

Impact of Water Conservation Programmes on Development Agricultural Cropping Patterns: A Case Study of Chikhalagaon village, Maharashtra.

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Abstract:

This paper examines the agriculture development pattern in Chikhalgaon village of Kolwan valley located in Western Ghats of Maharashtra, post watershed and minor irrigation tanks development. It highlights the importance of scientific information for the commons by demonstrating how even a simple synthesis of irrigated cropping pattern in a village is quite complex. Understanding this complexity holds the key to microplanning of land, water and crop management in a village. The main focus was on distribution of irrigated cropping, and sources of irrigation in Chikhalgaon village, which facilitated in analyzing the trend of cropping pattern change post various water conservation measures adopted in the Kolwan valley. This study is mainly based upon the primary agricultural cropping data collected from farmers fields, government land records data served as secondary source while remote sensing data was used as a background check for verifying pre-1998 agriculture data. Synthesis of data was done using GIS software. The study was undertaken under the broader umbrella of an ongoing international research project called "Augmenting Groundwater Resources by Artificial Recharge" (AGRAR), focusing on the Kolwan valley site.

Five Keywords: *Watershed development, Groundwater, Artificial recharge, Agriculture, Irrigated Cropping Pattern.*

BACKGROUND:

The pattern of land use of a country at any particular time is determined by the physical, economic, and institutional framework taken together. In other words the existing land use pattern in different regions in India has evolved as the result of the action and interaction of various factors, such as the physical characteristics of the land, the institutional framework, the structure of other resources available and the location of the region in relation to other aspects of economic development. The present pattern can therefore be considered to be in some sort of static harmony and adjustment with the other main characteristics of the economy of the region.

In the dynamic context, keeping in view the natural endowments and the recent advances in technology, the overall interests of a country may dictate a certain modification of or a change in the existing land use pattern of a region. A close study of the present land use patterns and the trends during recent years will help to suggest the scope for planned shifts in such patterns.

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Agriculture in India:

Cropping activities go on all the year-round in India, provided water is available for crops. In any locality, the prevalent cropping systems are the cumulative results of past and present decisions by individual, communities or government and other agencies. These decisions are usually based on experience, tradition, expected profit, personal preferences and resources, social and political pressures and so on.

The crops grown singly or as a mixed pattern are called as mixed cropping system whereas crops in a definite sequence are called rotational cropping system. The land may be occupied by one crop during one season, which is mono cropping, or by two crops, which is double cropping. Two or three crops may be grown in a year in sequence, mainly depending upon land, water and finances available. Of late, the trend is even towards more than two crops (multiple cropping) in a year. These intensive croppings may be done either in a sequence or even there may be relay-cropping – one crop undersown in a standing crop.

The village revenue officials keep plot-wise record of crops grown in each season. These are annually compiled district-wise, state-wise, and on an all India basis. From these records one could calculate the relative abundance of a crop or a group of crops in a region. Most figures available as secondary data are at the scale of a taluka. Data at village level is available, but is often not coherent with taluka records. The dynamics of micro-level information on cropping has implications on factors like water availability, access, water use etc. Hence, it was thought relevant to study irrigated cropping in a village so as to understand the dynamics of variability in space and also to get some idea of temporal trends, if any.

INTRODUCTION:

Speedy development of agriculture is vital for the progress of our country. Land and water are the two basic resources of a nation. For securing maximum crop production, the best use of the available land and water has to be made and the latest methods of crop husbandry and technology, together put into practice. But this depends on the availability of scientific information and guidance on all aspects of agriculture in an easily digestible form.

The current research theme “**Impact of Water Conservation Programmes on Development Agricultural Cropping Patterns: A Case Study of Chikhalagaon village, Maharashtra**” highlights the importance of such scientific information by demonstrating how even a simple synthesis of irrigated cropping pattern in a village is quite complex.

The present study aimed at analyzing the recent agriculture development pattern of Chikhalgaon, a typical village set in the western ghat region of Maharashtra. The study was undertaken under the broader umbrella of an ongoing international research project called “Augmenting Groundwater Resources by Artificial Recharge” (AGRAR).

The AGRAR project involves 3 research sites in India, of which one is the Kolwan valley where Chikhargaon village is located. The study in Kolwan valley is being conducted by ACWADAM (Advanced Center for Water Resources Development And Management), a Pune-based research NGO working on groundwater management problems in India. The project was funded by DFID and guided by the British Geological Survey.

Location of Area:

The Kolwan valley site in Mulshi taluka was selected primarily as it is largely representative of changing agriculture conditions within the western ghats as it represents various other typical dimensions common to many other regional as well as local settings, dominantly through watershed based interventions at the scale of a microwatershed or village.

Kolwan valley is the common synonym for the Walki river basin. The largest village in the river basin is Kolwan, and hence, the name. The Walki River is not such a well-known river even in western Maharashtra. It is a tributary of the Mula river that flows into the Bhima river. The Mula and Bhima are well-known river systems in Maharashtra. The Walki is however, quite typical of many small-sized rivers in western India, with lengths of a few tens of km. and its basin spread is about 80 km². The Kolwan valley has a population of about 15000 (GOMUKH, 2000).

The present study has characterized the Kolwan valley in detail (Kulkarni et al 2003). In summary, the Kolwan valley consists of 16 villages and 48 hamlets with the length of around 15 km and the average width of about 5.5 km. Kolwan valley is bounded by longitudes 73°30'0"-73°37'37.5" and by latitudes 18°32'05"-18°37'40". The basin trends roughly North West – South East. The Walki River originates in the western ghats and flows in a southeasterly direction, ultimately joining the Mula River to the north-east of Karmoli village, just over 1 km north of Paud; the taluka headquarters (Figures 4). The highest point within the watershed is 1100m above mean sea level and the lowest point is 570m above mean sea level. The area defined by the Walki river basin is included within the Survey of India toposheet number 47 F/10. The main villages in Kolwan valley are shown on the map (Figure 4), along with the main road that leads to Pune to the East South East and to Lonavala (towards Mumbai) to the North West.

Topography and Drainage:

The region is mainly hilly with expansive plateaux to the west and small plateaux to the north and south. The valleys itself is quite narrow and elongate, with steep ridge slopes that grade into a portion of terraces that, in turn, gently slope towards the main river channel. The slope of the land varies between 1 % and 50 %. Basaltic ridges on three sides surround the Walki River basin. The drainage pattern in the Kolwan valley is mostly dendritic to sub-dendritic. The rugged topography of the valley is apparent not only on a map but also actually when one travels to the area (Figures 5). Many streams originate in the northern basaltic ridges and drain south into the Walki River. There are

relatively fewer streams originating along the southern slopes. Rapid and large quantities of surface runoff are experienced in all portions of the valley.

THE RESEARCH PROBLEM:

Agriculture remains the main occupation of people from Chikhalgaon even today. Having said that, it was apparent from satellite data (1986 onwards until recently) that irrigated agriculture has grown significantly since the last 5-6 years. This theory was also confirmed during discussions with various organizations as well as the local communities. Moreover, it was apparent also that irrigated cropping in Kolwan valley has a fairly complex degree of scientific, technical, social and economic dynamics behind changes in irrigated crops. It is with this background, that the study in Chikhalgaon was undertaken so as to understand the physical distribution of irrigated crops in a typical village like Chikhalgaon.

This study was essentially more about a 'process' that attempted to use tools like remote sensing and GIS to understand field situations better. Hence, although the output from the study was limited to mapping irrigated crops in Chikhalgaon, a great deal of attention was paid to the process to this end. Therefore, one entire chapter has been dedicated to the research methodology, which included use of both primary and secondary data. The Research Methodology for data collection of the present study area was carried out using a series of related steps. The work was carried out in following steps:

The work was carried out in the following steps:

1. Collection of Data from all possible sources.
2. Field Visits to the Study Area.
3. Groundtruthing of the Data.
4. Creation of Input Database.
5. Analysis.
6. Preparation of Final Output.

Data and Methodology:

1. Primary Data

The Primary Database for cropping pattern changes regarding the irrigated agriculture in Chikhalgaon village has been collected by contacting individual farmers holding land in the Chikhalgaon area. Data has been verified and cross tallied by visiting all the fields in Chikhalgaon area. The data content has been solidly ground truthed by regular rigorous field visits for a period of over 6 months. This project began in October 2004 and culminated with the submission of this report in April 2005.

2. Secondary Data

The Secondary Database has been compiled on the basis of records of Government of Maharashtra Departments like Department for Land Records, Agriculture, Agriculture Statistics and Land revenue. Data was also collected from the Kolwan Khore Shetkari Mandal. The entire set of land records for Chikhalgaon, regarding the agriculture / non-agriculture / cultivable / non-cultivable / forest / crematory / roads / canals / streams, rivers has been collected in detail from such sources. The data of accurate land holding of each and every individual farmer in Chikhalgaon i.e. 1127 no's farmers details along with crops cultivated around the year and the land revenue incurred thereon as per 7/12, 8 A, record has been collected from the talathi office and cross-verified in the field. Background data in the preceding chapters was shared by ACWADAM as a part of its AGRAR dissemination and uptake strategy.

3. Methodology for Data Collection

The Primary and Secondary Database for the study area i.e. for cropping pattern changes regarding the irrigated agriculture in Chikhalgaon village has been collected with concentrated and continuous efforts. The Primary Database collected is by contacting each and every farmer holding land in the Chikhalgaon area. It was heavy task to collect the primary database, as there were 1127 farmers in Chikhalgaon. A questionnaire was prepared for the collecting primary data. The guidelines prepared for questionnaire helped to make the data collection fast, appropriate and to the point. The questionnaire was prepared for the 1998, 2004 and 2005 respective year. Present year 2005 data was also collected to help in understanding the study carried out and as it would be required for further continuation of study. The questionnaire made it easy to ground truth the data collected from all sources. The questionnaire was made in such a way so as to avoid complications and confusion during the primary data collection. This was an irritating task as every farmer had to be convinced that the data was for study purpose only. A table sheet was prepared containing the above specifications to make it easy and understandable to a layman. The questionnaire was prepared for the Rabi season considering following points:

- Survey No of plot,
- Name of Farmer,
- Total Area,
- Crops in the respective year required for study,
- Type of crop,
- Area cultivated therein.

Table 1: Questionnaire for primary survey in Chikhalgaon

Survey No.	Name of Farmer	Total Area	Crops in 2004		Crops in 1998	
			Type	Area	Type	Area

The Secondary Database has been collected from various Governmental and Non Governmental Organizations. The task for governmental data was an incessant effort as it had to be collected as per the governmental working procedures and their work timings. A regular follow up for collecting the data from various departments of the Government had to be undertaken to collect the secondary data. This required patience and an enormous amount of time. A lot of experience regarding the governmental working procedures was gathered while dealing with various government offices. Similarly, a few of the government staff also went out of their way to help obtain and record data during the study. They also offered comments on the irregularities in the data updating. These comments were noted, wherever they were relevant to the study.

Major data was collected from the Land Records department from the Talathi of Chikhalgaon grampanchayat at Kolwan. The Data for accurate land holding of each and every farmer in Chikhalgaon i.e. 1127 no's farmers details along with crops cultivated around the year was collected from the government land record of 2004. This was an exaggerating work as it had to be carried out as per the Talathi working days, many a times the assistant helped by making the records available on other than their working days. This process was time consuming, tiresome and laborious to understand the land records and make notes from therein. Total Land record of Chikhalgaon, regarding the agriculture / non-agriculture / cultivable / non-cultivable / forest / crematory / roads / canals / streams, rivers was collected in detail. The land revenue incurred thereon as per 7/12, 8 A, record was also noted and studied.

4. Groundtruthing of the Data

The Data has been verified and cross-tallied by visiting all the fields in Chikhalgaon area. The Data content has been solidly groundtruthed by regular rigorous field visits for a period of over 6 months.

RESEARCH METHODOLOGY USING REMOTE SENSING & GIS

The research methodology used two very important tools to aid this study. These tools included remote sensing data and a simple GIS to study the spatial distribution of irrigated crops in Chikhalgaon village.

The work was carried out in three main steps:

1. Creation of input database.

2. Analysis.
3. Preparation of final output.

Arrangement of data is in the following format

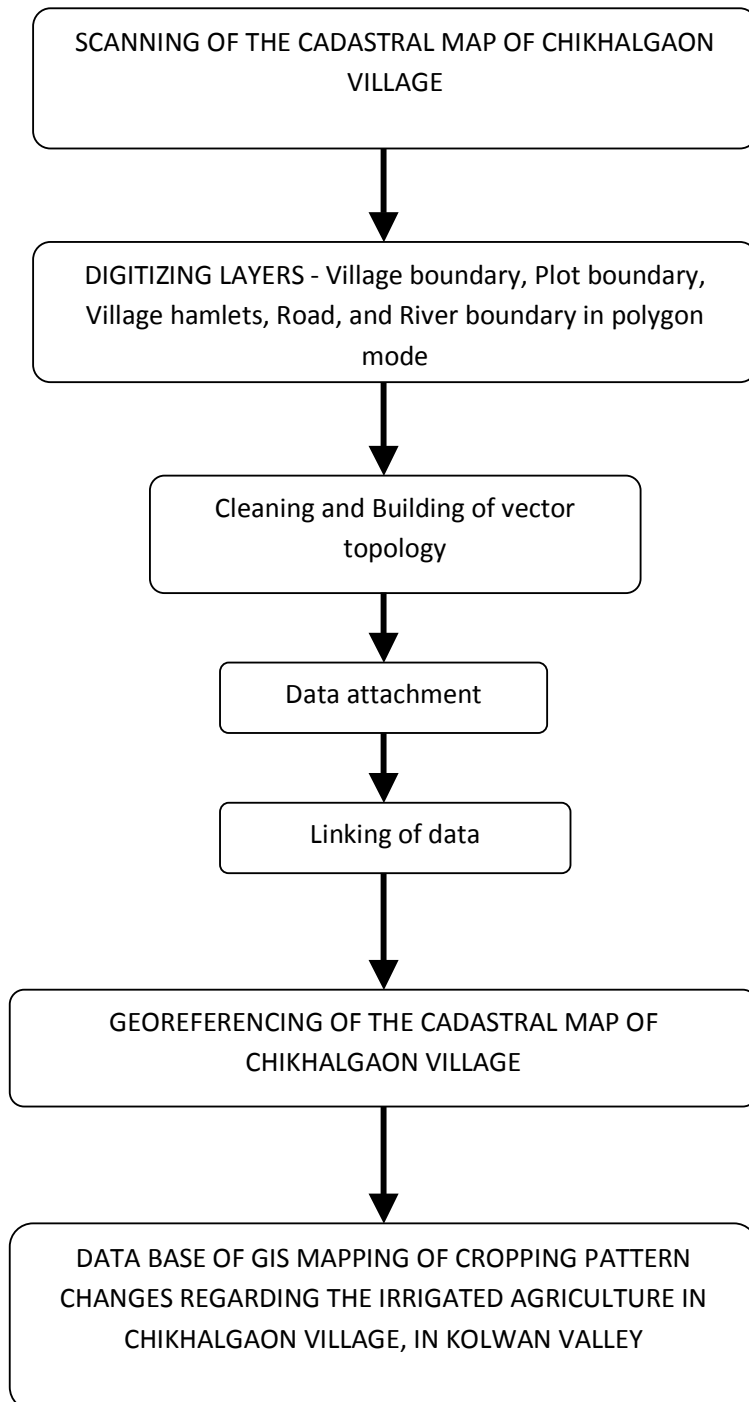
- Plot ID.
- Name of owner.
- Crops in 2004.
- Total cultivable area (ha).
- Cropped area in 2004 (ha).

1. *Images used:*

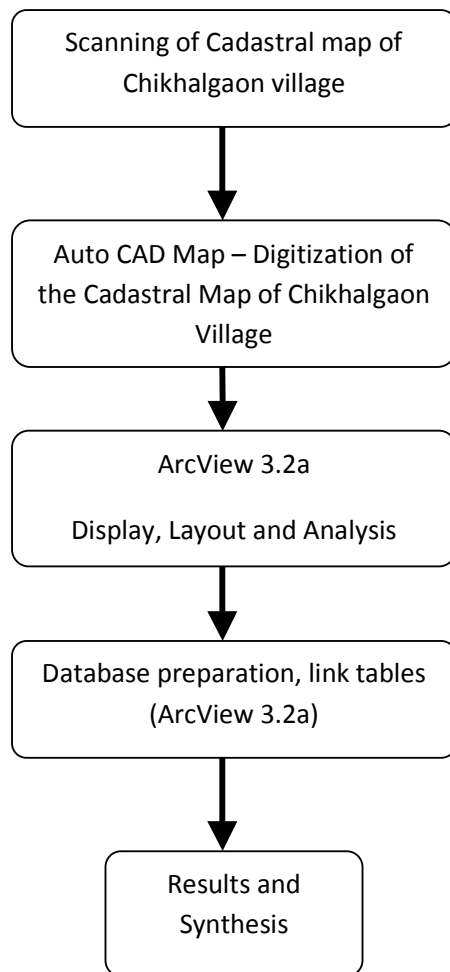
1. IRS-1C, Sensor: LISS- III & PAN Merged, Date of Image: 1st February 1998.
2. IRS-P6, Sensor: LISS- III, Date of Image: 25th January 2004.

The two detailed flow charts below demonstrate the process and research methodology using Geographical Information System and Remote sensing for study of spatial distribution of irrigated crops in Chikhalgaon village.

Flow chart 1: METHODOLOGY OF GIS MAPPING OF CROPPING PATTERN CHANGES REGARDING THE IRRIGATED AGRICULTURE IN CHIKHALGAON VILLAGE, IN KOLWAN VALLEY.



Flow Chart 2: SEQUENTIAL USE OF VARIOUS SOFTWARES



SIGNIFICANT RESULTS AND SYNTHESIS

The Commencement of Irrigated Rabi Season Cultivation in Chikhalgaon Village

Until the last decade, cropping pattern in Chikhalgaon, was in the form of the ancestral practice of single, rainfed Kharif crop. Subsequently, cropping pattern, in the Chikhalgaon area, changed significantly during the last decade. Prior to 1995-96, there was hardly any rabi season cultivation in this area. Paddy was the single crop in the area, grown during the Kharif season. Considering the sumptuous rainfall (1860 mm of rainfall was recorded during 2004 in Chikhalgaon...*Kulkarni et al, in press*). Most farmers cultivated paddy i.e. *Oryza sativa* in their respective fields (paddy in this area has a crop water requirement of 1500 to 2000 mm...*ICAR, 1997*). Paddy continues to dominate the area during the kharif season.

The probable reasons for non-cultivation of rabi crop until 1995-96 could be:

- Prevalent practice of conventional and traditional farming.
- Rabi season irrigation sources like wells, lift irrigation, canals, etc. were not available/accessible to farmers until recently
- Lack of technical information on cultivation of rabi crops.
- Lack of information on tapping surface / ground water as sources of irrigation.

Post 1995-96, there have been noticeable changes in the package of cultivation of the paddy crop (kharif) as well as a variety of rabi crops cultivated in smaller patches in Chikhalgaon. The variety of rabi crops introduced included Wheat, Gram and Jowar for the rabi season cultivation.

1. Spatial distribution of irrigated crops in Chikhalgaon (2004-05)

The study of irrigated crops in Chikhalgaon for the period June 2004 to April 2005 can be summarized into four parts, given below. This summary provides an insights into irrigated cropping in a typical village in Kolwan valley.

(a) Agriculture Plots: Kharif v/s. Rabi

The total available land for agriculture in Chikhalgaon was 300 ha, of which 50 ha was grassland. About 1100 farmers from Chikhalgaon cultivated the remaining 250 ha, during the kharif season. This 250 ha of land can be considered as rainfed agriculture. Incidentally, there are 1127 registered farmers in Chikhaglaon, implying that some 27 farmers do not cultivate their lands at all. The demand on irrigating the kharif crop through irrigation sources such as the river and wells was virtually nil because of the high-rainfall and good reliability of rain.

The rabi season cultivation (October 2004 to February 2005) amounted to about 40.28 ha, all of which was irrigated. Some 106 farmers out of the total 1100 irrigated rabi crops. The rabi season cultivation crops were wheat as the major crop, followed by sugarcane and a crop of various vegetables. The spatial distribution of irrigated crops

was identified for the rabi season of 2004 by visiting and locating each plot on the village map. It was found that these plots were located in close proximity to the Walki river and to the streams flowing on the either side of village boundary. Only a few plots were located in the upland area of Chikhalgaon, away from the river. Most of the irrigated crops received water from lift irrigation schemes at the river, with some pipelines laid out over distances in excess of 2 kms to their fields.

(b) Wheat

Wheat was the major rabi crop cultivated in Chikhalgaon. Some 26.29 ha of wheat is grown by 73 farmers. Spatial distribution of wheat in Chikhalgaon is mostly located away from the Walki river, on the upland area. The main source of irrigation for wheat is lift irrigation from the river. Although difficult to quantify, some farmers reported using well water as protective irrigation when there were problems with their lifts from the river.

(c) Sugarcane

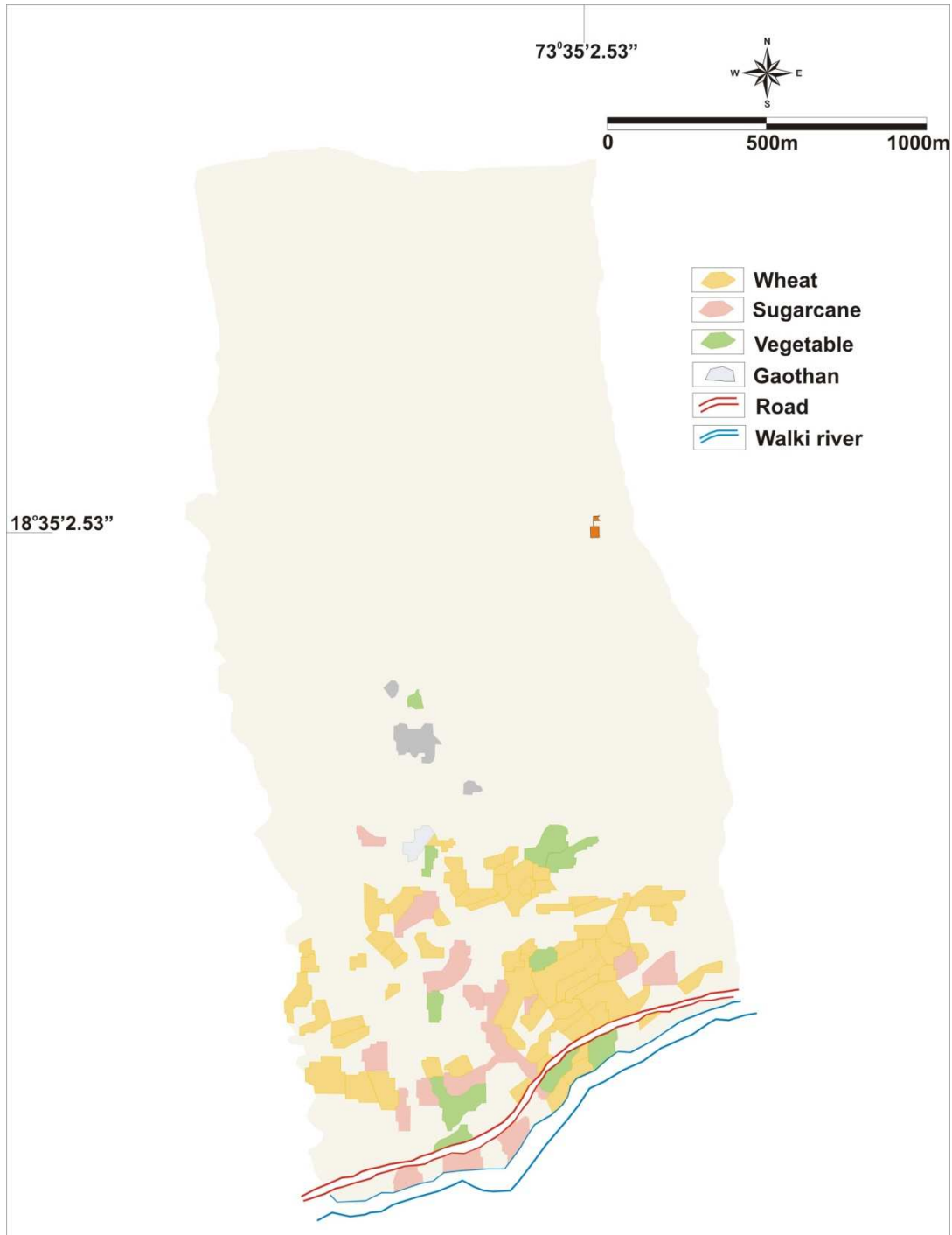
Sugarcane is the second largest irrigated crop cultivated in Chikhalgaon. Although it is an annual crop (unlike seasonal crops like rice, wheat and vegetables), requiring water throughout the year, irrigation from sources like the river and wells is restricted to the rabi season mentioned above. In Chikhalgaon, sugarcane was grown over 10.03 ha of land by 20 farmers. The spatial distribution of sugarcane was dispersed in the sense that it existed from low lands near the main river to fields in higher uplands. Sugarcane being an extremely high-water requiring crop (2800 to 3000 mm) meant that only lift irrigation from the river formed the sole irrigation source.

(d) Vegetables

Vegetable cultivation in Chikhalgaon was reported to be quite recent. Only 13 farmers from the village cultivated vegetables over some 6.43 ha. A variety of vegetables like potato, peas, cucumber, tomato and okra (lady's fingers) are grown on small patches of land, usually in the uplands close to Chikhalgaon village. These vegetables were irrigated using lift irrigated water from the river, with marginal support from groundwater.

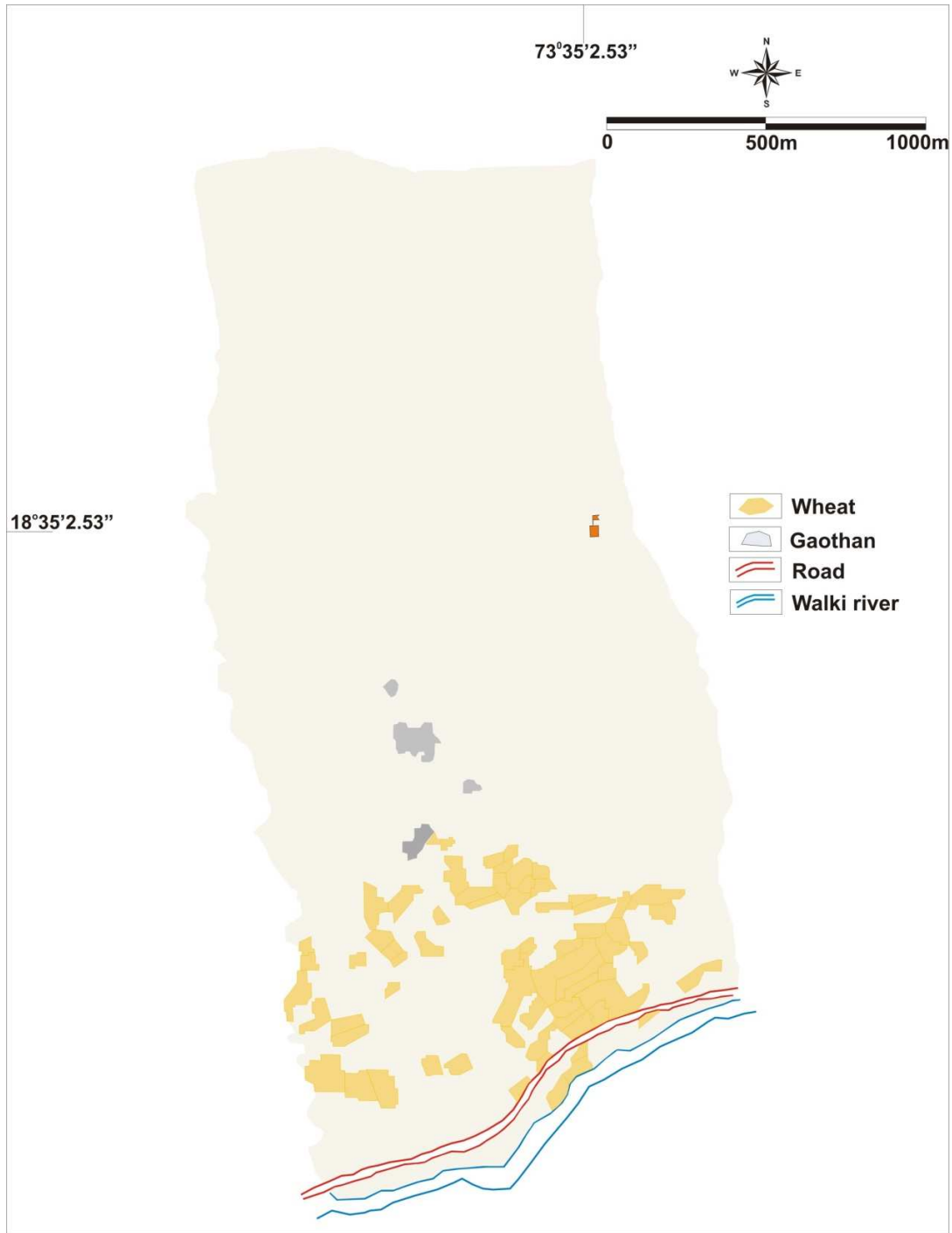


Map 1



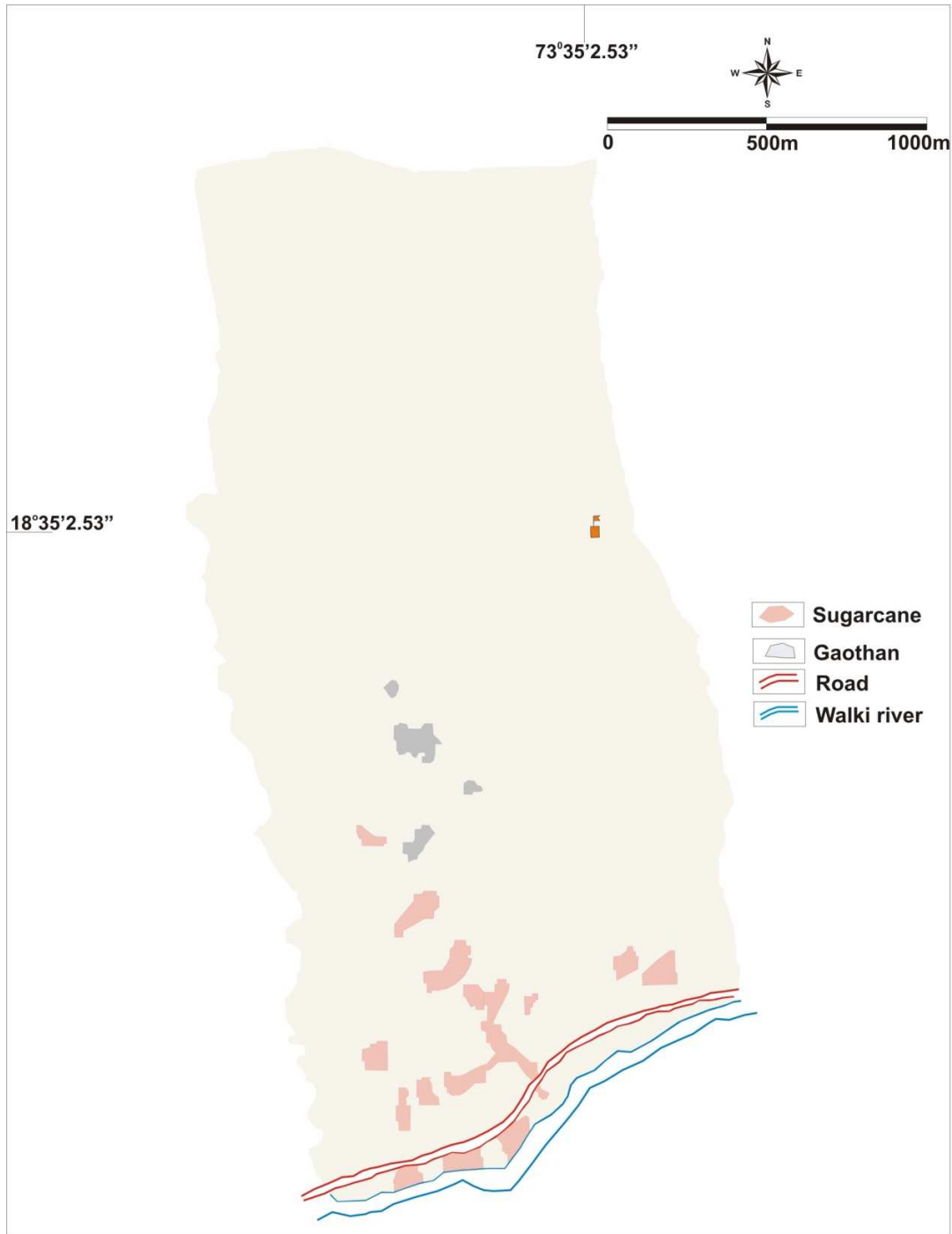
Map indicating irrigated crops in Chikhagaon

Map 2



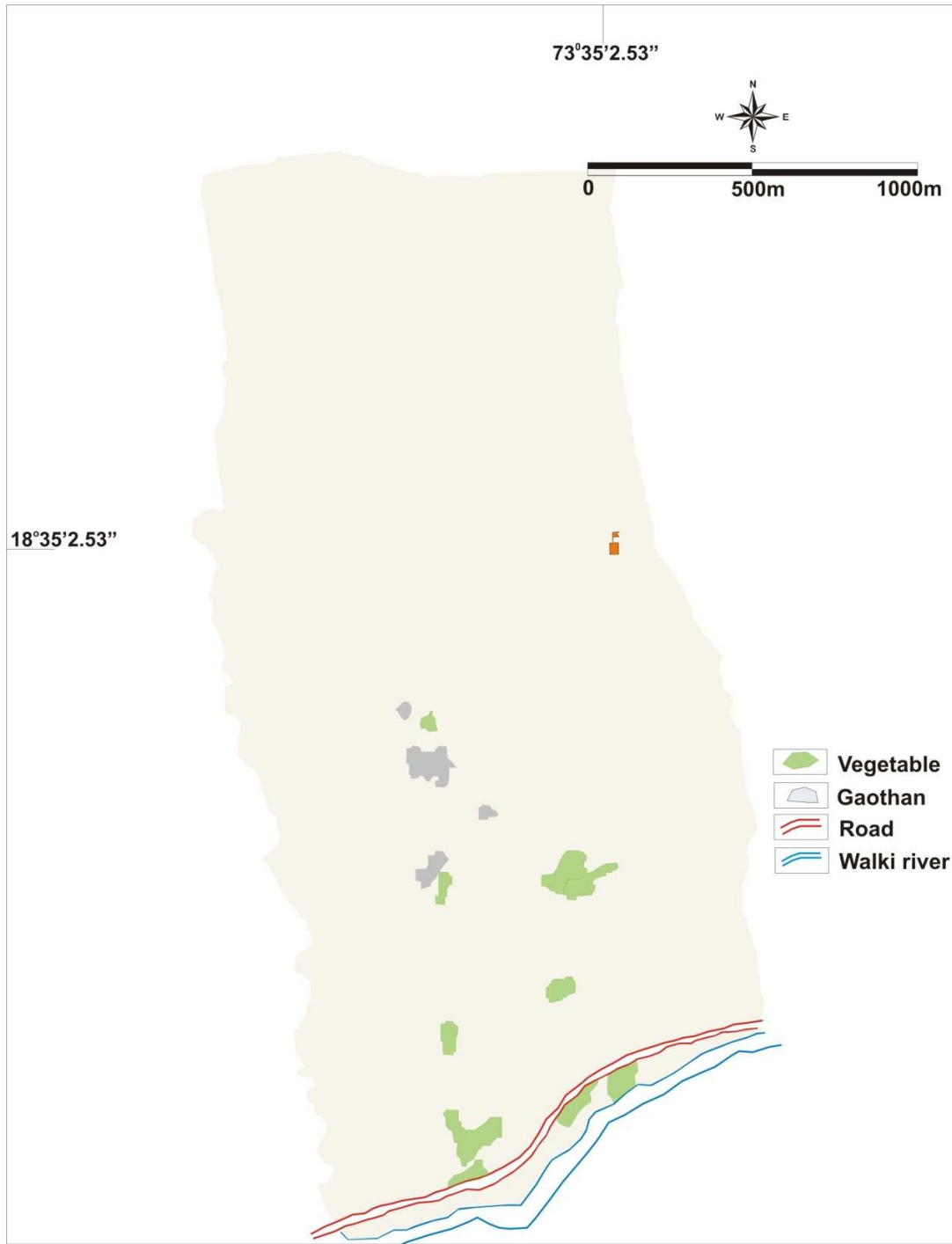
Map indicating irrigated crop, wheat in Chikhalgaon for 2004

Map 3



Map indicating irrigated crop, sugarcane in Chikhalgaon for 2004

Map 4



Map indicating irrigated vegetables in Chikhalgaon for 2004

Map 5

2. The Three Major Crops Cultivated in Chikhalgaon Village:

Wheat:

Wheat i.e. *Triticum dicoccum*, a short duration succession crop for the rabi season cultivation became popular in the study area during the last ten years or so. A relatively less water-demanding crop (500-600 mm) wheat became popular as rabi crop on irrigated conditions only after 1997-98, the year when GOMUKH began large-scale watershed development and artificial recharge work in Kolwan valley, including Chikhalgaon. Farmers report that the presence of soil moisture in the field, after the paddy harvest, helps cultivate wheat, as the initial water requirement for growing the crop is met through soil moisture available over a period of a month after the last spell of rains. However, AGRAR findings indicate that soil-moisture is relatively small (less than 50 mm) as compared to the crop water requirement for wheat. Farmers actually start pumping water from the river as soon as the crop is planted.

During the course of this investigation it was observed that wheat was sown in the fields of Chikhalgaon immediately after the paddy crop harvest. Irrespective of the size of land holding, the wheat crop forms a benchmark for the changing phase of agriculture in the history of the village. The wheat crop being short duration, i.e. maximum of 120 days / 4 months, has been successfully adopted by the farmers as a major rabi crop. The crop is cultivated over a range from 0.03 ha to 1.68 ha land holding. Generally speaking, a farmer in Chikhalgaon can obtain a profitable yield from wheat over this land holding range. There has been a steady increase in the number of farmers cultivating the crop, probably due to better returns than from other crops.

Sugarcane:

A considerable number of farmers are cultivating sugarcane, i.e. *Saccharum officinarum* L. in the Chikhalgaon area under irrigated condition. During the last half-decade, i.e. 1999 onwards, the crop of sugarcane was introduced in the Kolwan valley, and concurrently in Chikhalgaon. In terms of area and number of farmers engaged in cultivation of sugarcane it was the second largest crop during the rabi season in Chikhalgaon.

In the present study, and data on sugarcane under irrigated condition of 2004 rabi season in Chikhalgaon, it is evident that farmers have adopted advanced agricultural cropping systems where sugarcane is concerned. The water required for cultivating sugarcane ranges from 2800 to 3000 mm. Sugarcane in Chikhalgaon was planted after the harvest of the kharif paddy crop. "Suru" is the type of sugarcane crop grown in Chikhalgaon, where the crop matures within a year of its plantation. Initial irrigation coincides with rabi season irrigation and extends into the following monsoon when irrigation is purely rainfed.

The land holding for sugarcane in Chikhalgaon varied from 0.08 ha to 0.95 ha. Sugarcane fetches good returns to farmers but it is too premature to establish long-term

effects, that in other areas have proved detrimental from an environmental perspective.

Vegetables:

As mentioned earlier, vegetable cultivation is observed to have increased significantly in Chikhalgaon during the last 2-3 years. Intensive cropping of vegetables may be done either by growing a sequence of crops or through relay cropping, i.e. one crop undersown in a standing crop. The vegetables cultivated in Chikhalgaon were short duration crops, i.e. 90 days to 120 days or 3 - 4 months, perhaps the reason why intensive cropping was more popular. A variety of vegetables are grown during this period in the study area.

Vegetables are cultivated on a smaller scale as compared to sugarcane and wheat. Lands under irrigated vegetable cultivation ranged from 0.10 to 1.20 ha., with plantation of vegetables after the harvest of the kharif, paddy crop. The water requirement for the set of vegetables cultivated in Chikhalgaon is about 450-500 mm. depending on the type of vegetable. The number of farmers and area cultivated under various vegetables is reported to be increasing in Chikhalgaon.

3. Results from the study:

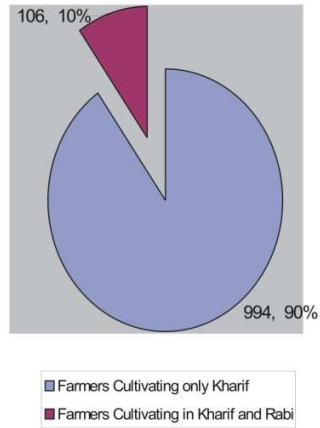
Data analysis was essentially Chikhalgaon-centric and looked exclusively at how irrigated rabi crops were distributed spatially and proportionately to the 'traditional' kharif paddy crop, which continues even today. 'Proportion analysis' was done using Microsoft Excel graph and database tables, whereas spatial distribution of crops was plotted as maps using a GIS platform.

(a) Only 10% of farmers cultivating crops grow rabi crops

There are some 1100 farmers in Chikhalgaon, all of whom grow a kharif crop (mostly paddy). It is evident from the *Pie Chart 1* that the number of farmers cultivating in kharif and rabi is as follows:

- Some 106 farmers cultivated different irrigated rabi crops implying that only 10 % of the total farmers grow irrigated rabi crops. Of the 1100 farmers, 994 cultivate crops only in kharif season, i.e. 90 % of farmers cultivate only kharif paddy.
- However, even this is a significant change from the cropping pattern for Chikhalgaon after 1995-96, when, apart from rainfed paddy there was virtually no irrigated rabi crop (GOMUKH, 2000).
- All farmers growing rabi season crops cultivate kharif season crops, again mostly paddy.

Pie Chart 1: Number of Farmers Cultivating in Kharif v/s Rabi Season of 2004.



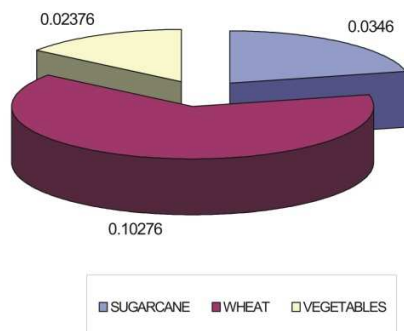
(b) Area on which rabi crops are grown is still quite small as compared to that used for kharif cropping

The proportion of cropped rabi area to the cropped kharif area is illustrated as *Pie Chart 2*. This relationship is based on the area under respective rabi crops to that under the kharif crop, expressed as the percentage to the actual cultivable agricultural land of 250 hectares in Chikhalgaon, in the pie chart.

Hence, we have:

- Wheat is grown on 10 % of the total cropped land (Kharif plus rabi).
- Sugarcane is grown on 3.46 % of the total cropped land.
- Vegetable is grown on 2.38 % of the total cropped land.

Pie Chart 2: Proportion of Rabi to Kharif Crops in 2004.

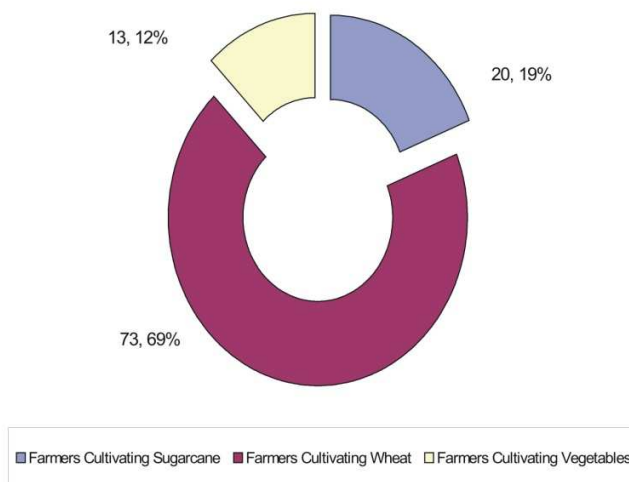


(c) A majority of farmers taking rabi crops grow wheat

Chart 3 (doughnut diagram), represents the break-up of the irrigated crops for the rabi season (2004-05) in Chikhalgaon. The farmers cultivating rabi season crops under irrigated condition can be classified as:

- There are 73 wheat-cultivating farmers, i.e. 69 % of the rabi season farmers grow wheat.
- There are 20 sugarcane-cultivating farmers, i.e. 19 % of the rabi season farmers grow sugarcane.
- There are 13 vegetable-cultivating farmers, i.e. 12 % of the rabi season farmers grow vegetables.

Chart 3: Break-up of Cropping Pattern under Irrigated Condition (Rabi Season)



(d) Irrigated crops: proportion of cropped land to plot size and distribution of farmers utilizing whole and part of their plot for irrigated cropping

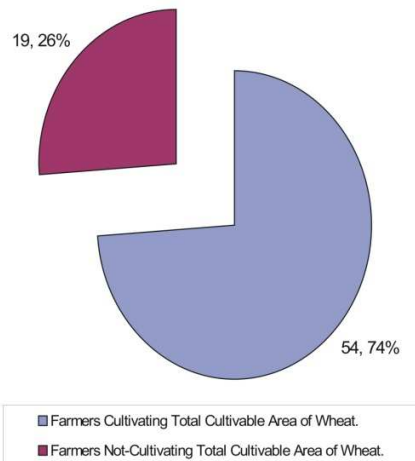
Despite the shift from pure, rainfed cropping to irrigated cropping in Chikhalgaon, not all the cultivable area in Chikhalgaon was cropped under rabi crops. It was thought interesting to study the amount of actually cropped land to the cultivable land for the three irrigated crops in Chikhalgaon.

Wheat

- Total cultivable area under wheat is 26.29 ha (*Land Records Office Register, Kolwan, 2004-05*) out of which net cropped area is 25.69 ha, implying that nearly all the cultivable area is cropped by wheat.
- The minimum area under wheat for the rabi season of 2004 was 0.03 ha.
- The maximum area under wheat for the rabi season of 2004 was 1.69 ha.
- Wheat is a benchmark crop for Chikhalgaon, because it is grown over small as well as larger land areas.

- *Pie chart 3 shows that 54 farmers, i.e. 74 % of the total, cultivated wheat on their entire plot of land whereas only 19 farmers, i.e. 26 %, do not cultivate their total cultivable area with wheat.*

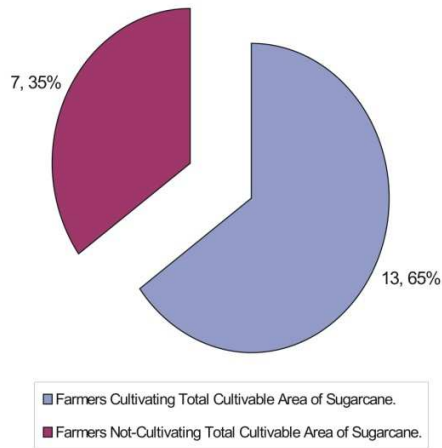
Pie Chart 3: Break-up of the Farmers According to Cultivation of Total Cultivable Area of Wheat under Irrigated Condition (Rabi Season 2004).



Sugarcane

- *Total cultivable area under sugarcane is 10.03 ha ha ([Land Records Office Register, Kolwan, 2004-05](#)) out of which net cropped area is 8.65 ha.*
- *The minimum area occupied by sugarcane for the rabi season 2004 was 0.08 ha.*
- *The maximum area occupied by sugarcane for the rabi season 2004 was 0.95 ha.*
- *Pie chart 4 illustrates that 13 farmers cultivated total cultivable area of sugarcane, i.e. 65 % of the total sugarcane cultivated during the rabi season of 2004. On the other hand, some 7 farmers did not cultivate total cultivable area of sugarcane, i.e. 35 % of the total sugarcane cultivated under irrigated condition in rabi season 2004.*

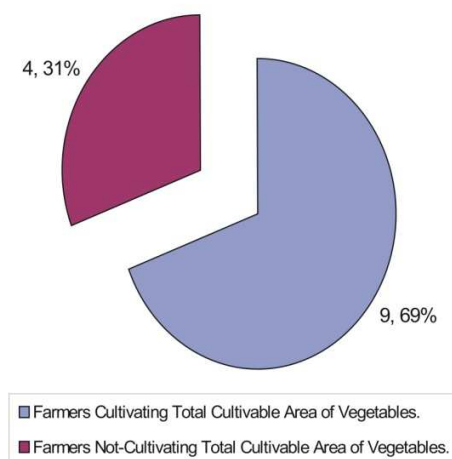
Pie Chart 4: Break-up of Farmers According to Cultivation of Total Cultivable Area of Sugarcane under Irrigated Condition (Rabi Season 2004).



Vegetables

- Total cultivable area under vegetables was 6.43 ha (*Land Records Office Register, Kolwan, 2004-05*), out of which net cropped area was 5.94 ha.
- A minimum of 0.10 ha was occupied irrigated vegetables in the rabi season of 2004.
- A maximum of 1.20 ha was occupied irrigated vegetables in the rabi season of 2004.
- Intensive and multiple cropping pattern in vegetable cultivation has been the most recent cropping pattern advancement in Chikhalgaon.
- Pie Chart 5 shows that 9 farmers, i.e. 69 %, cultivated their entire plots with vegetables in the rabi season of 2004, while 4 farmers, i.e. 31 % did not cultivate their total cultivable area under vegetables in the rabi season 2004.

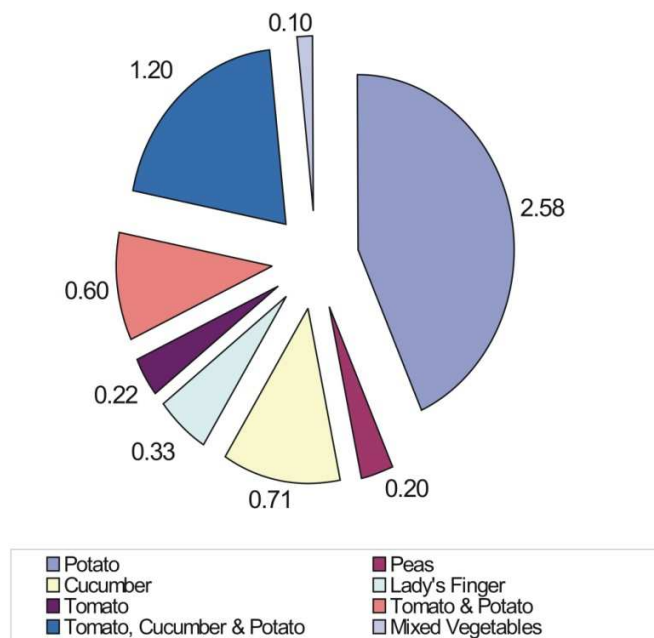
Pie Chart 5: Break-up of Farmer According to Cultivation of Total Cultivable Area under Irrigated Condition For Vegetables (Rabi Season).



Vegetables form the smallest proportion of the three irrigated crops in Chikhalgaon village. However, investigating a little further into vegetable cultivation, it was observed that farmers take a single crop of vegetables as well as practice a multiple vegetable cropping. *Pie Chart 6* indicates a break-up of various vegetables cultivated during the rabi season of 2004. Pie chart 6 illustrates this distribution and can be summarized It can be further classified (also illustrated in pie chart 6) as:

- Potato – 2.58 ha of cultivated area under irrigated condition.
- Peas – 0.20 ha of cultivated area under irrigated condition.
- Cucumber – 0.71 ha of cultivated area under irrigated condition.
- Lady's finger – 0.33 ha of cultivated area under irrigated condition.
- Tomato – 0.22 ha of cultivated area under irrigated condition.
- Tomato & Potato – 0.60 ha of cultivated area under irrigated condition.
- Tomato Cucumber & Potato – 1.20 ha of cultivated area under irrigated condition.
- Mixed Vegetables – 0.10 ha of cultivated area under irrigated condition.

Pie Chart 6: Further Classification of Various Vegetables Cultivation Area in ha under Irrigated Condition (Rabi Season 2004).



CONCLUSIONS

The major conclusions from this study are summarized into four parts, given below.

1. *Sources of Irrigation*

Lift irrigation forms the major source of irrigation to cultivate rabi season crops in Chikhalgaon. Some of the farmers also use well water to irrigate their crops but only marginally so, mostly as protective or supportive irrigation in times when the main source develops problems (like breaking down of pumps at the river, pipeline leaks etc.).

2. *Increase in groundwater irrigation recently: this may have induced vegetable cultivation*

Farmers in Chikhalgaon tended to traditionally farmlands, using rainwater. This involved growing paddy during the kharif season. In the last half-decade a lot of water-related works in the form of Watershed Development, Minor Irrigation Tanks and general awareness about water conservation in the Kolwan valley has occurred. These factors, together, have resulted in increasing water flows to streams and the river. Although groundwater abstraction for irrigation is not significant, a tendency to deepen wells and extract groundwater has been noticed recently, concurrently to a boom in lift irrigation schemes. All the factors, together, may have induced vegetable cultivation in Chikhalgaon.

3. *Wheat is currently the most popular rabi crop*

Wheat is the major rabi crop, both in terms of the farmers growing it as well as the area covered. Although one has the impression that it is too early to tell (farmers have been experimenting and will continue to try out combination crops), wheat remains popular, arguably because the benefit-to-cost ratio for wheat is maximum.

4. *Comparison with baseline Kolwan valley information (based on GOMUKH's 1996 data)*

In the data analysis done, there has been a significant change in the cropping pattern of Chikhalgaon and Kolwan valley as compared to the report of GOMUKH 1996. Few people cultivated wheat then and there was no sugarcane and vegetable cultivation in Chikhalgaon (GOMUKH 1996 data). In the present study, as per data generated and analyzed there has been increase in the number of farmers cultivating wheat while sugarcane and vegetables are also grown in the Chikhalgaon. A significant number of farmers have started cultivating their fields with different crops on irrigated condition for the rabi season.

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