						656	2617
11	Tehri Garhwal	947						7572	8519
12	U.S. Nagar	27198	12118	95183	107301	7528	61	6270	148358
13	Uttarkashi	3166						1894	5060

Table A22: Area irrigated (ha) by sources of irrigation across districts of Uttarakhand, 2006-07

S.No.	Districts	Canal	Public Tube-wells	Pvt Tube-wells	Total Tube-wells	Wells	Ponds	Others	Total
1	Almora	5883						990	6873
2	Bageshwar	3783						1559	5342
3	Chamoli	872						556	1428
4	Champawat	546	1656					229	775
5	Dehradun	13877	3078	403	3481			3602	20960
6	Garhwal	3008						6001	9009
7	Haridwar	14063	5078	86284	91362		117	2164	107706
8	Nainital	19110	6148	2690	8838			262	28210
9	Pithoragarh	1185						2239	3424
10	Rudraprayag	993						1326	2319
11	Tehri Garhwal	1025						6841	7866
12	U.S. Nagar	26956	10633	83518	94151	18389	137	4467	144100
13	Uttarkashi	3904						1565	5469

Table A23: Area irrigated (ha) by sources of irrigation across districts of Uttarakhand, 2008-09

S. No.	Districts	Canal	Public Tube-wells	Pvt Tube-wells	Total Tube-wells	Wells	Ponds	Others	Total
1	Almora	3570						2189	5759
2	Bageshwar	5043						823	5866
3	Chamoli	352						1340	1692
4	Champawat	567			1445				2012
5	Dehradun	12337			3135	118		3792	19382
6	Garhwal	2039					422	4907	7368
7	Haridwar	13097			92816			2328	108241
8	Nainital	23396			3105	1214		330	28045
9	Pithoragarh	541					105	2951	3597
10	Rudraprayag	1941						667	2608
11	Tehri Garhwal	855						7969	8824
12	U.S. Nagar	29090			97692	14255	243	253	141533
13	Uttar Kashi	3094						2108	5202

Table A24: Consumption of Chemical Fertilizer (tones), Uttarakhand, 1980-81 to 2007-08

Year	Nitrogen	Phosphorous	Potasic	NPK (Total)
1980-81	24370	8618	3878	36866
1981-82	28857	10003	3883	42743
1982-83	85121	13737	5910	104768
1986-87	44538	13975	4744	63257
1987-88	34901	10712	2890	48503
1988-89	54007	16814	4235	75056
1989-90	54049	19465	5019	78533
1990-91	59015	17909	5508	82432
1991-92	56340	18494	6001	80835
1992-93	57267	13741	4252	75460
1994-95	57396	14033	5679	77108
1995-96	65206	15124	6002	86332
1996-97	61763	15966	5581	83310
1999-00	84042	25797	13659	123498
2000-01	87833	25698	11270	124811
2001-02	86990	23150	9228	119368
2002-03	89584	24707	9462	123753
2005-06	78446	31066	13415	122926
2006-07	84557	29954	14410	128921
2007-08	88307	25956	10988	125251

Table A25: Consumption of Chemical Fertilizer (tones) across districts of Uttarakhand, 2002-03

S. No	Districts	Nitrogenous	Phosphorous	Potasic	NPK (Total)
1	Almora	305	120	11	436
2	Bageshwar	163	51	6	220
3	Chamoli	133	114	8	255
4	Champawat	114	45	6	165
5	Dehradun	3158	767	218	4143
6	Garhwal	159	80	2	241
7	Haridwar	19005	5061	798	24864
8	Nainital	5881	2094	692	8667
9	Pithoragarh	276	138	7	421
10	Rudraprayag	76	44		120
11	Tehri Garhwal	158	94	2	254
12	U.S. Nagar	59957	15814	7710	83481
13	Uttarkashi	199	285	2	486

Table A26: Consumption of Chemical Fertilizer (tones) across districts of Uttarakhand, 2005-06

S. No	Districts	Nitrogenous	Phosphorous	Potasic	NPK (Total)
1	Almora	226	68	15	309
2	Bagheshwar	269	75	15	359
3	Chamoli	127	110	8	245
4	Champawat	116	61	8	185
5	Dehradun	2802	1512	354	4668
6	Garhwal	272	91	12	375
7	Haridwar	20128	6740	1151	28019
8	Nainital	3067	1244	424	4735
9	Pithoragarh	147	64	15	225
10	Rudraprayag	76	32	1	109
11	Tehri Garhwal	141	76	2	219
12	U.S. Nagar	50885	20757	11401	83043
13	Uttarkashi	190	236	9	435

Table A27: Consumption of Chemical Fertilizer (tones) across districts of Uttarakhand, 2007-08

S. No	Districts	Nitrogenous	Phosphorous	Potasic	NPK (Total)
1	Almora	239	84	20	343
2	Bageshwar	257	105	21	383
3	Chamoli	121	104	10	235
4	Champawat	150	90	34	274
5	Dehradun	2536	835	95	3466
6	Garhwal	342	116	5	463
7	Haridwar	22719	5952	1211	29882
8	Nainital	6478	3225	1011	10714
9	Pithoragarh	180	88	21	289
10	Rudraprayag	84	46	2	132
11	Tehri Garhwal	161	100	2	263
12	U.S. Nagar	54779	14808	8484	78071
13	Uttarkashi	261	403	72	736

Table A27: Use of agricultural machineries and implements, Uttarakhand, 1978- 2003

Year	Plough		Improved Harrow & Cultivator	Improved Thresing Machine	Sprayer	Improved Sowing Machine	Tractors
	Wooden	Iron					
1978	466635	54161	23343	3579	5557	444	4023
1982	499490	73229	27978	5695	4042	5222	7199
1988	537180	74291	30301	7981	4738	6024	7992
1993	564431	72397	17369	10715	6804	14998	10164
1998	565204	83560	33633	19881	10526	13067	18595
2003	479976	59872	30213	7879	24771	26855	22041

Table A29: Use of agricultural machineries and implements across districts of Uttarakhand, 2003

S. No	Districts	Plough		Improved Harrow & Cultivator	Improved Thresing Machine	Improved Sowing Machine	Sprayer	Tractors
		Wooden	Iron					
1	Almora	72280	3370	98	20	536	137	9
2	Bagheshwar	21914	500	627	1	14	13	
3	Chamoli	52544	630	4289	1			
4	Champawat	22405	4033	856	23	528	556	20
5	Dehradun	20231	8900	2601	454	158	4401	1223
6	Garhwal	63735	3259	2733	92	4161	11	151
7	Haridwar	2963	13154	7055	4490	232	2208	8777
8	Nainital	22865	12415	2509	2083	13675	6998	3163
9	Pithoragarh	47513	261	643	1	3186	53	181
10	Rudraprayag	36129	1201	455		3600		
11	Tehri Garhwal	73160	1513	975	14	129	991	1
12	U.S. Nagar	2644	10122	3554	596	636	8022	8516
13	Uttarkashi	41593	514	3818	104		1381	

Table A30: Progress of state tubewells and other minor irrigation works (No.) in Uttarakhand, 1987-88 to 2007-08

Year	Canal (Length in kms)	Govt. Tube-wells (No.)	Masonary Wells (No.)	Persian Wheels (No.)	Pumping Sets (No.)	Boring Pump set (No.)	Pvt Tube-wells (No.)	Hauj (No.)	Guhl (in kms)	Hydram (No.)
1987-88	5493	279	620	125	3524	20145	6345	25763	8976	—
1988-89	5980	299	620	125	3527	21341	6869	26645	9249	—
1989-90	6198	335	621	125	3531	22617	7090	27715	9498	—
1990-91	6439	367	49	5	861	16141	5302	28463	9959	206
1991-92	6621	369	49	5	908	17259	5707	29043	10266	474
1995-96	6642	393	36	6	917	20292	7314	30584	11752	849
1999-00	7003	653	43	6	1301	44697	13252	26397	11543	1027
2000-01	7065	663	43	6	1301	52336	14898	25723	11338	1075
2001-02	6962	678	43	6	1301	47609	13920	26185	11822	1126
2002-03	6502	684	43	2	1289	47657	6862	23908	10792	1089
2003-04	7096	686	30	2	1609	47028	8022	26517	12935	1228
2005-06	7484	728	30	2	1441	47172	8060	27361	14925	1373
2006-07	7734	733	30	1	1683	47203	8060	28640	17018	1407
2007-08	7830	773	30	1	1687	47250	8055	30207	19647	1449

Table A31: Progress of state tube-wells and other minor irrigation works (No.) across districts of Uttarakhand, 2000-01

S. No	Districts	Canal (Length in km)	Govt. Tube-wells (No.)	Pvt Tube-wells (No.)	Total Tube-wells (No.)	Masonary Wells (No.)	Persian Wheels (No.)	Pumping Sets (No.)	Boring Pump set (No.)	Hauj (No.)	Guhl (in km)	Hydram (No.)
1	Almora	534						82		2263	1136	73
2	Bagheswar	362						18		730	578	67
3	Chamoli	383								1626	743	116
4	Champawat	217	7		7					1186	397	21
5	Dehradun	748	72	266	338	30	1	8	529	1198	967	155
6	Garhwal	769	16	0	16	0	0	0	0	5357	1505	135
7	Haridwar	300	228	7150	7378	0	0	0	31437	0	0	0
8	Nainital	904	91	420	511		1	331	560	2204	1161	114
9	Pithoragarh	386								2665	907	127
10	Rudraprayag	269	0	0		0	0	0	0	942	644	15
11	Tehri Garhwal	473	0	4	4	13	0	0	15	5893	1774	147
12	U.S. Nagar	1063	249	7058	7307		4	861	19795			
13	Uttarkashi	657	0			0	0	1	0	1659	1526	105

Table A32: Progress of state tube-wells and other minor irrigation works (No.) across districts of Uttarakhand, 2003-04

S. No	Districts	Canal (Length in km)	Govt. Tube-wells (No.)	Pvt Tube-wells (No.)	Total Tube-wells (No.)	Masonary Wells (No.)	Persian Wheels (No.)	Pumping Sets (No.)	Boring Pump set (No.)	Hauj (No.)	Guhl (in km)	Hydram (No.)
1	Almora	538						82		2359	1398	91
2	Bagheswar	382						18		761	644	81
3	Chamoli	383								1683	866	124
4	Champawat	217	10		10					1227	517	35
5	Dehradun	786	75	266	341	30	1	75	529	1208	1056	168
6	Garhwal	835	18		18					5422	1740	158
7	Haridwar	253	225	274	499			242	26129		10	
8	Nainital	928	102	420	522		1	331	560	2249	1240	133
9	Pithoragarh	401								2692	953	149
10	Rudraprayag	269								967	748	33
11	Tehri Garhwal	519		4	4				15	6244	2067	147
12	U.S. Nagar	924	256	7058	7314			861	19795			
13	Uttarkashi	661								1705	1696	109

Table A33: Progress of state tube-wells and other minor irrigation works (No.) across districts of Uttarakhand, 2007-08

S. No	Districts	Canal (Length in km)	Govt. Tubewells (No.)	Pvt Tubewells (No.)	Total Tubewells (No.)	Masonary Wells (No.)	Persian Wheels (No.)	Pumping Sets (No.)	Boring Pumpset (No.)	Hauj (No.)	Guhl (in km)	Hydram (No.)
1	Almora	546	0	0		0	0	107	0	2571	1951	137
2	Bagheshwar	396	0	0		0	0	18	0	930	1032	87
3	Chamoli	385								2386	1838	157
4	Champawat	224	16	0	16	0	0	0	0	1433	816	56
5	Dehradun	864	103	266	369	30		103	529	1418	2290	168
6	Garhwal	836	31		31					5721	2725	210
7	Haridwar	278	237	311	548			242	26351		27	
8	Nainital	1341	118	420	538	0	1	331	560	2681	1600	171
9	Pithoragarh	401	0	0		0	0	0	0	2905	1410	172
10	Rudraprayag	273								967	748	33
11	Tehri Garhwal	706		0					16	7056	2948	147
12	U.S. Nagar	925	268	7058	7326	0	0	861	19794	0	0	0
13	Uttarkashi	655						25		2139	2262	111

Table A34: Number of live stocks and poultry in Uttarakhand, 1978-2003ddd

Year	Cattle (Desi)				Cattle (Cross Breed)				Buffalo			
	Males Above 3 years	Females Above 3 years	Young Stock	Total	Males Above 2.5 years	Females Above 2.5 years	Young Stock	Total	Males Above 3 years	Females Above 3 years	Buffalo Young Stock	Total
1978	807998	665067	499768	1972833	—	—	—	—	26047	491648	181637	699332
1982	672868	604507	558314	1835689	37919	28026	28295	94240	29413	487745	250323	767481
1988	729254	624586	506924	1860764	27349	35174	18675	81198	31996	524050	270993	827039
1993	810202	650315	603408	1014832	27833	46534	44545	118912	27268	592040	307204	926512
2003	694808	711539	588010	1994357	31242	136861	63081	231184	70986	843115	350447	1264548

Table A35: Number of livestocks and poultry in Uttarakhand, 1978-2003 (contd.)

Year	Sheeps	Sheeps (Cross Breed)	Total	Total Goats	Horses & Ponies	Pigs (Desi)	Pigs (Cross Breed)	Total Pig	Other Livestock	Total Livestock	Poultry	Other Poultry
1978	405375	—	405375	948404	13731	6820	—	6820	118373	4164868	340193	15989
1982	334434	73402	407836	864932	13941	8016	3302	11318	9278	3984715	488184	23882
1988	273197	75041	348238	903485	18601	11817	1361	13178	138537	4191040	603836	9465
1993	319850	56747	376597	1149043	23106	8934	2530	11464	199818	4900577	663880	113658
2003	203771	90568	294339	1166084	20330	28018	6417	34435	221892	5227169	1973375	16715