Technological Opportunities for Distress Mitigation in Most Seriously Affected Areas of Wardha District

M S Swaminathan Research Foundation
Chennai

Office of the Principal Scientific Adviser
to the Government of India, New Delhi

Final

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Acknowledgement

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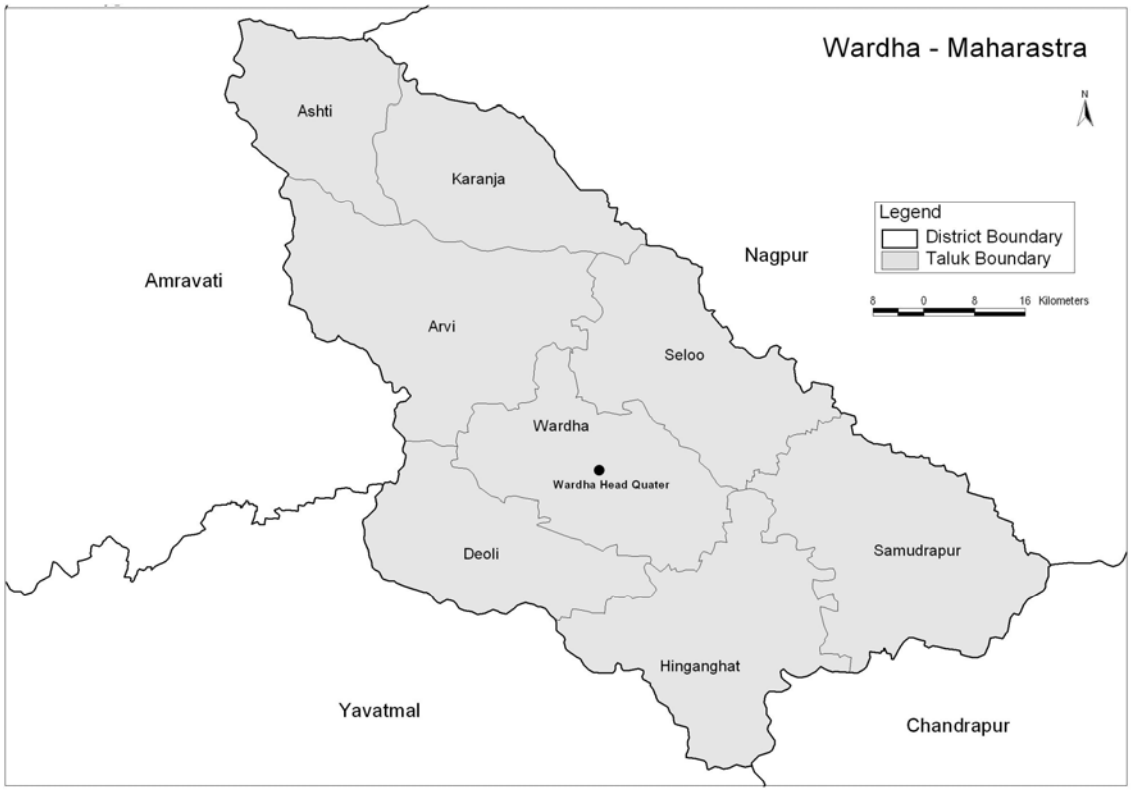
Manjula. M

Introduction

Wardha district (20° 18' to 21° 21' N. and 78° 4′ to 79° 15′ E) lies in the Vidarbha region of Maharashtra. The district is bounded on the north by Nagpur district and the south east by Chandrapur district and on the west by Amravati and Yavatamal districts. (Map 1). The district covers 6,309 sqkm. The district is divided into 3 major revenue sub divisions namely Wardha, Arvi, and Hinghanghat. For administrative purpose these divisions are further sub divided into 8 taluks[1].

Map 1. Wardha District



The district consists of a total of 1004 inhabited villages and 7 towns. The total population of the district is 1.2 million as per Census 2001. The district has a total of 8, 65,556 literate persons and a literacy rate of 80.06 per cent. The district is rural in nature with 74 per cent of its total population living in rural areas. The district has a predominantly agrarian economy with 65 per cent of the main workers being engaged in agricultural activities, either as cultivators or as agricultural labourers. The total cultivable area of the district is 4729 sqkm, which is about 75 per cent of the total geographical area of the district. The total livestock population of the district is 5.69

[1] The taluks are Wardha, Seloo, Samudrapur, Hinghanghat, Deoli, Arvi, Ashti, and Karanja

lakh of which 4.05 lakh are bovines and bovines' accounts for 71 per cent of the total livestock population of the district[2]. The cropping pattern of the district could be described as cash crop based production system with cotton and soyabean together accounting for about 71 per cent of the gross cropped area as of 2005-06. The other major crops of the district are red gram and sorghum.

Agriculture in Wardha is rainfed in nature. The district receives an average annual rainfall of 1041 mm. Black soil is the predominant soil type in the district and it is classified into heavy, medium and light categories. Wardha district forms a part of Wardha river basin. There are 4 major irrigation projects and 7 medium irrigation projects planned on Wardha river and its tributaries[3]. The predominant source of irrigation in the district is still ground water with 85 per cent of the total operational holding that is irrigated depending on open wells as a source of irrigation even by 2000-01[4]. This accounts for 83 per cent of the total net irrigated area in the district.

Rainfed agriculture that is practiced in Wardha district is largely dependant on the south west monsoon. South west monsoon- the lifeline of agriculture in Wardha district is erratic in nature, is skewed in its distribution, and shows a declining trend with a reduction in the number of rainy days. This has serious surface soil and water run-off implications for an area like Wardha, which has soils with poor water holding capacity[5]. Soil and water run off has very severe adverse impact on soil nutrient status, crop productivity and subsequently on the food and livelihood security of the rural people[6].

However, the adverse impact of the peculiar nature of the rainfed agriculture in Wardha can be mitigated by adopting appropriate interventions. Planning and implementing appropriate interventions are absolutely essential to sustain and improve agriculture on which nearly three fourths of the district's population depends.

[2] Government of Maharashtra 2005
[3] The tributaries are Wena, Pothra, Bor, Dham, Asoda, Bakli, and Kar.
[4] www.agcensus.nic.in; World agricultural census 2000-01. The total number of operational holding receiving irrigation as of 2000-01 is 21124 hectare. The total number of operational holding receiving irrigation from open wells is 18010.
[5] Inferences on the soil properties are drawn from the publications of National Bureau of Soil Survey and Land Use Planning, Nagpur.+
[6] Both the Government of Maharashtra in 2005 and Government of India in 2006 had identified the district as agriculture related suicide prone district and had introduced special packages to address the agricultural distress situation in the district.

The study attempts to draw action plans for scalable model of sustainable agricultural practices at two different levels – at the district level, and at the *panchayat* level. *Panchayat l*evel planning is attempted by taking the case of one *panchayat*, namely Lonsawali *panchayat*, in the district. The study uses a combination of primary and secondary data sources. Focus group discussions, participatory resource mapping, and participatory planning was done with the farmers in the village *panchayat*. Our previous study on Wardha district[7], the knowledge about the agricultural scenario in the district, the interactions with the officials of the different line departments and NGOs working in the area have been helpful in formulating an action plan for the district[8].

The report is organized into two major sections. Section 1 discusses the action plan drawn for Lonsawali village *panchayat* and section 2 presents the action plan for Wardha district as a whole.

[7] MSSRF had done a study on the technological dimension underlying agricultural distress in Wardha district. The study is titled '*Designing Rural Technology Delivery System for Mitigating Agricultural Distress- A study of Wardha District'*

[8] The list of officials and individuals interacted with is given in annexure 1.

Section 1

Lonsawali Village *Panchayat*

1.1. Salient Features of Lonsawali Village *Panchayat*[9]

Lonsawali village *panchayat* falls in Wardha taluk of Wardha district. The *panchayat* is bounded in the north by hills, in the north west and south west by Bori, and Kurchadi villages respectively and in the south by Waifad village (Map 2). The *panchayat* is located about 25 km from the district headquarters of Wardha. The village *panchayat* of Lonsawali comprises of the villages, Lonsawali, Dorli and the hamlet Shekapur. The *panchayat* office is located in Lonsawali. The total geographical area of the *panchayat* is 2087.66 hectares. Lonsawali *panchayat* has 440 households and a total population of 1888. Of this 895 are females and 993 are males[10] (Census 2001). The general literacy rate of Lonsawali *panchayat* is 54.9 percent, while that of the district is 78.50 per cent. The female literacy rate for the *panchayat* is 48.04 per cent while that of the district is 73.84.

Agriculture is the main source of livelihood of the people of Lonsawali with almost 85 percent of the total workers of the village *panchayat* being engaged in agriculture. As per 2001 census, the *panchayat* has about 941 cultivators and agricultural labourers. The total cultivable area of the *panchayat* is 1477 hectares which is about 76 per cent of the total geographical area of the *panchayat*. Agriculture is predominantly rainfed and the main crop growing season is kharif which extends from June-July to Nov-Dec. The major crops are cotton, soyabean, red gram, and sorghum.

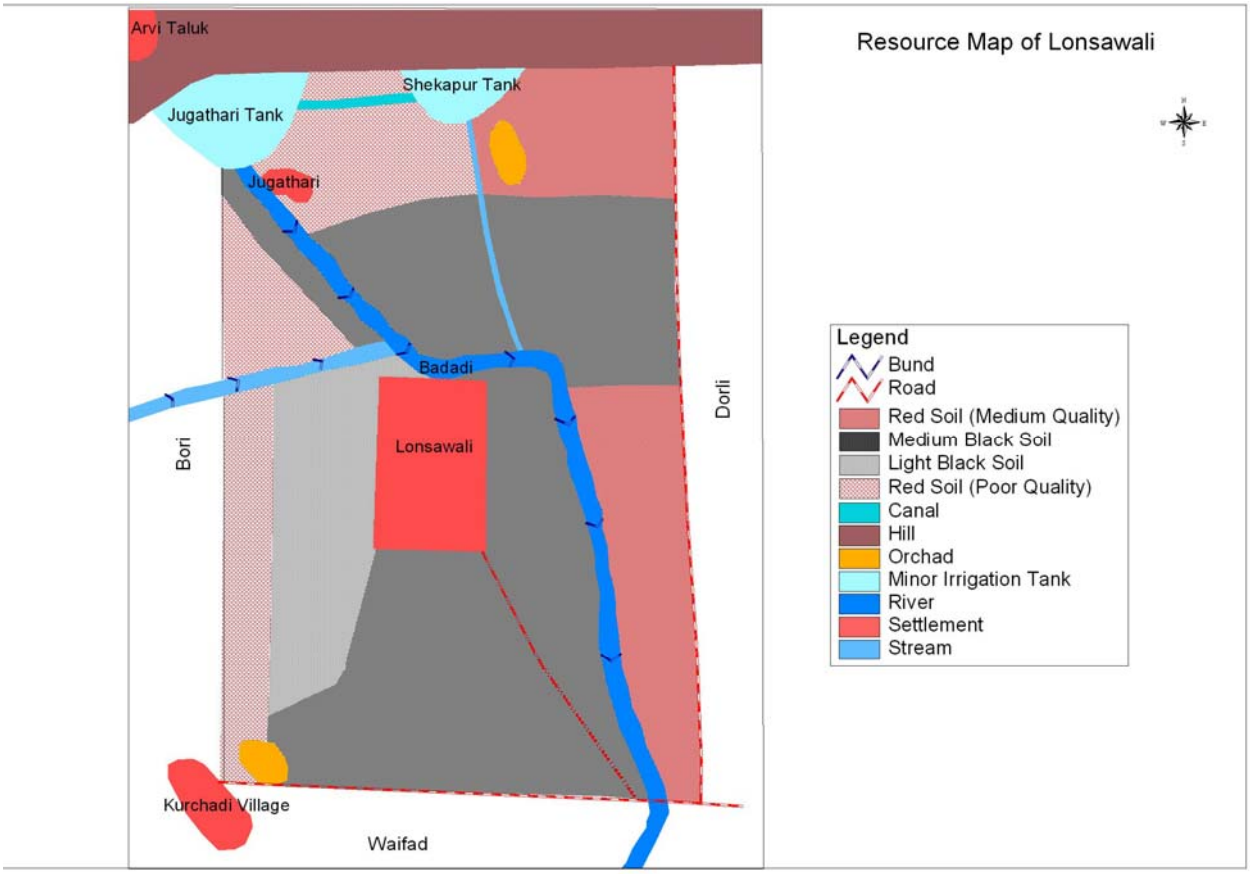
The major soil types in Lonsawali *panchayat* is black (light to medium) and red soil. Black soil is the predominant soil type in the *panchayat*. The soils in Lonsawali are of low to medium productive capacity. They have low organic carbon content, (which is an indicator of available nitrogen), low level of available phosphorous, and medium to high level of available potash. Agriculture in Lonsawali is predominantly rain fed. The area under irrigation throughout the year is 28.20 hectares, which is only about 2 per cent of the total cultivable area of the *panchayat*. The major source of irrigation in

[9] The section relies on the Village *Adarsh Tatka* and Cenus data

[10] The figures for Lonsawali *panchayat* has been arrived by adding up the figures for the revenue villages Lonsawali and Dorli which together form the Lonsawali *panchayat*. Lonsawali revenue village comprises of village Lonsawali and hamlet Shekapur. (Census 2001)

the *panchayat* is ground water. The *panchayat* has around 186 wells. All the wells have water throughout the *kharif* season, but only a few have water during *rabi*. As of March 2010 only 50 wells that is less than 1/3rd of all wells had water in them during rabi season. While majority of the wells are fitted with electric pumps there are a few diesel pumps too[11]. Lonsawali *panchayat* has two minor irrigation tanks the Shekapur tank, and the Jugadhari tank[12]. The catchment area[13] of both the tanks is 194 hectares each. The source of water for the tanks is the run-off water from the surrounding hills. The irrigable command area[14] of Jugadhari tank is 208 acres and that of Shekapur is 204 acres.

Map 2. Resource Map of Lonsawali *Panchayat*



[11] In the year 2009, there were 124 electric motor pumps in Lonsawali *panchayat* of which 6 are diesel pumps.
[12] Shekapur tank was completed in the year 1983 and Jugadhari tank was completed in 1990.
[13] Catchment area of a tank is the area which serves as a water collection source for the tank.
[14] Irrigable command area is the area under the tank command that can be irrigated when the tank has water up to the full tank level.

A seasonal river Badadi runs across Lonsawali village. There is a KT weir across this river near the Jugadhari hamlet in Lonsawali. The KT weir functions as artificial recharge structures. The shutters of the KT weir are removed at the beginning of monsoon during the month of July, and they are placed back when the monsoon recedes during the month of September. This prevents run off of rain water after the monsoon season and the retained water helps in ground water recharge. Lonsawali *panchayat* was part of the NABARD Holistic Watershed Development Project in Lonsawali Cluster. The watershed covered 2065 ha in Lonsawali *panchayat*, which is almost 98.9 per cent of the total geographical area of the *panchayat*.

1.2. Issues in Agriculture in Lonsawali Village *Panchayat*:

It is a well established fact that yield gap (the difference in yield in farmers field and the field level demonstration plots of the agricultural research stations) is very high in most of the crops in India. Agricultural productivity or crop yield is determined by a wide range of factors such as natural, physical, economical, behavioural etc. This section explores some of the limiting factors for agricultural productivity growth in Lonsawali *panchayat,* ranging from poor soil fertility status and poor soil management to absence of an effective extension system and wild life menace in the *panchayat*.

1.2.1. Soil health

Soil health indicates the productive capacity of the soil. Soil testing was done for about 50 samples in Lonsawali village in 2009-10[15]. The soils were tested for the status of the available macro nutrient like nitrogen, phosphorous, and potassium. The soil test results are given in Table 1. The soils in Lonsawali are found to have generally low to medium organic carbon content, (which is an indicator of available nitrogen), low level of available phosphorous, and medium to high level of available potash.

Table 1 Results of soil test in Lonsawali *Panchayat*

(Number of samples in each category)

Nutrient	Low	Medium	High	Total
Organic carbon	31	17	2	50
Available phosphorous	49	1	nil	50
Available potash	7	23	18	50

***Source**: Based on the soil test results given by the district soil test lab, Wardha and the Village Resource Centre Waifad*

The results from the district soil test lab shows the other essential nutrients like calcium and magnesium to be available in normal levels in the soil samples (Table 2). But calcium carbonate ($CaCO_3$) percentage in the soils was found to be high in all the 5 samples. This has implications on available phosphorous in the soil as phosphorous

[15] Of this, the Village Resource Centre at Waifad, carried out soil tests for 45 samples during 2009 and the test results were taken from the Village Resource Centre Waifad, The remaining 5 soil tests were done as part of this study in March 2010, and the results were provided by the District Soil Test Lab Wardha. Microbial status analysis was carried out on these 5 samples at the Microbiology Lab at MSSRF Chennai in March 2010.

is fixed in an unavailable form[16]. This has adverse effect on the soils of Lonsawali *panchayat* which are low in available phosphorous.

Table 2 Status of Essential Nutrients other than NPK in Soils of Lonsawali *Panchayat*

Nutrient	Low	Normal	High	Total
Calcium	Nil	5	Nil	5
Magenesium	NIl	5	Nil	5
Calcium carbonate	Nil	Nil	5	5

***Source**: Based on soil test results given by the District Soil Test lab, Wardha*

Microbial status analysis[17] was carried out on 5 representative soil samples from Lonsawali *panchayat*[18]. The samples were analyzed for their total microbial biomass[19]. The overall microbial population in the soil samples varied from 12-35 x 10^3 (which means there are 12-35 colony forming units (CFU) of microbes when 1 gram soil is diluted to 10^3 times). This amount is less when compared to the range reported in organic matter rich fertile soils. The population in organic matter rich fertile soils would be more than 12-35 x 10^6 to 10^7 (that is organic matter rich soil would have more than 12-35 colony forming units when 1 gram is diluted to 10^6 times). The diversity of the different microbial species like *Pseudomonas, Bacillus*, phosphate, zinc, and urea solubilisers was also found to be very low (Table 3).

Pseudomonas sp. is generally referred to as plant growth promoting *rhizobacteria* (PGPR's). This group of bacteria promote plant growth by different mechanism and

[16] The calcium ($Ca2^+$) of CaCo3 reacts with the available phosphate ions ($Po4^{3-}$) in the soil and fixes them as Ca3(Po4)2 (calcium phosphate), which is an unavailable form of phosphorous.
[17] Inferences on the microbial status of the soils of Lonsawali *panchayat* is based on the inputs received from the Microbiology lab at MSSRF.
[18] The 5 soil samples collected were representative of the different soil textures in the *panchayat* namely medium and light black soil and red soil.
[19] Soil microbial status was analysed by serial dilution method. **First stage dilution**: 1 gram of the respective soil sample was taken and diluted in 10 ml of sterile distilled water. This solution was vortexed for 10 minutes. (A vortex machine helps to break down the clodes of the soil particles and enable the soil microbes to come into the solution. The procedure is called vortexing.). **Second stage dilution**: 1 ml from the first dilution was transferred to the second tube with 9 ml of sterile distilled water and mixed well. **Third stage dilution**: 1 ml from the second dilution was again transferred to the third tube with 9 ml of sterile distilled water, mixed well and allowed to settle down for few minutes. 100µl of solution from the third dilution was spread plated on the respective medium and incubated for 48 hrs at room temperature and the number of colonies which appeared in each plate was counted which gives the colony forming unit (CFU) in one gram of soil diluted to 10^3 times and this represents the microbial population of that particular soil.

protect plants against biotic and abitotic stress. The CFU of *Pseudomonas* population was found to be extremely low in the soils of Lonsawali *panchayat*.

Table 3 Soil Microbial Test Results, Lonsawali *Panchayat* (number of CFU at 10^3 dilution)

Sl. No.	Total biomass (Nutrient medium)	King's medium (Pseudomonas spp)	Pikovskiya's medium (Phopho-solubilizer)	*Azospirillum* medium (*Azospirillum* spp.)	Zn solubilizing bacteria	Urea Medium (solubilizing bacteria)	Bacillus spp.
1.	20	1	-	-	-	-	1
2.	12	-	-	-	-	-	1
3.	12	1	1	-	-	-	-
4.	28	4	2	-	2	-	1
5.	35	1	3	1	-	-	1

Source: *Soil microbial results provided by Microbiology lab at MSSRF*

Azospirillum are associative symbiotic nitrogen fixing bacteria, which fixes the free atmospheric nitrogen in the soil and makes it available to the plant. The *Azospirrilum* spp. if present in appropriate numbers, fixes around 20-40kg of nitrogen/hec/season. In the soil samples of Lonsawali, the population of *Azospirrilum* is totally absent except in sample 5, which is reflective of the low available nitrogen in the soil.

The phosphate solublising bacteria increases phosphorous uptake by the plant and increases crop yield. The phosphate solublising bacteria secrete organic acids that helps in the dissolution of the bound phosphorous in the soil. Strains from the genera *Pseudomonas*, *Bacillus* and *Rhizobium* are among the most efficient phosphate solubilizers. Soil samples of Lonsawali have very low level of phosphate solubilisers. This is of significance in the event of high calcium carbonate content and the associated phosphorous fixation problems in the soils of Lonsawali *panchayat*.

Bacillus sp. is also plant growth promoting bacteria and this group has the ability to tide over harsh environment. Even these bacteria which have high survivability in a wide range of soils are observed in very low numbers in the soils of Lonsawali *panchayat*. Zinc solubilising and urease producing bacteria are totally absent in the soil samples of the *panchayat*.

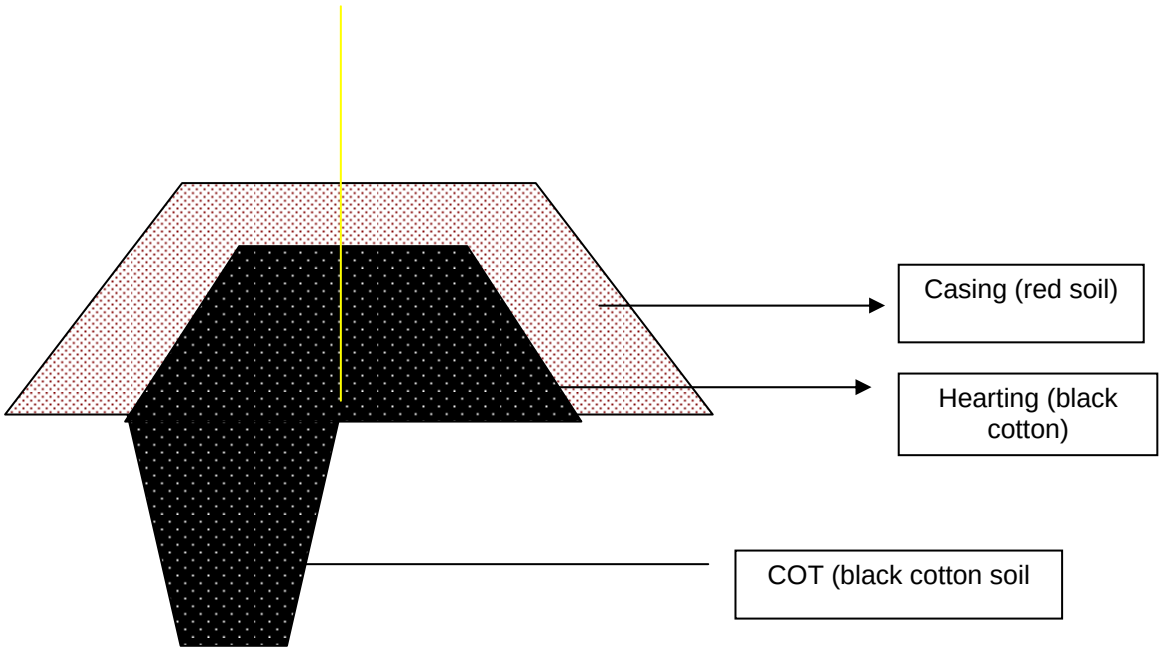
To sum up, microbial population plays an inevitable role in soil biological health, nutrient cycling, and nutrient availability to plants. Adequate availability of the microbial species is essential for good microbial activity. In Lonsawali *panchayat*, since the microbial population load is very low, augmentation of its population is to

be achieved through external application of bio-fertilisers coupled with organic matter application.

1.2.2 Irrigation

1.2.2a. Minor irrigation tanks: Lonsawali *panchayat* has two minor irrigation tanks Jugadhari and Shekapur. But the farmers of Lonsawali *panchayat* have not had any irrigation benefits from the two minor irrigation tanks in the *panchayat* till date. The tank is said to have never once reached its full tank level (FTL) after its completion. The reasons for non-filling of tanks are being attributed to low rainfall and also sub surface run off from the tank. The sub surface run-off could possibly be due to some technical flaw in the 'cut-off trench' (COT) or 'hearting' the two basic structures in any dam that is responsible for the function of retention of water in the tanks. An understanding of the physical structure of the tank would help better understand the link between the technical flaw and water retention in the tanks[20].

Fig 1. Dam structures:



[20] The section on the tank structures and the issues with the physical structure of the tank and its maintenance are based on discussion with officials of the ZP-Minor Irrigation Division (March 2010)

Dam Structures (Fig 1)

Casing: This is the outer covering of the earthen dam. This is usually made of red soil (murmatti). This part of the dam structure allows water to flow freely and does not help in water retention.

Hearting: This is the layer beneath the casing. This is made up of black cotton soil. This part of the dam structure helps in water retention.

Cut off trench (COT): A cut off trench is a structure usually taken beyond the central line of the tank in the upstream area. The thumb rule followed in deciding the depth of the cut-off trench is, depth of cut-off trench is equal to FTL – GL (ground level). It is also subjective to the type of strata available. The cut off trench should ideally rest on hard rock. But if the hard rock is available much beyond the FTL-GL level, it is advised to restrict the cut off trench to the FTL-GL level. The cut off trench should be filled with black cotton soil and the bottom layer of the cut off trench should be filled with black cotton soil, properly puddled, and compacted. If this procedure is not properly done, and the cut off trench is filled with red soil or other types of soils which does not help in water retention, water will seep out of the tank through the COT. The texture of the black soil that is used to fill the hearting and the cut-off trench determines the water retention capacity of these two structures. Heavy black soils help in better water retention in the tanks than medium/light black cotton soils. Usually soils within a radius of 2 to 2.5 km of the site of the tank are used to fill the COT.

Issues with the tank structure that hinders water retention in MI tanks:

- The texture of the black soil that is used to fill the 'hearting' and the 'cut-off trench' determines the water retention capacity of these two structures. The black cotton soils of Lonsawali village *Panchayat* are of medium and medium-light textures, which have average to poor water retaining capacity. If this soil had been used in either the cut-off trench or the hearting, they wouldn't be as effective in ensuring water retention in the tanks. Since it is stipulated that generally soils within a radius of 2 to 2.5 km of the site of the tank are used to fill the tank, it can be assumed that the soils used for filling

Issues with maintenance of MI tanks:

- The ownership, overall maintenance and management of Jugadhari and Shekapur tanks rests with Wardha Subdivision of the ZP-Minor Irrigation division. It is said that the funds allotted are not adequate for proper maintenance of tanks[21].
- Till date (as of August 2010), no society or water users association has been formed of the originally identified beneficiaries for taking up maintenance work of the supply channels of both these minor irrigation tanks as has been stipulated by the MMSIF Act 2005. In the absence of any kind of irrigation benefits from the minor irrigation tanks, the beneficiaries do not consider it worthwhile forming a society to maintain the supply channels of the minor irrigation tanks.

1.2.2b. Issues with KT Weir- The Artificial Recharge Structures

- The issue with KT weir, the artificial recharge structures over Badadi river in Lonsawali is that the gates are not being placed after the monsoon recedes, and hence it doesn't serve the purpose of ground water recharge.
- The reason given for not placing the shutters of the KT weir is that once the gate is placed, the water level in the Badadi river rises, making it difficult for farmers who have their fields on the other side of the KT weir to commute to their fields.
- While the farmers who own land on the other side of the KT weir demand that the District administration provide a foot bridge across the Badadi River near the KT weir to facilitate commuting; the ZP-Minor Irrigation Division which is in charge of maintenance and management of KT weirs states that it is highly economically unfeasible to built a foot bridge across the Badadi just for the sake of 3 or 4 farmers and that the farmers should explore other alternatives routes to reach their fields.
- The other reason gave for non placement of shutters across the KT weir is the non-agreement on the part of the beneficiaries of the KT weir with regard to

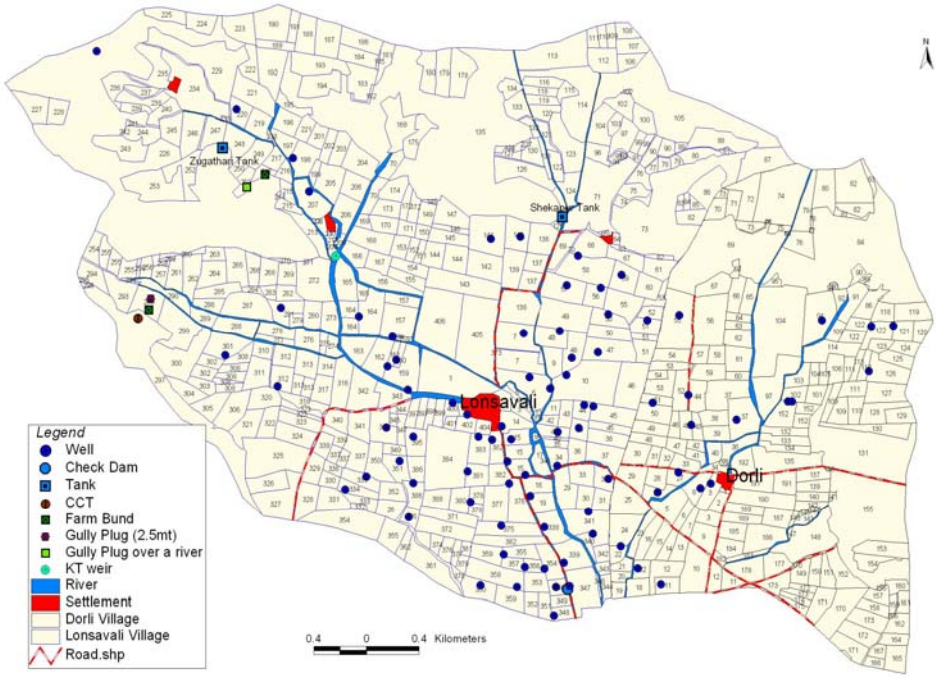
[21] Interview with officials at the ZP Minor Irrigation Division, Wardha, March 2010

sharing of labour charges required for placing and removing the shutters/pins in the KT weir.

1.2.3. Watershed

Though the NABARD holistic watershed implemented in the Lonsawali *Panchayat* followed the ridge to valley scheme of soil and water conservation, the majority of the work carried out under the watershed in the *Panchayat* pertains to ridge treatments and drainage line treatments (Map 3)

Map 3 Watershed Map of Lonsawali *Panchayat*



Note: *Watershed map generated using GPS points taken at Lonsawali during March 2010*
Source: *Cadastral Maps from Department of Land Survey and Land Records, Wardha*

The treatments done on the ridge/upper reach is continuous contour trench. According to the implementing agency in charge of the watershed in Lonsawali *panchayat*, the upper reach of the watershed have been fully targeted and the target covered 100 per cent. The treatments done on the drainage line are gully plugs, loose boulder structure, and gabion structures. The drainage line treatments have also been carried out according to plan target. The work planned in the lower reaches is farm bunds and repair of farm bunds. Treatments like contour bunds and graded bunds which are effective soil and water conservation treatments in the lower reaches of a watershed

were not planned in any of the fields. The farm bunds which were taken up on 1375 hectares of the cultivable area, about 92.9 per cent of the total cultivable area of the *panchayat*, were not taken according to the specification proposed in the action plan for the watershed. According to the implementing NGO, though they have covered the target given in the action plan on farm bunds, they have not been able to stick to the dimension specified in the action plan for farm bunds. The dimension specified for farm bunds in the action plan was 60-65 cm height and 1.5 metre breadth. The length to depend on the length of farmer's field. The size of the farm bunds in about 50 per cent of the fields were not according to specification. The size of the farm bunds taken were only 80 per cent of size proposed in the plan. The reason given for deviating from the dimensions specified in the action plan was the farmers' unwillingness to take up farm bunds in their fields citing difficulty/interference in the cultural operations. The reason given for the complete absence of contour and graded bunds was also the farmers' unwillingness to adopt this in their fields. Another structure conspicuously absent in the watershed was the farm ponds in the lower reaches. The farm ponds serve as effective water harvesting structures and also help in recharging of ground water.

1.2.4. Cultivation Practice[22]:

1.2.4a. Issues in cultivation practice in cotton:

The seed rate and spacing adopted in cotton is not as per recommendation given in the package of practice for cotton[23] (ICAR 2006). The seed rate used is more than the recommended seed rate of 800 g/acre and the spacing adopted is more than the recommended spacing of 2 ft x 2 ft in medium black cotton soil. The amount of fertiliser applied is less than the recommended dose of 32:16:16 kg/acre of NPK (Table 4a.). The use of fungicides like Bavistin and Dithane M-45 against a physiological disease like red leaf curl leaves a lot to be said about the effectiveness of the extension system in the village. All these factors contribute towards the yield of

[22] The issues discussed under cultivation practice are based on the findings of our earlier study in Lonsawali (MSSRF 2010), farmers field survey undertaken by MSSRF-Village Resource Centre Waifad (2006-07), focus group discussion with farmers in Lonsawali (March 2010) and interview with the Village Agricultural Officer, Lonsawali (March 2010).

[23] The package of practice for cotton is given in the Handbook of Agriculture published by ICAR.

cotton in Lonsawali being much less than the potential yield of 10-15 quintals/ acre in black cotton soil.

Table 4a Average Per Acre Fertiliser Application by Cotton Farmers Across Size Classes in Lonsawali

Respondents	Size of Operational Holding (in acre)	Name of Fertiliser Applied	Quantity of Fertiliser Applied (in kg/acre)		
			Nitrogen	Phosphorous	Potassium
1.	2.5	18:18:10 and Urea	32 (100)	9 (56)	5 (31)
2.	4.5	Diammonium phosphate	9 (28)	10 (63)	Nil
3.	6	18:18:10 and Urea	16.36 (51)	9 (56)	5 (31)
4.	9	12:32:16 and Urea	35 (109)	32 (200)	16 (100)
5.	17	12:32:16 and Magnesium sulphate	34 (106)	29 (181)	21 (131)
6.	18	18:18:10	54 (169)	54 (338)	30 (188)

Notes: *The recommended dose of fertiliser nitrogen, phosphorous, and potassium for rainfed cotton is 32:16:16 kg/acre Figures in parentheses give the index with respect to recommended dosage equating recommended dosage of nitrogen, phosphorous, and potassium to 100.*
Source*: MSSRF 2010*

1.2.4b. Issues in cultivation practice in soybean in Lonsawali:

Though seed treatment with thiram is a recommended practice in soybean most of the farmers seem to be unaware of the need for seed treatment in soybean. A survey undertaken by MSSRF in Lonsawali during the year 2008 shows that only 13/200 farmers surveyed had taken up seed treatment[24]. The lack of seed treatment is the major cause of root related diseases of soybean. It is recommended to maintain an optimum plant population of 1,40,000 plants per acre in soybean, while in Lonsawali, the farmers maintain only around 1,00,000 plants per acre. This could be attributed to the low germination percentage of the seeds. The farmers do not take up any germination tests before sowing. The fertilizer applied is found to be very less compared to the recommended dosage (Table 4b). In addition to this, sulphur which is one of the recommended nutrients in soybean was found to be invariably missing across the different size classes in Lonsawali. Sulphur is an essential nutrient in oilseed crops. Sulphur enhances the oil content in soyabean. The non-application of sulphur will result in poor oil content in the soyabean pods. All these factors could be contributing to the less than potential yield levels in soybean in Lonsawali.

[24] Data taken from the Village Resource Centre Waifad

Table 4b Average Per Acre Fertiliser Application by Soyabean Farmers Across Size Classes in Lonsawali

Respondents	Size of Operational Holding (in acre)	Name of Fertiliser Applied	Quantity of Fertiliser Applied (in kg/acre)			
			Nitrogen	Phosphorous	Potassium	Sulphur
1.	2.5	18:18:10 and Urea	16.4 (205)	7.2 (90)	4 (25)	Nil
2.	3	18:18:10 and Urea	5.94 (74)	5.94 (74)	3.3 (21)	Nil
3.	4.5	Diammonium phosphate and urea	32 (400)	10 (125)	Nil	Nil
4.	6	18:18:10	5.94 (74)	5.94 (74)	3.3 (21)	Nil
5.	9	Single super phosphate	Nil	8 (100)	Nil	5.5 (69)
6.	18	12:32:16	6 (75)	16 (200)	8 (50)	Nil

Notes: *The recommended dose of fertiliser nitrogen, phosphorous, potassium and sulphur for rainfed soybean is 8:8:16:8 kg/acre. Figures in parentheses give the index with respect to recommended dosage equating recommended dosage of nitrogen, phosphorous, and potassium and sulphur to 100*
Source*: MSSRF 2010*

1.2.5. Agricultural Extension

The status of technology delivery in Lonsawali is found to be very poor as is reflected by the incorrect cultivation practices adopted by the farmers of Lonsawali *panchayat.* The survey conducted by the MSSRF during 2006-07 in Lonsawali, adds further credential to this statement. Not a single farmer surveyed indicated agricultural extension officers or anyone else from the scientific community as their source of guidance and information for agricultural related problems and issues. The cultivation practice followed in cotton and soybean, the major crops in Lonsawali are clear indicators of the lack of guidance or advice from the scientific community/extension officers in the village. In the case of cotton, the seed rate and spacing adopted is not as per recommendation. The less than optimum dose of fertiliser application, and the non application of one or the other major nutrient, the erroneous use of pesticides/fungicides against *laliya*, red leaf curl, which is a physiological disease etc are the other problems in cultivation practice in cotton in Lonsawali. In the other major crop, soybean, the complete absence of seed treatment of soybean before sowing, the less than optimum plant population maintained per acre, less than recommended dose of fertliser application, and as in cotton the absence of one or the other of the recommended nutrients are all indicators of the lack of proper

understanding of scientific cultivation practices on the part of the farmers.

In addition to this, the villagers in general were unaware of the different schemes under the Department of Agriculture. The low level of adoption in Lonsawali of the various schemes offered under the Department of Agriculture points to this. In the year 2009-10 there were around 116 schemes under the different wings in the Department of Agriculture. The status of some of the schemes that were active in Wardha Taluk Agricultural Office during 2009-10, are analysed with respect to their reach and adoption in Lonsawali *panchayat*.

Table 5 Awareness and Access to Department of Agriculture Scheme in Lonsawali *Panchayat*

Broad area of the scheme	**Subsidy component and percentage subsidy**	**No of farmers in Lonsawali *Panchayat* who availed the scheme**
Soil and water conservation	70 per cent subsidy was given to marginal farmers for taking up farm ponds	None
National Horticultural Mission	• 100 per cent subsidy was given for promotion of orchards of oranges, mangoes, pomegranate, sapota, and gooseberries • Shade nets were given on 50 per cent subsidy to establish floriculture and vegetable nurseries. • Packhouse for storage of harvested material was also promoted on 50 per cent subsidy.	None
National Food Security Mission	• Sprinkler and drip irrigation system was supplied on 25 per cent subsidy. • Oil engines and electric motor pumps were given on 50 per cent subsidy	4 None
Support for Implements & Machinery	**50 per cent subsidy** to buy machineries that help in cultivation practices like seed-cum fertiliser drills, power spray pumps, and knapsack spray pumps	3 farmers got spray pumps
Input subsidy	• Zinc sulphate, gypsum, ferrous sulphate, etc are being given on 50 per cent subsidy. • Half litre of Endosulfan per farmer to control boll worm in cotton was allotted for all the farmers in the district	5 farmers got inputs on subsidy Around 10 litre of Endosulfan was supplied for 20 farmers in Lonsawali.

Source: *Based on Wardha Taluk Agriculture Office records*

Table 5 above brings out clearly the overall very poor level of awareness and access to the schemes of the Department of Agriculture among the farmers in Lonsawali

panchayat. This situation prevails in Lonsawali *panchayat* in spite of the Department of Agriculture's efforts in disseminating information about the schemes by displaying the scheme details and the target group on notice board in the respective village *panchayats*. But Lonsawali village *panchayat* did not have any display board announcing the schemes of the Department of Agriculture. The combination of factors like the absence of a display board, the inability of the agricultural officer to effectively pass on information in the absence of a permanent place to meet the villagers, and the absence of a contact farmer who resides in the village all results in the poor adoption of the schemes of the department.

The staffing pattern and the staff strength of the Wardha Taluk Agriculture Office as of March 2010 show the department to be grossly understaffed.

Table 6 Wardha Taluk Agriculture Office – Staff Strength (as of March 2010)

Position	**Sanctioned**	**Filled**	**Vacant**
Taluk Agricultural Officer	1	1	Nil
Mandal Agricultural Officers	2	1	1
Agricultural Supervisors	2	1	1
Agricultural Assistants	12	6	6
Tracer	1	1	Nil
Total	**18**	**10**	**8**

Source: *Data collected from Taluk Agricultural Office, Wardha Taluk*

As of March 2010, only 50 per cent of the posts of agricultural assistants have been filled up at Wardha taluk (Table 6). The agricultural assistants are the field level workers in the Department of Agriculture. Wardha taluk has approximately around 130 villages including some big hamlets[25]. Even assuming full strength of agricultural assistants at taluk level, on an average one agricultural assistant would be in charge of 10-11 villages. Assuming an average of 250 farm families per village, each Agricultural Assistant would be in charge of around 2500 to 2750 farm families. In a day, on an average, an agricultural assistant can meet up to a maximum of 5 farm families. The agricultural assistant responsible for Lonsawali is also responsible for another 5 villages in Wardha taluk. In addition to this, as of March 2010, he had additional charge of 4 other villages. So in total he had 10 villages under his charge.

[25] An approximation arrived at based on the taluk level village boundary map for Wardha taluk given in the Atlas published by Department of Soil Conservation and Watershed Management, Pune – Maharashtra.

The villages are also widespread making them quite inaccessible. The agricultural assistants are not provided with any mode of transport, and they are advised to use bicycle by the Department. They are given a flat/permanent transport allowance of Rs.1250 per month. The agricultural assistants unlike the *panchayat* secretary or the village revenue officer do not have a permanent office/place at the village where people could access him on the day he visits the village. This and the absence of a peon at the village level make it difficult for the agricultural assistant to mobilize the farmers on the day of his visit to the village. The contact farmers the agricultural assistants have in the village are progressive farmers. They do not actively participate in the extension activity and hence fail to bring in the intended multiplier effect. It is ironical that the contact farmer the department has in Lonsawali does not even live in the village!

The agricultural assistants are responsible for agricultural extension, soil and water conservation, and other activities of the department at the field level, in addition to ensuring delivery of the different schemes of the department. This leads to overburdening of staff at the field level which leaves no time for effective extension activity at the field level.

1.2.6. Barren and Fallow Land in Lonsawali *Panchayat*:

The total barren land and fallow land (inclusive of current fallows) in the village *panchayat* during the year 2009-10 is 427.14 ha and this accounts for 20.46 per cent of the total geographical area of the village *panchayat*[26]. This is much higher when compared with the total barren land and fallow land (inclusive for current fallows) for Wardha district during the year 2005-06. During 2005-06, the total barren land and fallow land (inclusive of current fallow) in the district was 15.04 per cent of the total geographical area of the district. Though several reasons like poor quality of the soil close to the foot hills and wild animal attack were cited as reasons for land being left fallow during the focus group discussion; the problem of existence of high percentage of barren and fallow land is a researchable question requiring an elaborate and intensive study of the factors underlying the phenomena.

[26] Based on land record details got from the village revenue officer, Lonsawali & Dorli

1.2.7. Wild Life Menace

Crop loss due to wild life menace is a regular feature especially in the fields of those farmers who own land close to the foot of the hills. The compensation got for crop damage/loss due to wild animal attack is very minimal compared to the effort and money spent on raising the crops. Hence many of the farmers who own land near the foot hills choose to leave their land barren than cultivate and lose it to wild animal attack. The Department of Forests pays a minimal compensation in the event of crop damages, cattle loss/injury and human injury/loss. The compensation paid in the event of injury to humans is in the range of Rs.5000 for minimal injury to Rs.50,000 for major injuries. The compensation paid on loss of human life due to wild animal attack is Rs.2 lakhs. The maximum compensation paid for any injury or death of cattle due to wild animal attack is Rs.7,500. The compensation for crop damages ranges from Rs.2000 to Rs.5000 per hectare. The amount to be paid as compensation depends on the extent of crop damage.

Added to this, the procedure for claiming the compensation is also said to be very cumbersome and time consuming. The farmer should complain within 3 days of the occurrence of damage with his farm record, FMB record, and a supporting proof like a photograph of the attacked field. A team of officials consisting of consulting forest officer, the gram sevak, police patil, forest guard, and village revenue officer, surveys the reported area ascertain the severity of attack, and fix the level of compensation to be paid. This report is cross checked by the assistant conservator of forest and they put up a note sheet containing their recommendation. The note sheet has to get the approval of the district conservator of forest. The district conservator of forests then gives the order for release of compensation money in the name of the farmer. Owing to the low compensation being paid, and the cumbersome procedure of claiming it, most of the cases of crop damage due to wild life attack remain unreported in Lonsawali *panchayat.*

1.3. Action Plan for Sustainable Agricultural Development in Lonsawali *Panchayat*

The action plan details major issues in the sphere of agriculture and suggests remedial measures. Further identification of agencies capable of implementing the remedial measures is also attempted. The schemes listed and the agencies identified are on the basis of extensive exploration of the respective department websites. To the extent possible, physical quantification of the individual remedial measures have been attempted.

Item	Issue	Remedial Measures	Action Plan	Agencies Concerned
Soil health	• Low to medium organic carbon content, (which is an indicator of available nitrogen), • Low level of available phosphorous • Medium to high level of available potash • Low to normal levels of micronutrients.	• Create awareness about the need for undertaking **soil tests** • **Soil testing to be done annually** in every individual field. Have one soil sample per 5 acre of land for soil testing • Supply of **soil health card** to every individual farmers to help track the dynamics of soil health and help in effective soil health management • **Apply organic matter[27] (farm yard manure, green manure, bio-residues/crop residues etc) to increase the nutrient responsiveness of the soil**. This will also help improve soil properties like soil texture, soil water holding capacity, and the soil organic carbon content. The practice that has scope for promotion in the *panchayat* is the application of farm yard manure as traditionally they have a practice of storing dung	• Carry out soil tests annually • Supply soil health card • Promote organic matter application	• Department of Agriculture (awareness about soil test, soil test, and soil health card, subsidy for growing green manure crops) • NGOs working in the field of sustainable agriculture (awareness about soil test, soil health card, the need for raising green manure crops) • KVKs (awareness about soil test, soil health card) • Soil test labs – public/co-operative/private (soil tests & soil health cards)

[27] It is recommended to apply on an average 7.5 tons of farm yard manure (FYM)/hectare per annum, the total requirement of FYM for the total cultivable area of 1477 hectares would be roughly 11,078 tons/annum.

Item	Issue	Remedial Measures	Action Plan	Agencies Concerned
Soil health	• Low overall microbial population load • Low diversity of the different microbial species • Soil test based nutrient management practices are not followed	• Promote **application of bio fertilizers** for augmenting the beneficial microbial mass in the soil and thus increase the microbial activity resulting in increased availability of the nutrients in the soil • **Bio fertilisers need to be applied at the rate of 1 kg/acre/crop season**. If the total cultivable area of the village would be brought under cultivation both the seasons-(kharif& rabi), the total amount of bio fertilisers required would be 3693 kg that is 4 tons of bio fertiliser per annum approximately. In order to promote the utilization of bio-fertilisers at the local area, a decentralized production facility could be established at the *Panchayat* level with a focus to promoting bio-fertilisers based on efficient local strains. Establish bio-fertiliser unit with a production capacity of minimum of 5 tons per annum at Lonsawali *Panchayat*. This could be promoted as an enterprise under the Swarnajayanthi Swarozgar Yojana of DRDA and taken up by SHGs promoted by DRDA and also through mahila kisan samitis promoted by MSSRF[28]	• Bio fertiliser application • Decentralised production of biofertilisers	• Regional Biofertiliser Development Centre, Nagpur – **(**to supply strains of microbes for bio fertiliser production, and to help in quality control of bio-fertilisers) • District Rural Development Agency (DRDA) (to promote bio-fertiliser units under Swarna Jayanthi Swarozgar Yojana) • Mahila kisan samitis promoted by MSSRF to run bio fertiliser units**.**

[28] Budget for setting up a bio fertiliser unit given in annexure 2

Item	Issue	Remedial Measures	Action Plan	Agency Concerned
Irrigation	• The faultiness of the cut-off trench that prevents water retention in the Shekapur and Jugadhari minor irrigation tanks	• Another cut-off trench (COT) in the minor irrigation tanks to be taken • Convert the minor irrigation tanks to percolation tanks by closing the outlet sluices • Promote farm ponds as recharge structures as well as for soil and water conservation. It is ideal to have one farm pond of 30x30x3 mts per 5 ha plot. • The KT weir-the artificial recharge structure in the village across the Badadi river to be better managed. The shutters should be placed and removed in synchronisation with the stoppage and beginning of the monsoon.	• Take cut-off-trench • Close the outlet sluice of minor irrigation tanks in the *panchayat* • Promote farm ponds • Better manage KT weir	• Zilla parishad Minor irrigation department – (to take another COT after working out the techno-economic feasibility of taking another COT in the tank • Irrigation component under Bharath Nirman Programme could be sourced into for taking up another COT. • ZP minor irrigation department to convert the MI tanks into percolation tanks by closing the outlet sluice plugs to help retain water in the tanks during monsoon, which will improve ground water recharge

Item	Issue	Remedial Measures	Action Plan	Agencies Concerned
Irrigation continued	• Absence of a water users association to maintain the tanks or look into the issues related to the tank • Non-placement of shutters over the KT weir after the monsoon recedes • Absence of an effective community management system of the KT weir leading to ineffectiveness of the system as a recharge structure	• The farmers having land in the command area of Jugadhari and Shekapur tanks to form Water Users Association (WUA). This can serve as a forum for the farmers in the tank command to raise their issues with the concerned officials of the ZP Minor Irrigation Division • The farmers having land in the KT weir command to have a more effective community management system in place	• Form water users association for the tanks in the *panchayat* • Have better institutional mechanism to manage the KT weir	• Department of Agriculture (Source into their watershed programmes for farm ponds) • DRDA (Source into their watershed programs for farm ponds) • The village community to create institutions like water users association(WUA) for Shekapur and Jugadhari for better management of tanks (like demanding for another COT to be taken, or for the sluice plug to be closed)

Item	Issue	Remedial Measure	Action Plan	Agency Concerned
Watershed (Soil & water conservation)	• Not enough watershed treatment work in the lower reaches • Limited coverage of the dry land horticulture, only 10 per cent of the total fallow lands brought under this. • Lack of awareness about the importance of having farm bunds and contour bunds in the individual farmers field	• The work done in the upper reaches to be complemented with conservation measures like farm bunds and contour bunds in the lower reaches to fully harness the benefits of the watershed treatments. • Create awareness about the necessity of having watershed treatments like contour and farm bunds in the cultivable area • Dry land horticulture to be promoted on fallow lands in the *Panchayat* • Nano-orchards of 0.2 acres each can also be promoted on individual farmer's field	• Take up farm bunds and contour bunds in the individual fields • Awareness creation on contour bunding • Promotion of dry land horticulture	Harness the watershed programmes implemented through • Department of Agriculture • DRDA • NABARD • The watershed implementing agencies to source into the National Horticultural Mission for promotion of dryland horticulture and nano-orchards

Item	Issue	Remedial Measures	Action Plan	Agency Concerned
Cultivation practices	• Incorrect seed rate and spacing • Lack of knowledge on the necessity of seed treatment • Imbalanced and suboptimal fertiliser application • Incorrect pesticide usage	• Conduct **training camps on cultivation practices** in the villages – **one pre-kharif and one-pre rabi**. Instead of having mandals, which consists of 40-45 villages, as the unit for conducting training camps, the department should ensure one pre-kharif/pre-rabi training camp per 4-5 contiguous villages. This would ensure maximum reach of the training and demonstrations conducted by the Department. • Create awareness and provide demonstrations/training on **seed treatment** in soyabean – one demonstration pre-kharif, the sowing season of soybean. Seed treatment with fungicides like thiram helps to prevent disease attack on the roots. Treating the seeds with biofertiliser like rhizobium (leguminous crop seeds), helps in adequate nodulation of roots which help in better nitrogen fixing. Non-leguminous crop seeds can be treated with Azotobacter and Azospirillium to get healthier plants[29]. • Give orientation on the need for conducting **germination tests** before sowing to ascertain the germination potential of the seed lot	• Conduct training camps – one pre-kharif and one-pre rabi • Make 4-5 contiguous village as the unit of training instead of the current mandals • Provide training and demonstration on o Seed treatment o Seed germination test o Integrated nutrient management o Integrated pest management o Post harvest handling of produce	• Department of Agriculture (training camps, demonstrations, and subsidised supply of inputs) • NGOs working in the field of sustainable agriculture (orientation, training camps, and demonstrations) • KVKs (orientation, training camps and demonstrations)

[29] Bioferiliser requirement for the *panchayat* has been worked out in the next section on soil health

Item	Issue	Remedial Measures	Action Plan	Agency Concerned
Agricultural Extension	• Poor status of technology delivery in Lonsawali *panchayat* • Lack of awareness and access to the different schemes of the Department of Agriculture • Poor staff strength and vacancies in the staff position in the Wardha Taluk Agriculture Office, leading to high field level extension officer farmer ratio	**To ensure better awareness and access to the different schemes of the Department of Agriculture**: • Entitlement card listing all the agricultural schemes, the target groups and process of accessing them could be distributed to the individual households. • Display the details of the entitlement cards on notice boards where farmers frequent like the PDS shop, the provision stores, and the local temple. • The public address system in the *panchayat* could be used to broadcast details of the schemes • The Village Knowledge Centre (VKC) in Lonsawali could be used to disseminate information on the various schemes of the Department	• Prepare entitlement card of all the schemes in the concerned departments • Display entitlement card in common places • Information dissemination through public address system and the VKC	• Department of Agriculture (awareness creation & ensuring access to entitlements) • NGOs (information dissemination, awareness creation, and facilitating access to entitlement) • Local Administration (awareness creation and ensuring access to entitlements)

Item	Issue	Remedial Measures	Action Plan	Agency Concerned
Agrl Extn	• Absence of a competent contact farmer at the village	**To ensure effective functioning of the extension machinery in the Department of Agriculture**: • There should be a substantial increase in the field level staff of the Department of Agriculture by recruitment for existing positions and creation of additional positions[30] • The Permanent Travel Allowance should be sufficient to take care of the required number of trips by the Agricultural Assistants for effective technology transfer to the farmers • The Department should be revamped in such a way as to realise the full benefit of the restructuring of the Department into the Single Window System. There should be adequate staff with the required skill sets to carry out extension activity and soil and water conservation work at the field level making the delivery of these activities more effective.	• Increase the total number of field level staff in Wardha taluk agriculture office • Provision of adequate permanent travel allowance of field level staff • Revamp the Department of Agriculture to realise the benefits of single window system	**Government of Maharashtra to make policy level changes**: To restructure the Department of Agriculture in lieu with the pre-single window system • To increase the total number of sanctioned post in the Department of Agriculture in the districts of Maharashtra • Provisioning of adequate permanent travel allowance

[30] Assuming a ratio of 1000 farm families or approximately 4 villages per Agricultural Assistant as ideal, the approximate number of Agricultural Assistants to be sanctioned at Wardha Taluk is about 33 which is about 175 per cent more than the currently sanctioned posts at Wardha Taluk

Item	Issue	Remedial Measures	Action Plan	Agency Concerned
Agricultural Marketing	• Lack of community storage space for crop produce • Difficulty in knowing the daily market price and the associated difficulty in taking informed decisions regarding the time and price of sale of their produce	• Establish a community storage structure at the *panchayat* level. This would help the farmers to store the grain type crops like soybean, wheat, red gram, and bengal gram and prevent distress sale of these produce. • The daily market price could be displayed in the *panchayat* office or the VKC, so that the farmers who sell their produce to private markets outside the village have prior information about the prevailing price level. o This will help them decide the best price and time at which they can sell the produce.	• Establish community storage structures • Have a display board at the *panchayat* to display daily market price	• Department of Agriculture (pack house schemes to construct community/individual storage structures) • Local Administration (have a display board for the daily market price) • NGOs (access and provide the daily market price through the knowledge network connectivity)

Item	Issue	Remedial Measures	Action Plan	Agency Concerned
Weather variability adaptation	• Untimely rains and fluctuations in the weather patterns gives rise to new pest and disease • Vagaries in weather results in fluctuations in the weather based agricultural activities like sowing, fertiliser application etc and results in a strain on labour and draught power available for all the cultural practices from land preparation to harvesting.	• Localized weather monitoring is very much essential for effective planning of weather based agricultural activities at the village level to meet the weather variability's • Establishing village level mini agro-met observatory (Type c[31]) will help to develop weather based thumb rules for decisions in farm operations. Type c agro-met observatory can be established on 24 square metre of land[32]. • Village level mini agro-met observatory will also help in developing a cadre of Climate Risk Reduction Managers	• Establish village level mini agro-met observatory	• Local Administration (to allot revenue land for agro-met observatory) • NGOs (to help establish the agro-met observatory, train the cadre of weather risk managers) • Department of Agriculture (to provide monetary support for setting up the observatory)

[31] Type-c agro-met observatory helps measure relative humidity, temperature, quantity of rainfall and wind velocity. The instruments required are Stevenson screen, dry bulb thermometer, wet bulb thermometer, maximum & minimum thermometer, rain gauge, grass minimum thermometer, and cup anemometer

[32] Budget for setting up a village level mini-agromet observatory is given in annexure 3

Item	Issue	Remedial Measures	Action Plan	Agency Concerned
Wild life menace	• Low level of compensation paid in the event of crop/livestock/human loss due to wild life attack • The cumbersome nature of claiming compensation • Absence of any representative from the *panchayat* in the committee which ascertains the extent of damage and fixes the level of compensation to be given due to wild life attack	• To make the process of ascertaining compensation for damage due to wildlife menace more acceptable to the village community, steps should be taken to include the panchayat president/panchayat samiti member in the team which ascertains the crop damage and compensation • The compensation paid for crop/livestock/human life loss in the event of wild life attack is very minimal. The compensation amount need to be increased, and this should be at least equal to the sum assured in the event of crop loss under the prevailing crop insurance schemes.	• Include *panchayat* president/member in the team ascertaining crop damage and compensation • Increase the compensation amount paid in the event of crop loss due to wild animal attack	Government of Maharashtra & GoI to effect policy level changes to: • Raise the level of compensation • Speed-up the process of compensation • Have a representative from the *panchayat* in the committee which ascertains the damage, and fixes the level of compensation

Section 2

Wardha District

2.1. Issues in Agriculture in Wardha District[33]:

This section explores some of the limiting factors for agricultural productivity growth in Wardha district. This issues discussed pertains to changes in land use, cropping pattern, rainfall, soil health, status of soil and water conservation, extension etc that have a direct implication for agricultural growth in the district.

2.1.1. Land use, cropping pattern and crop production[34]:

An analysis of the land-use pattern in Wardha district over the four-and-half decades since the 1960s indicates a reduction in net sown area in absolute terms over the decades. The net sown area which was around 4.02 lakh hectares and accounted for 63.9 per cent of the total geographical area (TGA) during the triennium centred around 1961-62 reduced to 3.65 lakh hectares (57.86 per cent of TGA) by triennium centred around 2004-05. The total fallow lands comprising of current and other fallows, which was 22,013 hectares during the triennium centred around 1961-62 increased to 85,033 hectares during the triennium centred around 2004-05, an almost 4 times increase over 1961-62.

Traditionally though cotton has always been a major crop in the cropping pattern of the district, the production system of the district could be described as food grain based with total food grains constituting more than 50 per cent of the gross cropped area (GCA) till the mid-80s. Since mid-1980s soyabean has become an extremely important *kharif* crop in Wardha district, and the area under soybean has expanded by replacing cotton and sorghum (grown in *kharif)* and dry wheat[35] (grown in *rabi*) in Wardha district. By the year 2004-05, total foodgrains constituted 28.7 per cent of

[33] The sections on Land use, Cropping Pattern, and Crop production, Irrigation, and Structural Changes in the Department of Agriculture & Implications for Field Level Advisory/Activity are completely based on our earlier work in Wardha – MSSRF 2010 with the exception of the staff strength in the department of agriculture which is been updated.. Sections on Rainfall and Soil Characteristics partially draws from our earlier work.

[35] Dry *rabi* crop in Wardha district used to be grown in fields that were unirrigated and left fallow during the rainy season. Such fields would often be the ones that were prone to flooding and had the ability to retain moisture. With the introduction of soyabean, lands that were earlier reserved for dry *rabi* are getting cultivated in *kharif* season.

GCA, cotton 22.3 per cent of GCA, while soyabean occupied 44.7 per cent of GCA. This took the share of the total cash crops in the cropping system of the district to about 71 per cent, making the agricultural economy of the district a cash-crop economy.

Crop production in the district is characterised by a declining trend and high degree of instability in yield. Foodgrain production per capita per day in Wardha district declined from 532 g in 1961 to 369 g in 2001: a 31 percent decline over the forty-year period. Among the cash crops cotton production declined at the rate of 4 percent per annum over the years 1996-97 to 2004-05. Soyabean is the only crop that is registered an increase in its production, over the years 1991–92 to 2004–05. The crop registered a nine fold increase in its yield during this period.

A comparison of yield levels of cotton, soybean, and redgram in the district to that of the State and All India figures shows that yield levels of soyabean and redgram in Wardha district, in general, are equivalent to or higher than that of Maharashtra and All India. But cotton yield in Wardha district is lower than the country but higher than the state of Maharashtra (Table 7). The period 2001-02 to 2004-05 shows a decline in yield of red gram and soybean in Wardha district with soybean yield falling by 15 per cent over this period.

Table 7 Yield of Major Crops, Wardha District (in kilogram per Hectare) Triennium Average Centred around the Year

Crop	Area	1961-62	1971-72	1981-82	1991-92	2001-02	2004-05
Red Gram	Wardha Dist	1,379.46	870.72	1,065.03	690.45	1,121.67	1,086.00
	Maharashtra	697.89	414.49	564.07	450.99	667.50	665.00
	India	684.33	740.67	704.67	637.67	649.33	700.67
Cotton	Wardha Dist.	54.20	56.95	100.03	149.71	169.00	211.33
	Maharashtra	91.61	64.01	93.11	104.41	129.00	184.33
	India	1,16.67	128.00	160.33	232.67	189.00	329.00
Soyabean	Wardha Dist.				810.45	1,243.67	1,056.33
	Maharashtra				878.29	1,182.00	1,018.17
	India				897.00	841.33	1,058.00

Source: *MSSRF 2010*

Yield levels of crops in Wardha district is also characterised by high level of fluctuations. A comparison of the index of instability[36] measure at the district state and national level for the four major crops in the district namely, cotton, soybean, sorghum, and red gram indicate a high level of instability in yield for these crops in Wardha district (Table 8).

Table 8. Index of Instability in Yield of Crops, Wardha District, 1960-61 to 2005-06 (percentage)

	Wardha	Maharashtra	India
Soyabean	27	11	11
Cotton	18	16	6
Jowar	15	11	6
Redgram	11	10	7

***Note**: Calculations for soyabean is for a period 1987–88 to 2005–06*
***Source**: MSSRF 2010*

2.1.2. Rainfall and Soil Characteristics:

Wardha district receives an annual mean rainfall of 1041 mm. An analysis of the rainfall data of the district reveals a declining trend in the quantum of rainfall received and a reduction in the number of rainy days during the south west monsoon. The declining trend in the quantum of the south west monsoon has serious implication for the predominantly rainfed agriculture system of the district

Black soil is the predominant soil type in Wardha. This is further classified into light, medium, and heavy black soils. An analysis of the soil characteristics of Wardha district indicates that one-fifth of the soil is classified as light black soil, which is not very conducive for crop growth, while four-fifths is accounted for by heavy and medium black soils that have relatively better levels of productive potential. However, heavy and medium category soils have several inherent problems and deficiencies such as low level of availability of macro- and micronutrients; low microbial activity, problem of phosphorous fixation and so on.

The dominant physical limiting factors of the soils of Wardha district are its depth, texture, and high erodability. About 48.4 per cent of the total geographical area of the

[36] Instability in yield is measured as the average percentage deviation of actual value in each year around the three-year moving average value for that year.

district is covered by soils which have depth in the range of <10 to 50cm and are classified as extremely shallow to shallow soils. Soil depth is of significance to plant growth as it determines root development, available water holding capacity, and nutrient availability in the soils. The proliferation of roots is largely determined by soil depth. Soils with more than 100 cm depth are suitable for intensive agriculture. Only about 36.2 per cent of the TGA of the district has soils with more than 100 cm depth which are amenable for intensive cultivation.

Soil texture refers to the relative proportion of sand, silt, and clay in a soil mass. Soil texture determines the soil water condition and its availability to plants, availability and retention of plant nutrients, workability of soil, infiltration and drainage condition, and stability of the soil structure. Loamy textured soils especially the silty loams are the best suited for crop production. Silty loam soil is absent in Wardha district. Clay textural class covers 69.7 per cent of the TGA of the district. Clay soils have poor infiltration rate and poor workability. These are also soils which get easily flooded. About 28.7 per cent of the TGA is covered by soils which are sandy loam to clay loam. These are soils which have poor water holding and retentive capacity (*NBSSLUP 2005)*.

The low water holding capacity of the soils, results in substantial extent of run-off of rain water. The run-off water is estimated to be 355 mm (3,550 cubic metre of rain water/ hectare/annum) especially during the south–west monsoon. The run-off results in loss of fertile top soil, leading to serious problems of soil erosion. Around 91.7 per cent of the TGA of the district have an expected soil loss which is much higher than the permissible limit of 10 tonnes per hectare per year. Of this, around 16.5 per cent of the TGA of the district is affected by severe erosion with expected erosion levels of 15-20 tonnes per hectare per year; and about 75.2 per cent of the TGA is affected by moderate erosion with expected erosion levels of 10-15 tonnes per hectare per year. A soil loss estimation done based on the different erosion classes for Wardha district given by NBSSLUP shows that after accounting for the maximum permissible limit of soil loss of 10 tonnes per hectare per year, the extent of soil loss in the district due to erosion is in the order of 19.6 lakh tonnes per annum (MSSRF 2010).

2.1.3. Soil and water conservation efforts:

According to land capability classification[37] of Wardha district, 90 per cent of the land falls under Classes II to IV. Among the classes suitable for cultivation, class I land is the most fertile land and extremely suitable for growing a wide variety of crops (Kolay AK 1993). Wardha district does not have any land that can be classified as class I land[38]. About 50 percent of the cultivable land in the district falls under class II (Table 9). Although the available nutrients on Class II lands are poor, these are lands that can be regularly cultivated. But systematic efforts should be taken to maintain the productivity of the land by adopting special conservation practices like contour farming and other soil and water conservation measures. In the district, 18 per cent of the land falls in class III. These lands can be cultivated only by following intensive soil-conservation practices like terracing. Class III lands are those lands that are 'more severely affected by salinity and alkalinity and soil erosion than Class II lands. They have poor nutrient content and moisture-retention capacity'. Wardha district has 22 per cent of land under class IV. Class IV lands are advised to be brought under intensive cultivation only once in four years, and the remaining years it is to be left under grasses. The land capability classification and the soil characteristics described above clearly bring out the importance of soil and water conservation efforts in the district.

Table 9 Land Capability Classes – Wardha District

Land capability Class	Wardha District	
	Area	Percentage
Class I	nil	nil
Class II	229514	50
Class III	81768	18
Class IV	102344	22
Class V	nil	nil
Class VI	nil	nil
Class VII	48166	10
Class VIII	nil	nil
Total geographical area	461792	100

Source: *Based on data provided by Soil Test Lab, Wardha*

[37] Land capability classifications groups soils under different land capability classes, based on inherent soil characteristics as well as external land features and other environmental factors that determine the different uses to which the soils can be put (Kolay AK 1993). Land units that fall under a particular class of land capability classification would have similar relative degree of susceptibility to various factors that cause soil damage and decrease in productivity and similar potential for crop production. Land capability classification groups soils into VIII land capability classes. Soils suitable for cultivation are grouped under classes I to IV.

[38] Land capability classification for Wardha district given by the District soil test lab, Wardha.

Soil and water conservation activities are taken up under the comprehensive watershed programmes in the district since 1992. The watersheds of Wardha district falls in the Godavari basin. The total watershed area under the district is 4,09,105.12 hectares which accounts for 2/3rd of the geographical area of the district. There are about 40 watersheds in the district. Out of this 15 watersheds fall in the least priority category of watersheds[39]. While in a relative sense, the case of Wardha district is far better compared to most other districts of Maharashtra, given the extent of soil loss due to erosion in the districts and the inherent poor quality of the soils of the district, soil and water conservation efforts remain a priority area for agricultural productivity improvement in the district.

Watershed activities in the district are carried out by the both the Government and private agencies. The government watersheds are implemented by District Rural Development Agency, Department of Agriculture, and the Ground Water Surveys and Development Agency. Of the total watershed area in the district, only 34.14 per cent of the area has been targeted by the different agencies under watershed activities till 2011. And of the total area targeted by the different agencies only 45.92 per cent have been covered as of July 2010 (Table 10).

[39] Watershed priority categories classifies watersheds into high, moderate, low, and least priority watersheds based on the weighted index of geomorphology, land use/land cover, and soil erodability of the region. The highest weighted index is given to given to unit indicative of high run-off, while lowest weightage index is given to the unit indicative of low run-off. The anticipated highest index is 18 and the lowest index is 3. The cut-off point 9 was taken for deciding priority watersheds. Watersheds with weighted index more than 9 are classified as priority watersheds, and watersheds with weighted index less than 9 are taken as least priority watersheds. The prioritized watersheds were then again classified into 4 groups, in which watersheds with index more than 10 have been classified as high priority watersheds. The watersheds with index ranging between 10 to 9.5 have been classified as moderate and watersheds with index ranging between 9.5 to its cut off value (9.5 to 9) have been classified as low priority watersheds, while the watersheds with index less than cut-off value have been classified as least priority watersheds. *(http://waterconserve.maharashtra.gov.in)*

Table 10 Watershed Details of Ongoing Projects in Wardha district as on July 2010

Agency	**Duration**	**Taluks covered**	**Project Target Area (in hectares)**	**Area covered as of June 2010-07-26(in ha)**	**% covered as on July 2010**	**Remarks**
NABARD – Nabard Holistic Watershed Development Programme (NHWDP)	Phase – I 2003-2010	Wardha, Arvi, Karanja & Samudrapur	15768.23	13235	83.93	Lonsawali cluster is the only one completed so far out of the 4 clusters planned
NABARD - NHWDP	Phase-II	Arvi, Deoli, Hinghanghat, Samudrapur	14580.56	900.42	6.17	All clusters in capacity building phase. In this stage, 10-15% of the total targeted area under the watershed will only be covered.
Indo-German Watershed Development Project (IGWDP)	2007-2011	Arvi	1456.83	394	27.04	Ongoing
DRDA						
– Total Hariyali-II	2003-2011	Arvi, Ashti, Seloo, Karanja	22481.78	6365	28.31	Ongoing. Many of the projects under this had been sanctioned in the year 2007. These projects have developed their full project design but are in the intermediate phase of implementation
IWDP	2002-2011	Ashti	3004.53	3000	99.84	Project is completed
Vidarbha Watershed Development Mission (VWDM)	2005-2011	Arvi, Ashti	6200.07	4858.00	78.53	Project ongoing
Total DRDA			**31686.38**	**14214**	**44.85**	
Agricultural Department						
VWDM	2005-2011		35356.56	35356	100	Completed
MEGA Panlot (RIDF-XV)	2009-10	Arvi, Karanja, Seloo	17250			In planning stage
IWMP	2010-2011	Arvi Ashti Karanja	18275			In planning stage
Total Ag. Dept			**70881.56**	**35356**	**49.88**	
Geological Survey			**4797.12**			
Social Forestry			**394**			
Grand total under all watersheds			**139564.68**	**64099.42**	**45.92**	

***Source**: Data/information collated from the respective agencies*

2.1.4 Soil health:

Soil fertility index[40] has been developed for macro nutrients like nitrogen, phosphorous, and potash at the district level by the District Soil Testing Lab based on soil sample analysis done during the period 2000-01 to 2007-08. Based on the range of fertility index for each of the nutrients, the soils are classified into low (0-1.5), medium (1.5-2.5), and high (>2.5) categories for availability of each of the nutrients. Micronutrient status of the soils at the district and taluk level was also studied. A total of 19380 samples were analysed for the district as a whole and the soil fertility index developed for the district based on the sample is presented in Table 11.

Table 11. Soil Fertility Index – Wardha District (2000-01 to 2007-08) (No of samples under each category)

Soil nutrients	No. of samples analysed	V. Low	Low	Medium	Med-High	High	V. High	Soil Fertility Index (SFI)
Organic carbon content	19380	1344 (10)	8407 (46)	6250 (26)	1926 (8)	788 (5)	665 (5)	1.36
Available Phosphorous	19380	10450 (54)	8031 (41)	731 (4)	87 (0.5)	35 (0.2)	46 (0.3)	0.76
Available Potash	19380	741 (4)	1140 (6)	3600 (19)	3664 (19)	2948 (15)	7287 (37)	2.44

***Notes**: Figures in parenthesis is the percentage to total number of samples*
***Source**: Based on data received from District Soil Testing Lab, Wardha*

Organic carbon content is an indicator of available nitrogen in the soil. Out of the total 19380 samples analysed in the district 82 per cent of the soils have low organic carbon content and hence low available nitrogen and the remaining 18 per cent have medium high to very high range of organic carbon. The soil fertility index for all the three nutrients indicates medium level of availability of each of the nutrients.

The soils of Wardha district have very low level of available phosphorous. At the district level, 95 per cent of the samples reported very low to low available phosphorous. The soil fertility index for available phosphorous is also extremely low at 0.76 for Wardha district.

[40] Soil fertility index (SFI)is calculated by employing the following formula:
S.F.I = [{(No of samples under very low category x 0.5) + (No:of samples in low category x 1) +(No. of samples in medium category x 1.5) + (No. of samples in medium-high category x 2) +(No. of samples in high x 2.5) + (No. of samples in very high x 3) } / total number of samples] ; where 0.5 is weight given to very low category, 1, 1.5, 2, 2.5 and 3 are weights given to low, medium, medium-high, high, and very high categories

The available potash level is on the higher side in the district. At the district level, 93 per cent of the samples reported medium to very high level of available potash. The soil fertility index for available potash for the district is above 2, which indicates a medium level of availability of the nutrient in the soil.

Over the period 2000-01 to 2007-08, a total of 1965 samples were analysed for micronutrient status in Wardha District. The micronutrients tested for were copper, iron, manganese, and zinc. Of this, 1367 samples showed zinc deficiency, while none of the samples reported copper, iron, or manganese deficiency. This shows that zinc is the only micronutrient that is deficient in the district.

2.1.5. Soil Test Labs

The district has a total of 5 soil testing laboratories. Out of which one is the government soil testing lab, 1 is a cooperative and public undertaking lab, and the remaining 3 are in the private sector. The total analyzing capacity of the government sector soil testing lab is around 6500 samples. The cooperative and public undertaking lab has an annual analyzing capacity of 2500 samples. The 3 private labs put together have a total annual capacity of 4500 samples. Except for the 1 government sector lab in the district, none of the labs have Atomic Absorption Spectrometry (AAS) facility which is essential for analysis of micronutrients like zinc, manganese, iron and copper. The current annual capacity of all the existing labs, public and private put together for macro nutrient analysis in Wardha district is 13,500 samples. The maximum annual soil testing capacity for carrying out micronutrient analysis is 6500 for the district as whole.

It is recommended to draw 1 sample per 5 acre of land to arrive at the soil physical, chemical, and biological properties. Given that the total cultivable area of the district is 11,82,250 acres, the total number of samples to be drawn to arrive at soil fertility of the district is 2,36,450. Assuming that all the labs work to their full potential, it would require around 18 years to carry out soil testing for the district as a whole. But it is advised to take up soil testing on all the fields on an annual basis. Ensuring soil test to be done for the whole district annually, calls for augmenting the current annual capacity of 13500 samples in all the existing labs in the district by 18 times.

Assuming an annual capacity of 20,000 samples per year per lab, the district would require 12 soil testing labs to take up soil testing for the whole district on an annual basis.

2.1.6. Irrigation:

Agriculture in Wardha is essentially rainfed with *kharif* as the major crop growing season in the district. Though there has been an expansion of area under irrigation over the years, even by 2000-01, the gross irrigation ratio[41] for the district was 4.52 with 12 per cent of the total operational holding in the district with irrigation. The area irrigated by wells as well as surface sources fluctuates a great deal, as irrigation in Wardha District is closely related to the rainfall pattern. The predominant source of irrigation in the district is still ground water with 84 per cent of the total operational holding that is irrigated depending on wells as a source of irrigation even by 2001-02. The importance of surface irrigation has increased since mid-1990s. Of the four major irrigation projects that have been planned on Wardha river and its tributaries[42], only one, namely the one on Bor river has been completed. Till date, only one-fourth of the surface irrigation potential that was planned has been actually created. Of the 7 medium irrigation projects planned, only 3 have been completed as of July 2010. The remaining projects are expected to be completed earliest by 2011. Moreover, of the irrigation capacity created, only one-third is actually being utilised[43].

[41] Gross irrigation ratio is gross irrigated area as a percent of gross cultivated area.
[42] The tributaries are Wena, Pothra, Bor, Dham, Asoda, Bakli, and Kara and the major irrigation projects planned are on Wena, Wardha and Bor.
[43] Inference based on an analysis of the data supplied by the Wardha Irrigation Department on the status of the irrigation projects in the district.

2.1.7. Structural Changes in the Department of Agriculture & Implications for Field Level Advisory/Activity:

Before 1998, the Department of Agriculture had three major wings: Soil and water conservation, horticulture, and agricultural extension. Each one of these wings had a separate set of staff. Total sanctioned posts in the department of agriculture in the pre-1998 period, in the state of Maharashtra, was about 30,000. Of the total posts in the department of agriculture in the entire state of Maharashtra, 17,116 posts (52 percent) were exclusively in the department of soil and water conservation, 12,761 (39 percent) was in agricultural extension and the remaining 10 percent was in the horticulture department. Under this system, a substantial number of posts were created to carry on the work at the village level. Of the total sanctioned posts, the staff working at the village level, viz. agriculture supervisors and agriculture assistants, ranged in the order of 46 percent in the case of soil and water conservation and 57 percent in agricultural extension. In 1998, a single window system (SWS) was introduced in the department of agriculture, Maharashtra, whereby the three major wings of the agricultural department, namely, soil and water conservation, agricultural extension and horticulture, were merged. This meant that there was no exclusive staff available to carry out either soil and water conservation work or field level extension work (MSSRF 2010). In addition to this, no concerted efforts were being taken to fill up vacant posts in the department. As on March 2010, about 30 percent of staff positions remain vacant in the Office of the District Superintendent of Agriculture Officer, Wardha (Table 12). This structural change in the Department of Agriculture has had severe field level implication on the quantity and quality of work carried out by the department in the district.

Table 12 Wardha District Agriculture Office – Staff Strength (as of March 2010)

Position	Sanctioned	Filled	Vacant
Class I (superintendent, Assistant & Divisional officers)	5	1	4
Class II (taluk agricultural officers)	19	13	6
Class II c Mandal agricultural officers)	34	24	10
Class III (officers at District Office)	8	4	4
Class III[44] (Field/office staff –agricultural assistants & agricultural supervisors)	422	298	124
Total	**488**	**340**	**148**

Source: *Data collected from Department of Agriculture, Wardha district*

[44] Of the 422 class III officers, 235 are field level agricultural assistants and agricultural supervisors

2.1.7.a.Implication for Soil & Water Conservation Activity: A critical examination of the soil and water conservation activities in two time periods 1992-99 (pre-single window system) and 1999-2007 (post-single window system), marks the year 1998 as a watershed year for soil and water conservation activities in the district, with the range and magnitude of activities coming down drastically post-1998.

Considering a common set of activities[45] during the time periods, pre-SWS, and post-SWS, it was observed that the index of activity has drastically come down post-SWS for all the activities except for farm ponds that received particular attention in the special packages announced for Wardha (Table 13).

The reduced availability of manpower on the one hand combined with the restructuring of the agricultural department, which had implications for availability of staff exclusively for soil- and water-conservation activities, resulted in an absolute decline in the quantum of soil- and water-conservation activities in Wardha district.

[45] Graded bund, continuous contour trenching, loose boulder structure, earthen structure, cement nala bunding, clay nala bunding, underground bund, live filter strip, farm ponds, live check dam, and brush wood dam.

Table 13. Analysis of Watershed Activities, Wardha District

District	Period	Graded bund	CCT	Loose boulder structure	Earthen structure	Cement nala bunding	Clay nala bund	Under ground bund	Live filter strip	Farm ponds	Live check dam	Brush wood dam
		Ha	Ha	No.	No.	No.	No.	No.	Ha	No.	No.	No.
Watershed activities completed	1992–1999	24,165.30	654	14,529	1,004	394	465	641	4,238.83	226	749	9,934
	1999–2007	22,523.70	54	3,383	383	552	155	19	1691.17	1,715	338	68
Average activity/ year	1992–1999	3,452.19	93.43	2,075.57	143.43	56.29	66.43	91.57	605.55	32.29	107	1,419.14
	1999–2007	2,815.46	6.75	422.88	47.88	69	19.38	2.38	211.40	214.38	42.25	8.5
Index of Activity	1992–1999	100	100	100	100	100	100	100	100	100	100	100
	1999–2007	82	7	20	33	123	29	3	35	664	39	1

Note: *CCT refers to Contour continuous trench; Index of Activity for 1999–2007 is worked out keeping the activity in the base year 1992–99 as 100.*
Source*: March 2010*

2.1.7b. Implication for Agricultural Extension:

The agricultural extension system plays a crucial role in facilitating the various decisions farmers make during a crop cycle. The field level interactions in two villages[46] in Wardha district, as part of an earlier study on the district as well as the current study, have brought out a large number of instances which point to the near absence of public extension system in the district.

The reason given for the complete absence of extension activity is again the structural change in the Department post 1998 and the associated lack of manpower, overburdening of manpower, and changes in staff compensations. Doing away with the concept of contact farmer, who acted as a catalyst for change in the villages during the training & visit system of the green revolution period is also cited as a major constraint in the spread of knowledge and technology by the Department.

2.1.8. Agricultural Extension Reforms:

Wardha is one of the Agricultural Technology Management Agency (ATMA) districts[47]. And it's also one of the districts chosen to pilot "*The Extension Reforms Scheme- Support to State Extension Programs for Extension Reforms*" introduced by the GoI during the X Plan period under the broad preview of the Policy Framework for Agriculture Extension (PFAE). This scheme came into effect in the year 2005. Under this scheme, ATMA was mandated to develop a demand driven, situation specific, multi-actor oriented Strategic Research and Extension Plan (SREP) to accelerate agricultural development in the project districts. The SREP was to serve as the basic document, which not only guided the development activities that need to be carried out, but also spelled out the manner in which it was to be done, and also identified the officials/departments mandated to implement the different development activities. The effectiveness of SREP as a methodology in establishing effective Research –Extension-Farmer linkages is recognized and acknowledged across the

[46] The villages are Lonsawali in Wardha Taluk and Kosurla in Hinghanghat Taluk

[47] ATMA is a registered society of key stake holders responsible for technology dissemination and agricultural activities for sustainable agricultural development at the district level. It is a focal point for integrating Research and Extension activities and decentralising day to day management of the public Agricultural Technology System (ATS). The ATMA at district level would be highly responsible for all the technology dissemination activities at the district level. It would have linkage with all the line departments, research organizations, non-governmental organizations and agencies associated with agricultural development in the district.

ATMA districts in the country[48]. The ATMA agency in Wardha district is yet to prepare the SREP which is very essential for carrying forward the extension reforms programme in the district.

[48] The assessment study conducted by the National Academy of Agricultural Research Management (NAARM), Hyderabad in 2004, highlighted the significance and effectiveness of the SREP methodology for establishing Research-Extension-Farmer linkages. The findings inferred that:

- A majority of the stakeholders perceived SREP as a useful methodology for addressing research and extension issues based on farmers' needs.
- SREP should be commissioned in all the targeted districts simultaneously
- The SREP guidelines should be revised to comprehensively cover planning, operationalisation, implementation, monitoring and evaluation of SREP initiatives.

2.2. Action Plan for Sustainable Agricultural Development in Wardha District:

The action plan details major issues in the sphere of agriculture and suggests remedial measures. Further identification of agencies capable of implementing the remedial measures is also attempted. The schemes listed and the agencies identified are on the basis of extensive exploration of the respective department websites. To the extent possible, physical quantification of the individual remedial measures have been attempted.

Item	Issue	Remedial Measures	Action Plan	Agency Concerned
Land use, cropping pattern and crop production	• Decline in net sown area • Increase in fallow land acreage • Reduction in the area under food grains in the cropping system • Increase of cash crop acreage in cropping system • High level of instability in yield of the major crops in the district (cotton, soybean, jowar, redgram)	• The current cropping system in the district is in favour of cash crops. The very high instability in yield of these crops adds to the vulnerability of the cash crop based cropping system. A more diversified cropping pattern with equal emphasis given on both food and non-food crops would make the cropping system more balanced and sustainable[49]. • The district should tap into the provisions available in National Food Security Mission (NFSM) and the Accelerated pulses programme to promote pulses under these schemes, and into the National Horticulture Mission to promote fruits and flowers.	• Diversification of cropping pattern with a balanced and sustainable combination of food and non-food crops • Source into the different central and state government schemes available for cropping pattern diversification	• State Agricultural University and Regional Research Stations (to design cropping systems suitable to the agro-climate of the region) • Department of Agriculture (for extension activity, training and demonstration on different cropping systems.

[49] Some of the alternative cropping systems developed by CRIDA for Wardha district like Cotton (AKH 84635) with greengram (Kopergaon) as an intercrop in 1:1 row ratio; and sorghum (CSH-13) with intercrop of greengram/ blackgram in 1:1 row ratio need to be promoted. In deep soils sorghum (CSH-9/CSH-13) intercropped with pigeonpea (C-11) in 6:2 row ratio is recommended. In case of delayed monsoons, it is advisable to reduce area under cotton and replace it with sorghum (CRIDA 2002)

Item	Issue	Remedial Measures	Action Plan	Agency Concerned
Land use, cropping pattern and crop production	• Low coverage of the different schemes available for crop diversification in the district[50]	• The district is identified as a pulse district under NFSM in Maharashtra. The district administration should use this opportunity to promote large number of seed villages for pulses in Wardha district. This will improve the seed replacement rate of pulses[51] and bring more and more area under good quality pulses seeds and thus help improve their productivity • Expansion of the NHM coverage in the district. NHM crop cluster in the district consists of mango, mandarin orange, kagzi lime, custard apple, guava, spices, medicinal and aromatic plants, and flowers. Dry land horticultural crops could also be promoted on fallow lands in the district under NHM in the district	• Promote pulse seed villages • Expansion of the area under NHM in the district	• KVK (extension activity, and training and demonstration on different cropping systems) • NGO working in the field of sustainable agriculture (extension activity- training and demonstration on suitable cropping systems) • DoA to ensure effective implementation of the schemes like NFSM, NHM, accelerated pulses programme, and other crop specific programmes)

[50] Up till June 2010, 1228.75 ha of fruits and 120.10 ha of flowers have been promoted under NHM in the District. This accounts for less than 1 per cent of the total cultivable area of the district. The district has a total fallow land of 85,033 hectares, which is about 13.5 per cent of the total geographical area of the district. This indicates the further scope in expanding the area under NHM in the district.

[51] The current seed replacement rate of red gram the major pulse in the district is 45 per cent.

Item	Issue	Remedial Measures	Action Plan	Agency Concerned
Rainfall & soil properties	• Declining trend in the total annual rainfall • Decline in the number of rainy days • Poor texture of the soil, • Low water holding capacity and the resultant heavy surface water run-off • Associated problems of soil erosion • Low cation exchange capacity – which has an impact on the ability of the soil to respond to fertiliser application • Soil alkalinity – about 40.22 per cent of the total geographical area is affected by medium to high alkalinity problems	• Soil and water conservation measures with a ridge to valley approach • Promotion of conservation tillage- any tillage system in which at least 30% of the soil surface is covered by residue after planting; strip cropping- the planting of alternating strips of crops of different heights or seasonal maturities across a landscape; and **contour farming-** the production of crops across instead of with slopes to reduce the erosion forces of wind and water. • Addition of biomass (farm yard manure, other compost, green manure etc) to the soil to improve the organic matter content which will help in: o improving the texture of the soil o improve cation exchange capacity and hence the nutrient response of the soil o Improve water holding capacity of the soil	• Ridge to valley approach in watersheds to be strictly adhered to • Participatory planning of watershed treatments • Adoption of steps to reduce erosion losses • Biomass addition to improve soil texture and	• Department of Agriculture, DRDA, NABARD & NGOs (involved in implementation of watersheds (to create awareness, to take up participatory planning of watershed treatments to ensure community willingness to adopt the suggested conservation treatments and to ensure their participation; promote green manure crops as part of the watersheds)

Item	Issue	*Remedial Measures*	Action Plan	Agency Concerned
Rainfall and soil properties		• **It is recommended to apply on an average 7.5 tons of farm yard manure (FYM)/hectare per annum**, the total requirement of FYM for the total cultivable area of 472900 hectares would be roughly 35.47 lakh tons/annum • Promote **application of bio fertilizers** for augmenting the availability of the nutrients in the soil • **Apply bio fertilisers at the rate of 1 kg/acre/crop season**. Even assuming that the total cultivable area of the district (4.72 lakh hectares) would be brought under cultivation both the seasons-(*kharif & rabi*), the total amount of bio fertilisers required would be 11.82 lakh kgs, that is 1182 tons of bio fertiliser per annum approximately • Promote bio fertiliser production as a group enterprises under the Swarnajayanthi Grameen Swarozgar Yojana (SGSY) implemented through the DRDA. • Promote biofertiliser units as an enterprise among the SHGS promoted by the different agencies in the district	• Bio fertiliser application • Promote bio fertiliser units as group enterprises	• Department of Agriculture, KVK, and NGOs working in the field of sustainable agriculture (to create awareness about and to train on the different soil erosion control techniques) • Department of Agriculture, KVK, and NGOs working in the field of sustainable agriculture (to create awareness about the need of adding biomass and give training and demonstration on the different methods of composting) • Department of Animal Husbandry (Schemes of supply of indigenous breed milch animals in subsidy, and scheme of feed subsidy to milch animals • Regional Biofertiliser Development Centre, Nagpur – **(**to supply strains of microbes for bio fertiliser production, and to help in quality control of bio-fertilisers) • District Rural Development Agency (DRDA) (to promote bio-fertiliser units under SGSY scheme)

Item	Issue	Remedial Measures	Action Plan	Agencies Concerned
Soil & water conservation efforts and land improvement	• The absence of best quality class-I land in the district • The need for conservation measures to maintain the other land classes. • The need for ameliorative measures to address soil alkalinity on 2.54 lakh hectares of land. • The reduction in the total quantum of the soil and water conservation works in the district • The lack of soil and water conservation measures in the upper and middle reaches of the watershed • Lack of enough skilled staff to carry out soil and water conservation efforts in the district	• Concerted efforts should be taken towards land improvement so as to make them amenable for intensive cultivation. On class-III lands, land development programmes like terracing, manuring, mulching, and biomass recycling to increase the organic matter content of the soil should be taken up. This will help enhance the water holding capacity of the soils and also improve the nutrient supplying capacity of the soil by improving the soil cation exchange capacity • Scope of taking up land development programmes under the MREGS[52] scheme wherever feasible should be worked out	• Land development programmes like terracing, manuring, mulching, and biomass recycling to be carried out on class III lands • Land development programme to be taken up under MREGS	• Agencies involved in watershed implementation in the district (Dept of Agrl, DRDA, KVK, NABARD, NGOs) • Zilla parishad to take up land improvement and soil and water conservation treatments under NREGS • Department of agriculture, KVK, NGOS – (training and demonstration on alkalinity treatments) • Department of agriculture to supply gypsum at subsidised rate to regions facing problems of alkalinity within the district

[52] Mahatma Gandhi Rural Employment Guarantee Scheme

Item	Issue	Remedial Measures.	Action Plan	Agency Concerned
Soil & water conservation efforts and land improvement	•	• Land rehabilitation by promoting native vegetation should also be done. This will help reduce soil erosion. Planting of avenue trees/shade trees like acacia, pongamia, gulmohar etc should be undertaken under the MREG scheme. Dryland horticultural plants like mango, mandarin orange, anola, custard apple etc should be promoted under the National Horticultural Mission. Currently less than 1 per cent of the total cultivable area has been covered under fruit crops under the National Horticulture Mission in Wardha district, and there is huge scope for bringing more area under fruit crops in the District • In areas where soil is calcareous and have alkalinity problems (about 40.2 percent of the total geographical area of the district), land reclamation efforts like improving drainage, leaching with with excess water and salt below root zone, and application of gypsum should be taken up[53].	• Promotion of avenue plantation • Promotion of dry land horticulture • To reclaim alkaline affected soils: o Leaching o Gypsum application as ameliorative to be taken up	• Zilla Parishad Wardha district which is implementing the MREGS in the district to take up avenue plantation as an activity under MREGS • Department of Agriculture to promote dry land horticulture under NHM • Department of Agriculture to supply gypsum at subsidy rate

[53] The alkaline affected soils of Wardha have pH in the range of 8.3 to 8.6. The recommended dosage of gypsum for soils for pH range 8 to 9 is 1 ton/acre (TNAU 1999). This need to be applied in one single dose before sowing. The total alkaline affected area of the district is about 627437 acres (NBSSLIUP 2005). The total gypsum requirement for the alkaline affected area of the district would be 627.44 tons of gypsum/annum

Item	Issue	Remedial Measures	Action Plan	Agency Concerned
Soil health & soil test labs	• Low range of organic carbon content in the soils of Wardha and the consequent low level of available nitrogen levels in the district • Low level of available phosphorous • Low level of zinc among the micronutrients • Low capacity of the existing soil test labs to carry out full scale soil tests (macro+micro nutrient and microbial load) in the district • Lack of atomic absorption spectrometry facility, a requirement to carry out micronutrient analysis of the soil in all the soil testing labs of the district. • The less than potential utilisation of the facility by the existing soil testing labs in the district	• Application of biomass and promotion of use of bio fertilizers as discussed in the section on soil property improvement To tackle specific nutrient problems the following specific measures to be followed: • Improvement in the available nitrogen status could be effected through improvement of the organic carbon status of the soil through application of farm yard manure, compost and other biomass addition. The other ways of improving the nitrogen status of the soil is through application of nitrogen fixing biofertilsers and introducing more legumes in the cropping system. • Application of phosphorous solublizing bacteria and application of lime will help improve the available phosphorous status of the soils of the district. • Application of zinc sulphate and supply of the same through subsidized rate through the Department of agriculture is important to take care of the zinc deficiency in the soils of Wardha district	• Biomass application • Bio-fertiliser application • Micronutrient application • Following integrated nutrient method	• Department of Animal Husbandry (Schemes of supply of indigenous breed milch animals in subsidy, and scheme of feed subsidy to milch animals) • Regional Biofertiliser Development Centre, Nagpur – (to supply strains of microbes for bio fertiliser production, and to help in quality control of bio-fertilisers) • District Rural Development Agency (DRDA) (to promote bio-fertiliser units under Swarna Jayanthi Grameen Swarozgar Yojana)

Item	Issues	Remedial Measures	Action Plan	Agency Concerned
Soil health & soil test labs		• Provision of soil health card for soil health management: • Soil variability within the village and across the villages is very high in Wardha district. Knowledge on the health of the soil in individual fields is extremely crucial for farmers to apply appropriate quantity of organic and chemical fertilisers. In this context, it is very important that every farmer is provided a **soil health card** specific to his land in order to facilitate balanced nutrient application to the soil To sensitise and facilitate soil testing and to improve the soil test infrastructure in the district • Create more awareness about the need for conducting soil tests among farmers • Create a provision to collect the farmers' soil samples at least at the Taluk level and then transport it to the soil testing lab at Wardha. The samples could be collected at the Taluk Agricultural Office	• Provide soil health card • Awareness creation on the need for soil test • Provision of soil test sample collection at the Taluk level	• Department of Agriculture (awareness about soil test, soil health card) • • NGOs working in the field of sustainable agriculture (awareness about soil test, soil health card) • KVKs (awareness about soil test, soil health card) • Soil test labs – public/co-operative/private (soil tests & soil health cards) • Department of Agriculture (make provision for collecting soil test samples at the taluk agricultural office)

Item	Issue	Remedial Measures	Action Plan	Agency Concerned
Soil health & soil test labs		• Allot at least one mobile soil testing lab to the district • Increase the capacity of the government sector labs and upgrade the existing soil testing laboratories. It is estimated that the district would require 12 soil testing labs, with a capacity of 20,000 samples annually to enable soil testing for the entire district. There are 8 taluks in the district and each taluk should necessarily have at least one soil testing labs while bigger taluk should have more than one lab such that the district as a whole has 12 labs • Encourage the cooperative labs and private labs to work to their full potential. Currently, the private and cooperative labs utilise less than half of their potential capacity. • Establish atomic absorption spectrophotometer facility in the cooperative labs for micronutrient analysis. • Regulate the amount to be paid for soil sample analysis by the private labs	• Augment the annual capacity of the district soil test lab • Increase the number of soil testing labs to 12 in the district • Enable all labs to have atomic absorption spectrophotometer for micronutrient analysis • Equip labs to take up soil microbial load analysis • Regulate soil test charges of private labs	• Government of Maharashtra

Item	Issue	Remedial Measures	Action Plan	Agency Concerned
Irrigation	• Low level of irrigation. The net irrigated area as a percentage of net sown area is only 7.05 as of 2001-02 • Incompletion of the planned irrigation projects in the district • Overdependence on ground water as a source of irrigation	• Ongoing surface irrigation projects should be completed on a mission mode. Should explore the scope of using the Rural Infrastructure Development fund and NABARD funds, in addition to the allocation given to the district for Irrigation Department to speed up the completing of the ongoing projects. • The fact that 85 % of the operational holdings that are irrigated still depend on ground water as a source of irrigation highlights the importance of ground water to the agricultural economy of the Wardha district. Efforts should be taken to augment and conserve the ground water resources in the district. Sustainable ground water planning should be made an integral part of any watershed programme. • The watershed programmes of the district should plan for more ground water recharge through dug-well recharge, tank-recharge and strengthening of water harvesting cum recharge structures like check dams and farm ponds in the watershed programmes. The location of ground water recharge structures like check dams should be planned by taking into account the ground water catchment contours and variations in hydrogeology of the district. This will help improve the effectiveness of these recharge structures, thus ensuring sustainability of the ground water resources	• Completion of ongoing surface irrigation projects • Have ground water recharge structures like check dams and farm ponds as part of watershed programmes	• The different central and state government major, medium, and minor irrigation departments in the district of Wardha. • Agencies responsible for watershed implementation in the district to take up ground water recharge structures

Item	Issue	Remedial Measure	Action Plan	Agency Concerned
Structural Changes in the Department of Agriculture & Implications for Field Level Advisory/Activity:	• Doing away with the system of allocating dedicated skilled field staff in the different sections namely, soil and water conservation and extension • Large number of vacant posts in the district due to stoppage of fresh recruitments in the department • The resultant reduction in quantity and quality of work carried out at the field level by the Department of Agriculture • Lack of manpower to carry out extension work • The overburdening of the field level staff due to shift to single window system • Doing away with the concept of contact farmer • The resultant poor level of extension work in terms of quantity and quality	• The agricultural extension system in the district has to be strengthened. An extension system that is much more dynamic and mobile is urgently needed. Allocation of separate staff at the field level for general agricultural extension activities and soil and water conservation activities should be reintroduced[54]. • The extension machinery should play a more proactive role in tapping technologies on shelf for increasing productivity, profitability, and sustainability of the farming system of Wardha district. Given that the State Agricultural University does not have a mandate to be directly engaged in farmer extension activities, it is necessary that concerted efforts are taken to transfer the relevant knowledge developed in these institutions to farmers. This entails a stronger and more effective research-extension linkage.	Allocation of separate staff at field level for agricultural extension and soil & water conservation • Have a more effective extension-research linkage	Government of Maharashtra (to make policy level changes to revamp and restructure the Department of Agriculture) • To restructure the Department of Agriculture in lieu with the pre-single window system, • To increase the total number of sanctioned post in the Department of Agriculture in the districts of Maharashtra • To allot exclusive staff for extension and soil and water conservation works • To increase the permanent travel allowance

[54] According to Census 2001, the total number of inhabited villages in the district is 1004. Assuming an average of 250 farm families per village, the total number of farm families in the district works out to be 2, 51,000. Assuming a ratio of 1000 farm families per agricultural assistant, the district would require about 251 field level agricultural assistants to carry out agricultural extension work effectively. An equal number of staff (251) for exclusive field level soil and water conservation works should also be recruited. This takes the total field level staff requirement for extension and soil and water conservation to be 502. This requires the current sanctioned field level agricultural assistants/supervisors strength of 235 (as of March 2010) to be doubled.

Item	Issue	Remedial Measures	Action Plan	Agency Concerned
Extension reforms	Absence of the Strategic Research and Extension Plan (SREP), which is very essential for establishing strong and effective research-extension-farmer linkage in the district and also for effective panning of extension activities in the district.	ATMA to play a more proactive role in the extension activity in the district. ATMA to prepare SREP. The development and use of SREP would help in the following aspects: • *Get an overview of the prevailing scenario in the district* • *Explore and understand the problems and opportunities in different farming systems, preference and priorities of the farming community* • *Facilitate long-term visioning and strategic planning for agricultural development in the district in a concerted manner* • *Facilitate involvement of all actors at different levels in the development process and, in the long run, share the load on the public extension system* • *Facilitate integration of and redesigning the on-going developmental programmes for the benefit of the farmers* • *Development of annual action plans for each block in respect of the prevailing Agro-Ecological Situation* • *Develop farmer centered market oriented extension research management system*	Prepare Strategic Research & Extension Plan (SREP) for the district	ATMA to evolve SREP for the district

Section 3

Conclusion

The factors that act as an impediment to agricultural growth in Wardha district are manifold. The rainfed nature of its agriculture, the erractic nature of monsoon, the poor quality of its soils, the lack of concerted efforts in soil and water conservation, and the poor level and quality of agricultural extension practiced in the district are to mention a few of them. A detailed study of one of the *panchayat's* of the district was also attempted. The study on the *panchayat* reveals the poor soil quality, ineffective agricultural extension system, and lack of irrigation as some of the factors inhibiting agricultural growth in the *panchayat*. The current study details the issues underlying the nature of each of these factors and suggests measures to overcome these issues Attempt has been made to quantify the suggestions in terms of an action plan. Action plans have been drawn at two different levels- at the district level and at the *panchayat* level. The action plan not only gives the remedial measures but also identifies the agency which can take up the measures suggested, and lists out some of the relevant schemes under which this can be taken up. For this purpose, the action plan sources into the current and ongoing schemes for agricultural and rural development in the district.

The Action plan can be used to seek funding under the Rashtriya Krishi Vikas Yojana (RKVY), through the Government of Maharashtra. RKVY is an additional Central Assistance scheme that provides incentives to states to increase public investment in agriculture and allied sectors. The State government can also source into funds allotted for rural development by Ministry of Rural Development, the Mahatma Gandhi Rural Employment Guarantee Schemes, Bharath Nirman Programme, & other related and relevant schemes of the Department of Agriculture, and also the *Panchayat* Raj Funds for implementing the measures suggested for achieving sustainable agricultural progress and agrarian prosperity. The action plan stresses on greater convergence of the different schemes implemented by different departments and also on intensification of the outreach of the current programmes/schemes for overall agricultural development in the district.

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Annexures

Annexure 1: List of People Interacted With

District Collector Office:
Mr. Rajesh Khawali – Deputy Collector
Mr. Vinay S. Moon – District Revenue Officer

Department of Agriculture, Wardha District
Mr. Arjun Sopan Tandale - District Superintendent of Agriculture
Dr. Amrudhkar - District Project Coordinator
Mr. Prakash Kadu – Tracer

District Soil Testing Lab, Wardha District
Mr. Phating - District Soil Survey and Soil Testing Officer
Mr. **S**.P.Tumsare – Krishi Pariveshak
Mr. Alwadkar – Supervisor

Zilla Parishad Minor Irrigation Division, Wardha District
Mr. Kadse - Executive Engineer
Mr. R.B. Bangle - Sectional Engineer - Wardha Subdivision
Mr. A.R. Katale - Sectional Engineer – Wardha (?) Sub Division

PWD Minor Irrigation Department
Mr. Vijay Bopate – Sectional Engineer

District Rural Development Agency, Wardha District
Mr. Manohar – Project Director, DRDA
Ms. Sangeetha Bhorkar -
Mr. Charde – Technical Assistant

Forest Department
Mr. L.V.Swami – Assistant Conservator of Forest
Mr. Sham Dhamande – PA to District Conservator of Forests

District Statistical Office
District Statistical Officer

District Land Survey and Land Records Department, Wardha District
Mr. P.S. Bujade - Officer

Wardha Taluk Office , Wardha District
Mr. H.M. Lokhande – Tehsildar

Wardha Taluk Agricultural Office
Mr. Bhaskar Mughe – Agricultural Assitant, Lonsawali *Panchayat*
Mr. Sunil Javdekar – Agricultural Assistant

Vividha Office
Mr. Vaibhave Chople – Technical Assistant

Microplex Private Limited – Bio-fertiliser Company
Mr. Sunil - Microbiologist
Ms. Meenakshi – Microbiologist
Ms. Priya Gadse – Microbiologist
Ms. Deepali – Microbiologist
Ms. Sarika – Microbiologist
Mr. Surendra Raut – Sales Manager

NGO's

WOTR
Mr. Ranjith Yadav – Manager

Mr. Raju - Jan Seva Grameen Vikas Prathistan
Project Director – NHWDP Lonsawali Cluster

Lonsawali Village *Panchayat*
Mr. Gavande – Village Administrative Officer (Gram Sevak)
Mr.Rajendra Bagar – Village Revenue Officer (Patwari)
Mrs.Kalpana Nidhin Gadge – *Panchayat* President (Sarpanch)
Pradhnyavanth Wagmare - Village Watershed Committee Membern cum Supervisor

PRA and Focus Group Discussion with farmers in Lonsawali *Panchayat*
Venue: Krishna Mandir, Lonsawali
Participating Members:
Mr. Diwakar Jadav
Mr. Purushothamrao Aurgude
Mr. Damodar Dandare
Mr. Shenkar Goha
Mr. Shandaramji Bhalerao
Mr. Diwakar Attram
Mr. Vittalrao Jadhav
Mr. Ramraoji Aurgude
Mr. Murlidhar Gode
Mr. Sukhudev Kodape
Mr. Ganbaji Imarathi
Mr. Shridhar Dhandare
Mr. Pradhyanath Wagmare
Mr. Vijay Wagmare
Ms. Vanitha Gude
Ms. Shalini Khakar
Ms. Smitha Patil
Mr. Anthakal Omkar

Annexure 2: Budget - Bio-fertiliser Unit

Budget for the Biofertilizer unit (With the capacity to produce 5 t per annum of each *Azosprillum,, Phosphobactor and Rhizobium)*

Details	**Cost (Rs)**
Pressure Cooker	5,000
Poly bag sealer	500
Weighing balance	3,500
Gas connection	5000
Autoclave	30,000
Low cost laminar flow and racks	35,000
Bottles (250 ml) and plastic wares	1500
Beakers and glass wares 1. Petri plates 2. Beakers (250ml, 500ml- each two, plastic) 3. Measuring cylinder (one litre) 4. Test tubes, stand and Sprit lamp 5. Pipette (1ml, 5 ml, 10ml – one each)	8000
Chemicals	7000
Registers	500
Transport	1500
Vermicompost	3000
Operational expenses including labour and building cost for an year	50,000
Total Cost	1,50,500

Annexure 3: Budget – Village Level Mini-Agromet Observatory

I. Instruments costs

Sl. No.	Instruments	No.	Amount
1.	Stevenson screen	1	15750
2.	Anemometer Cup counter	1	6450
3.	Non recording rain gauge with Borosil measuring cylinder	1	3750
4.	Dry bulb thermometer	2	2650
5.	Wet bulb thermometer	2	2650
6.	Maximum thermometer	2	2900
7.	Minimum thermometer	2	2900
8.	Grass minimum thermometer	1	695
9.	Transport cost		5000
	Total cost of the instruments		**42745**

II. Installation material costs

Sl. No.	Materials	No.	Amount
1.	Bricks	1200 nos	3600
2.	Cement	20 bags	5000
3.	Gravel	15 bags	1000
4.	Sand	15 bags	1000
5.	Fencing post 6 feet ht		500
6.	10.5 feet pole of GI pipe of two inches (Hollow) with reducer coupling		1000
7.	Running meter length of 22.5 with one-meter width of wire-mesh (single eye)		4500
8.	26 nos. of poles (1½ inches GI Pipe) with 6 feet height		8000
9.	Board		1400
	Total Installation material costs		**26000**

III. Installation – consultancy charges

Sl. No.	Consultancy	No.	Amount
1.	IMD certified expert for installation	2 days	5000
2.	Training on management	2 day	5000
	Total consultancy charges		**10000**

Total cost = 78,745

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