June 2015

2030 Water Resources Group

MAHARASHTRA:

HYDRO-ECONOMICAL ANALYSIS OF OPPORTUNITIES TO IMPROVE WATER USE IN AGRICULTURE SECTOR

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Report on Preliminary Hydro-Economical Analysis of Opportunities to Improve Water Use in Maharashtra's Agriculture Sector

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Contents

ACRONYMS

BAU	Business as Usual
BCI	Better Cotton Initiative
BCM	Billion Cubic Meter
CAGR	Compound Annual Growth Rate
CCA	Command Control Areas
CSR	Corporate Social Responsibility
GDP	Gross Domestic Product
GIS	Geographical Information Systems
GSDA	Groundwater Surveys and Development Agency
GSDP	Gross State Domestic Product
Ha	Hectare
HUF	Hindustan Unilever Foundation
HUL	Hindustan Unilever Limited
INR	Indian Rupees
IWMI	International Water Management Institute
MIS	Micro Irrigation Systems
MWRRA	Maharashtra Water Resources Regulatory Authority
NABARD	National Bank for Agriculture and Rural Development
NGO	Non-government Organization
PPCP	Public Private Community Partnership
PPP	Public Private Partnerships
PPP – IAD	Public Private Partnership for Integrated Agriculture Development
SAGP	Sustainable Agriculture Guiding Principles
UPNRM	Umbrella Programme for Natural Resource Management
USD	United States Dollar
VIIDP	Vidarbha Intensive Irrigation Development Program
WEF	World Economic Forum
WRD	Water Resources Department
WRG	Water Resources Group
WUE	Water Use Efficiency
WWF	World Wide Fund for Nature

Executive Summary

Introduction

Maharashtra is an important State for India's economy with strong industrial and services sectors. Even though agriculture sector's contribution to Maharashtra's economic performance is only 11%, agriculture growth is critical for Maharashtra to improve lives of its population as about 50% of the State's population depends on agriculture sector, either directly or indirectly, for livelihoods. The agriculture sector in Maharashtra has grown at 6% over the last few years, however, it is highly variable and is heavily dependent on the erratic rainfall during any particular year. This situation reflects the need for the State to not only focus on higher GSDP growth in agriculture sector but also the need to control variability of the growth through better management of its water resources.

Maharashtra's historical agriculture growth has been supported by expansion in area under agriculture, higher productivity and change in cropping pattern. Water has been an important enabler in increasing the agriculture output of Maharashtra. One of the key trends contributing to historical agriculture growth is the shift away from low water consuming cereals and pulses to high water consuming and high value crops such as Sugarcane and Cotton. Each crop presents a different trade-off in terms of three key factors – land utilization, water utilization and value of output produced. It is important for policy makers to understand these trade-offs in their efforts to promote sustainable agriculture growth with available water in the State.

It is also equally important to recognize that the State's agriculture output is supported by more water than is generally considered. Most statistics related to water consumption in agriculture tend to focus on consumption of water from surface water or ground water which is explicitly made available to the farms by diverting them through either irrigation systems or through groundwater abstraction structures such as wells and bore-wells (Blue Water). However, water use in agriculture sector also comes from a third source which soil moisture created through rainfall (Green Water). The report presents an initial water balance for Maharashtra which captures these dynamics. The water balance shows that there are significant limitations to further irrigation development from the perspective of overall water resource availability. About 50% of the State's population will continue to be outside of CCA and hence long lasting solutions need to be developed to support rainfed agriculture even as the State invests heavily on development of irrigation systems.

Pillars for Agriculture Growth in Maharashtra going forward

There are three pillars supporting agriculture growth output (in physical quantity terms) in any State or Country. These are a) Shift to higher value crops b) Growth in productivity and c) Expansion of gross area under agriculture. By 2019-20, shifting to higher value crops could contribute about 35% of the agriculture growth but it would take 50% of the additional water required. On the other hand growth in agriculture productivity could boost growth by about 50% with less than 10% of water. Area expansion is the most water intensive growth strategy with contribution to growth of about 15% with 40% additional water requirements. Overall Maharashtra can achieve 6% annual growth in agriculture sector. However, this would require increase of total water consumption in agriculture sector by about 8% till 2020. The State is making substantial investments in developing irrigation facilities and utilizing its water resources. Irrespective of that, the State can achieve 4% GSDP growth in agriculture sector overall and more than 6% growth in rainfed areas if it focusses on improving productivity of its key crops and strengthening the trend of shifting to higher value crops.

Challenges and development priorities for enabling agriculture growth

Agriculture in Maharashtra is practiced through smallholder farmers. The landholdings are increasingly getting fragmented due to rapid increase in population. The following diagram presents key challenges, resultant development priorities and key recommendations for promoting rainfed agriculture growth in Maharashtra:

Challenges	Priorities	Recommendations
Poor Water Management and Soil Erosion ❑ High variability of Output due to very high dependence on rainfall ❑ Soil erosion	**Watershed Development** ❑ Developing local sources for supplementary irrigation through Watershed Development which will also arrest soil erosion	**Watershed Development** ❑ Review financial norms for investment ❑ Consider more focus on on-field works in place of drainage line treatment works ❑ Assess ways to gain a fuller understanding of local water balance and its relation to overall water balance of the sub-basin ❑ Consider increasing the capacity of the watershed program implementing agencies
Poor water-use efficiency ❑ Lack of modern technology for water delivery systems	**Water-use Efficiency** ❑ Aggressively promote Micro-irrigation in Rainfed areas	**Water-use Efficiency** ❑ Rapidly expand coverage under Micro-irrigation ❑ Develop smart subsidies to increase leverage of public investments
Outdated farming practices ❑ Sub-optimal rainwater management practices ❑ Lack of Availability of Quality Inputs (Seeds, Fertilizers and Pesticides ❑ **Inadequate access to Market** ❑ Need for Storage and processing facilities ❑ Need for assured market ❑ Collective bargaining for smallholders	**Increase productivity of Agriculture through scientific planning** ❑ Agriculture extension to promote measures to increase productivity ❑ Promote Practices for rainwater harvesting and management to achieve higher water-use efficiency **Access to Market** ❑ Facilitate market linkages ❑ Invest in storage and processing facilities ❑ Promote formation of agriculture collectives	**Increase productivity of Agriculture through scientific planning and Access to Markets** ❑ Use ongoing PPP – IAD program as a vehicle for promoting rainwater management and water use efficiency practices
Lack of convergence of efforts ❑ Insufficient co-ordination of efforts within the Agriculture Department ❑ Need for convergence of initiatives with Department of Water Resources	**Convergence** ❑ Create a few crop specific clusters where all efforts converge with Watershed as a starting point ❑ Develop integrated river basin plans for holistic economic development based on water availability	**Convergence** ❑ Develop a Watershed ++ model for select crop value chains ❑ Develop Integrated River Basin Development Plans ❑ Create a Multi-stakeholder Platform

As shown in the diagram, there are a range of challenges with associated development priorities. Many of these challenges are well understood by the State government and programs are underway to address them with significant outlays. The report outlines some recommendations to strengthen the existing programs and schemes. In addition, the report identifies two areas where convergence amongst various activities and actors could significantly enhance outcomes. One intervention is development of a Watershed ++ model which can channelize resources and efforts of programs related to watershed development, water use efficiency improvement, practices related to rainwater management and agriculture efficiency and linkage to market in one watershed for a specific crop value chain. It is suggested that such an intervention is developed in a long term partnership with private sector organizations. The report identifies various types of companies and a business case for partnering with the government in the Watershed ++ model.

The report also argues for a need to integrate efforts with the Water Resource Department and other key stakeholders which use water such as cities and industries. An integrated river basin development plan which promotes holistic economic development of both rainfed and irrigated areas in the basin or sub-basin considering total available resources (water and others) would be an important initiative in this regard. It is also suggested that a multi-stakeholder platform is created as an instrument for convergence between public sector, private sector and civil society to guide development of above mentioned watershed ++ model as well as the overall water sector transformation in the State.

1 Background

The 2030 Water Resources Group (2030 WRG) is a public-private-expert-civil society partnership and a platform for collaboration, helping governments to initiate and catalyse reforms designed to ensure sustainable water resources management in order to support long-term development and economic growth. The 2030 WRG supports water sector transformation by mobilising a range of key stakeholders, and providing comprehensive water resources analyses, understandable to politicians, business leaders and other key stakeholders in the Water sector.

The 2030 WRG works at the invitation of governments across various countries, including India, Mexico, Peru, Mongolia, Tanzania etc. In India, Government of Maharashtra expressed its interest in exploring partnership options for sustainable water resources management in Maharashtra with the support of the 2030 WRG. The State of Maharashtra faces severe challenges with respect to its water resources, especially in drought prone areas practicing rainfed agriculture. This partnership intends to assist the State to respond to these challenges.

In order to effectively align and catalyse the work of the Department of Agriculture, as well as of the 2030 WRG, a consulting project for a 'Preliminary Hydro-economic analysis for improving the Agri-Water Efficiency in Maharashtra' was commissioned to Deloitte. The underlying theme for the engagement of 2030 WRG and the Govt. of Maharashtra was how to meet the desired agriculture GSDP growth outside the CCA area without using additional water and how the private sector can participate in this endeavour.

1.1 Setting the Context

Maharashtra has a total population of 112 Million as per census of 2011[1]. With 9.3% of country's population and 9.4% of country's geographic area, Maharashtra is the 2nd largest state in terms of both of these parameters[2]. The State is one of the economic growth engines of the country and contributes to about 14.1% to the national GDP. Structurally, Maharashtra is more urbanized and industrialized as compared to the rest of the country and so economic contribution of industries sector at 25.5% of GSDP and of services sector which contributes about 63.1% are much larger than Agriculture and allied services sector at about 11.4%[3]. Agriculture sector is the highest user of fresh water, withdrawing more than 80% of the water (Blue water) available to the State. The continuation of the State's strong economic growth performance would however need to be supported by higher water availability in all three sectors of the economy – agriculture, industry and services. As the overall water resources available to the State cannot be increased, it is important that the State devises strategies to grow agriculture sector in the most water efficient manner possible (preferably with same or less water than what is used today) so that water is available for other more economically important sectors of the economy to grow.

While on the face of it, agriculture sector's contribution to Maharashtra's economic growth prospects may not appear very significant, the reality is agriculture growth is critical for Maharashtra to improve lives of its population as about 50% of the State's population depends on agriculture sector, either directly or

[1] Census of India, 2011

[2] Economic Survey of Maharashtra – 2013- 14

[3] - do-

indirectly, for livelihoods.[4] This explains the centrality of agriculture sector in Maharashtra's economic and political landscape.

Maharashtra has witnessed rapid economic growth in the last decade, with average economic growth rate of over 8%. Even agriculture sector has grown at a CAGR of 6.4% from 2004-05 to 2011-12[5]. However, the growth of agriculture sector has been fluctuating and has heavily depended on the highly erratic rainfall during any particular year. This situation reflects the need for the State to not only focus on higher GSDP growth in agriculture sector but also the need to control variability of the growth through better management of its water resources. Additionally, distribution of rainfall is highly uneven in Maharashtra with some areas in western region of Konkan receiving more than 6000 mm of rainfall annually and some other drought prone areas in the rain shadow areas of Western Ghats receiving less than 400 mm.[6] Annexure I and II present maps showing the agro-climatic conditions in Maharashtra and rainfall variability across the various regions. Climate change has already begun to show its impact in Maharashtra as number of rain events reduce and instances of heavy rainfall increase posing severe challenges for the farmers in rainfed region.

Despite substantial investments made in irrigation sector over the last six decades since independence, approximately 80% of the agricultural land in Maharashtra remains outside formal irrigation systems provided by the State.[7] The State's effort on water resource development has thus far been on creating the storage infrastructure and providing irrigation facilities through development of canals and command areas. Assuming that the State is successful in developing its economically utilizable surface water resources, the state government estimates indicate that Maharashtra will be unable to bring more than 50% of its area under agriculture in irrigation systems. This signifies the need for Maharashtra to simultaneously invest in rainfed agriculture through other solutions.

This report presents a preliminary assessment of initiatives required to support 4% agriculture growth in the State in the coming five years with emphasis on areas outside Command Control Areas (CCA) of irrigation systems through the lens of water management and governance. The overall guiding theme which emerged during the course of the study was the need for soil moisture security to achieve the state's agriculture GSDP and how an integrated model involving public schemes and the private sector could move towards that objective. In the Indian context, there has been very little discussion and policy dialogue on green water and soil moisture security in rain fed areas. This study brings this important issue to the forefront and also the possibility of the public and the private sector participating together in an integrated model to bring in full benefits of public sector investments in watershed development.

1.2 Study Approach

2030 WRG adopts a three step, A-C-T approach: Analyze, Convene and Transform while engaging with the governments. This study presents the analysis phase of the Maharashtra engagement. This is one of the initial such studies being carried out by WRG 2030 which focuses on green water, which is normally neglected in policy debates. In this context, for this engagement, a slightly modified approach was adopted by 2030 WRG, i.e. the analysis phase was carried out in conjunction with the convene process. This was done so that the analytics is in line with the overall objectives of the partnership with the state government and relevant stakeholders. 2030 WRG decided to create a parallel stakeholder consultation in order to provide continuous feedback to the study team and ensure that results are useful to the key stakeholders. To guide the study and State partnership a Sounding Board was constituted comprising of representatives from Government, private sector and Civil society. The composition of the Sounding

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[5] -do-

[6] Indiastat

[7] - Economic Survey of Maharashtra – 2013-14

Board is given in Annexure – V. The study team followed a highly consultative process which comprised of the following phases.

Inception Phase - Individual Stakeholder Meetings – The engagement commenced on 26th May, 2014. An initial round of meetings were carried out in the first two weeks of the engagement with the members of the Sounding Board along with the 2030 WRG representatives. The key objectives of each of these meetings were as follows:

- Introduce the study and team to Sounding Board members
- Discuss about the context and key expectations from the engagement. Discuss about past experience with similar exercises in Maharashtra and elsewhere focusing on ideas that have shown promise and can be examined further in the engagement.
- Identify key challenges that need to be addressed for long term sustainable growth of agriculture and dependent economic sectors in Maharashtra
- Identify key themes (crops / regions / thematic areas) which can be explored through the deep dives and their relevance for the larger stakeholder community.
- Understand the organizational set-up in Maharashtra and key economic linkages with respect to water and agro resource base of the State

Sounding Board meetings

The Sounding Board met for three times during the course of the study. All findings presented in this report along with recommendations have been discussed in detail with the Sounding Board members during the course of these meetings.

Technical Committee Review

Considering the highly technical nature of this engagement (from the perspective of water resource issues and its linkage with the rainfed agriculture), a technical review committee consisting of some of the country's foremost water sector experts was formed to provide independent review of the study's key recommendations. The Annexure VII presents the composition of the technical review committee. All comments of the review committee members have been incorporated in this final report as considered appropriate.

In addition to members of these committees, the study team met several stakeholders from public, private and civil society. A list of these stakeholders is provided in Annexure VI.

1.3 Deep Dives

One of the important objectives of the Inception Phase was to identify the Deep Dives. This was initially undertaken through a series of discussions with stakeholders to identify potential candidates. Subsequently a fact based approach was adopted to prioritize deep dives which have the potential for highest impact on agriculture and water sectors as well as emerge as examples for further action in other crops and regions. The following deep dives were finally selected: a) Cotton crop and b) Aurangabad Region

The Annexure III and Annexure IV present findings of these deep dives. Major lessons from the deep dives have been incorporated in the main body of the report.

1.4 Existing Programs and Schemes

To ensure that the study incorporates lessons learnt from implementation of all ongoing initiatives, we carried out a mapping exercise to identify the major ongoing initiatives of Government and Private sector.

1.4.1 Government Programs

The Government invests heavily in supply side of agriculture and water management sectors in Maharashtra. Government of Maharashtra implements a large program called **Integrated Watershed Management Program** to develop watersheds in the State. The Government also has an interesting **Public Private Partnership for Integrated Agriculture Development** (PPP- IAD) program with support of the World Economic Forum. The aim of the program is to facilitate modern technology transfer in select crop value chains by complementing public investments with private sector and farmer investments. **Vidarbha Intensive Irrigation Development Program** (VIIDP) is a special package created for drought prone area of Vidarbha in Maharashtra. It provides investment support for drought proofing the region by investment in irrigation, micro-irrigation and watershed development activities. **NABARD** under its **Umbrella Program in Natural Resource Management** provides financial support for undertaking Drip irrigation systems. NABARD also has an **Indo-German Watershed Development Program** to support implementation of watershed activities in select watersheds of the State.

The main report provides more information about these programs and schemes in Chapter 4. An inventory of all programs and schemes including details such as cost and impact on agriculture growth and demand side water efficiency have been provided in Annexure X.

1.4.2 Private Sector and CSR initiatives

Private sector initiatives in agriculture sector fall into following categories:

a) **CSR initiatives related to watershed development** – companies such as SAB Miller, Hindustan Unilever (through its CSR foundation Hindustan Unilever Foundation), Mahindra and Mahindra etc. have implemented CSR programs focusing on watershed development.
b) **Implementing agriculture productivity improvement programs in PPP-IAD Scheme of Government of Maharashtra –** Companies such as Jain Irrigation, Rallis, Hindustan Unilever and several others have participated in PPP – IAD project of Government of Maharashtra on specific value chains.
c) **Adoption of sustainable procurement principles –** Companies such as Coca Cola, Hindustan Unilever have adopted sustainable procurement principles which also have a component of water responsibility in them. However, these are more of guidelines and are not implemented as directly projects.
d) **Other initiatives –** There are specific projects by companies that focus on certain intervention. For example, Jain Irrigation has created a Public – Private – Partnership to create a water storage structure. Similarly Sakal Group has created a WaterLab initiative to bring various stakeholders together for a discussion on water resource challenges of Maharashtra. Olam international is trying to increase water use efficiency in Sugarcane farms with from whom they procure their raw materials. As mentioned earlier, details about these interventions are mentioned in Annexure – X.

In general, it was felt based on the review that most of the initiatives in their current form would not impact water efficiency in a scalable and sustainable model in rainfed conditions. Therefore based on discussions with the Sounding Board member and 2030 WRG team, it was decided to not pursue analysis of such programs from the perspective of measuring their water footprint.

The next chapter presents a diagnostic assessment of the water challenges in agriculture sector in Maharashtra.

2 Diagnosing the Water Challenge in Maharashtra Agriculture

2.1 Introduction

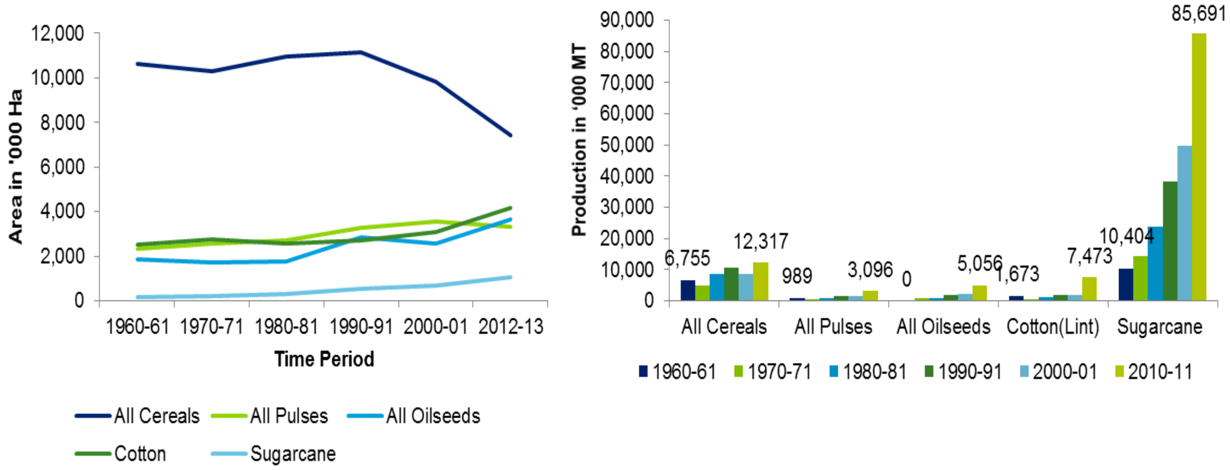
This chapter explores some of the trends which are significant to understand Maharashtra's agriculture growth performance in the past. It also establishes the connection of this growth performance with water by exploring water intensity and area intensity of key agriculture crops of Maharashtra. The chapter ends by examining the key constraint to making additional water available to agriculture sector by presenting a preliminary water balance.

2.2 Understanding agriculture growth in Maharashtra from Water perspective

Maharashtra's agriculture growth has been supported by expansion in area under agriculture, higher productivity and change in cropping pattern

Total area under principal crops in agriculture sector in Maharashtra has increased marginally from about 17.4 Million Ha in 1960-61 to about 19.6 Million Ha in 2012-13[8]. This of course contributes to higher agriculture output. However, total production has increased at a much faster rate from about 7.7 Million tons in 1960-61 (for all cereals, pulses and oilseeds) to 20.4 Million tons in 2012-13. The graph below shows decadal trends of area under production and total agricultural output for this period for the purpose of understanding relative change in the mix of crop production.

Figure 1: Cropping pattern and production of Maharashtra for principal crops from 1960-61 to 2010-11



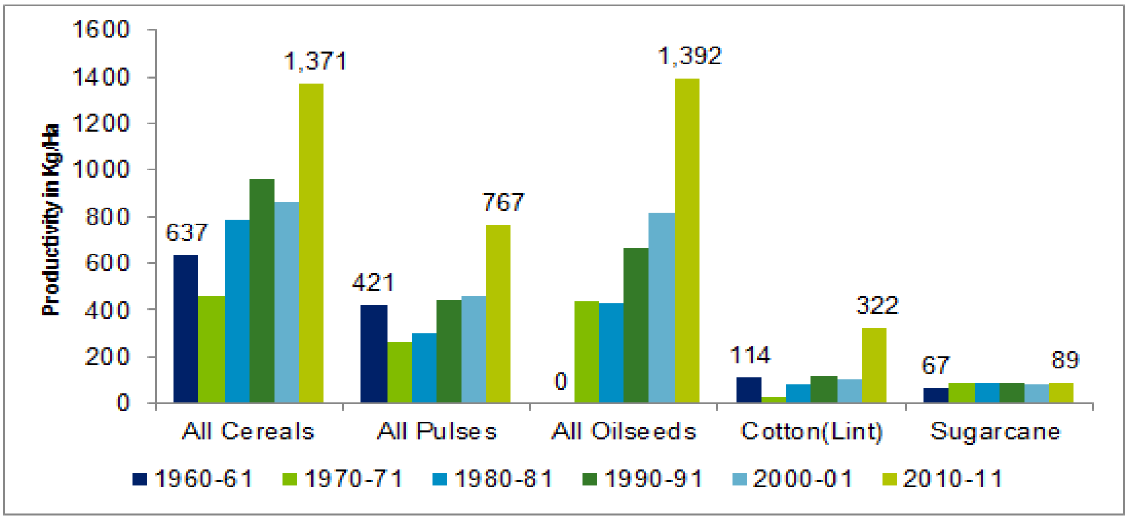
Note: Production of Cotton(Lint) in '000 bales of 170kg per bale

Source: Socio-economic Survey of Maharashtra – 2013-14

[8] Source: Economic Survey of Maharashtra – 2013-14

In addition to the output in cereals, pulses and oilseeds, the State has rapidly increased its area under cash crops such as Cotton and Sugarcane. Along with the area, there has been improvement in the productivity of crops as well. The following graph depicts the change in productivity figures of crop categories over the years.

Figure 2: Productivity of principal crops in Maharashtra from 1960-61 to 2010-11



Note: Productivity of Sugarcane in MT/Ha

Source: Socio-economic Survey of Maharashtra – 2013-14

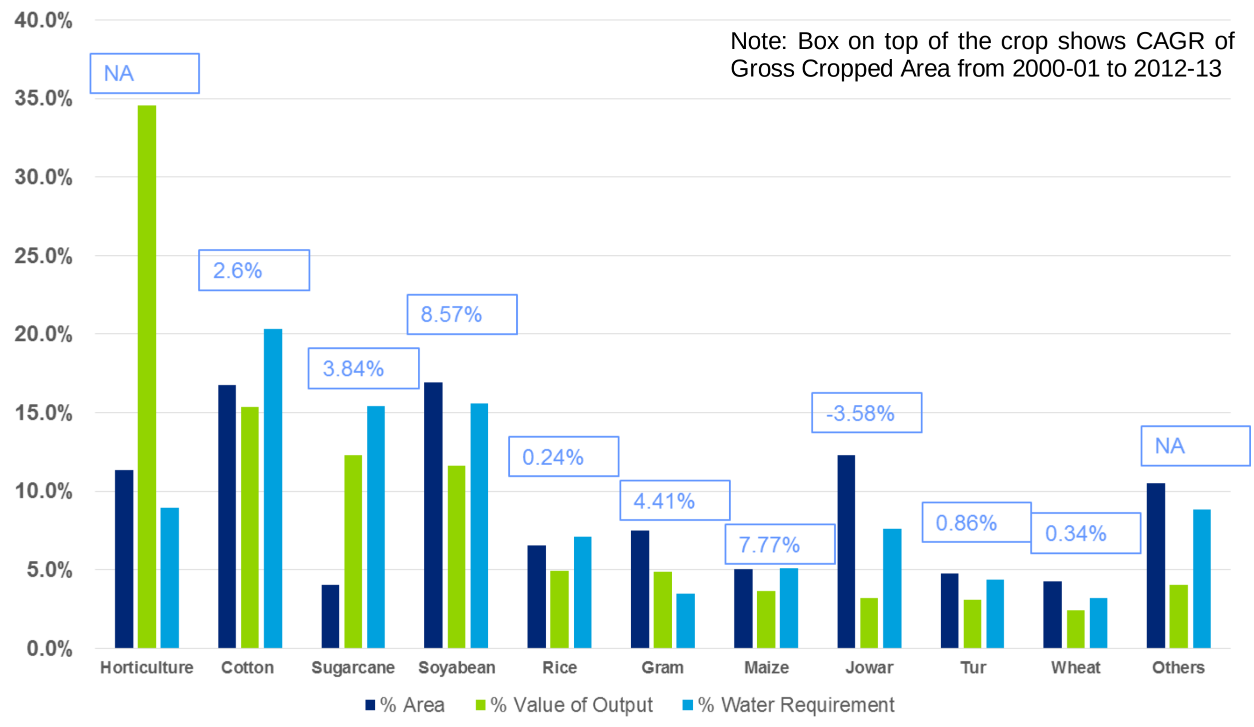
The productivity of crops has shown constant improvement over the years for all categories. This gain has been largely due to the productivity gains made during the Green Revolution. Productivity in the last decade has seen substantial growth as compared to earlier years due to various agricultural interventions.

Water has been an important enabler in increasing the agriculture output of Maharashtra

The higher agriculture output growth has been supported by several factors with investment in water delivery systems, mainly through development of irrigation infrastructure, being a key enabler. One of the key trends visible in both the graph above is the shift away from low water consuming cereals and pulses to high water consuming and high value crops such as Sugarcane and Cotton. This preliminary analysis also illuminates the significance of water in enabling agriculture growth.

In fact, each crop presents a different trade-off in terms of three key factors – land utilization, water utilization and value of output produced. An analysis has been carried out to compute the relative share of Gross value of output, total area under the crop and total water consumption (based on normative crop water requirements) for a few major crops of Maharashtra. It is clarified that this analysis presents the relative share along these three factors only among these crops. The diagram below shows results of for Maharashtra for the period 2000-01 to 2012-13.

Figure 3: Relative share of area, gross value of output and water requirement for principal crops in Maharashtra in 2013-14

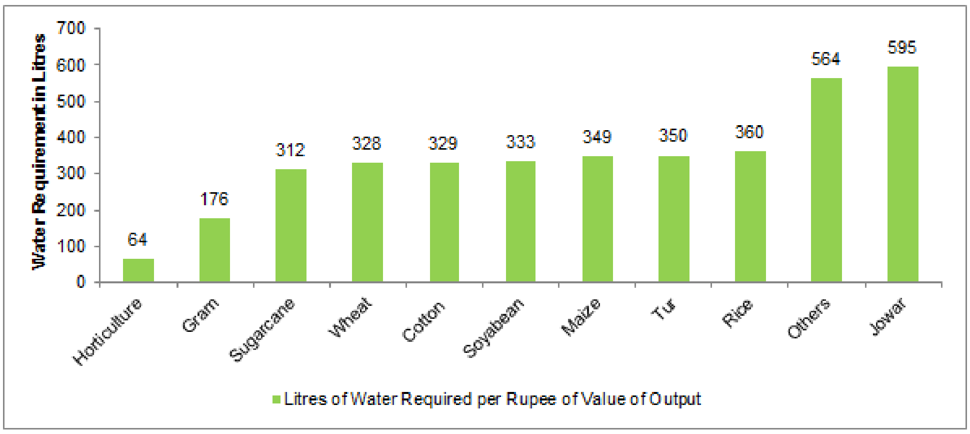


Source: Socio Economic Survey of Maharashtra 2013-14, FAO crop water requirements, MOSPI Report, Deloitte Analysis

The above charts show some interesting trade-offs. For example, Sugarcane which has received significant attention in India for its high water consumption, is extremely beneficial in terms of the area required to produce the economic output. It is also growing rapidly in Maharashtra in the last decade or so with a CAGR of area growth of about 3.84%. Soybean is another crop which is growing very rapidly in Maharashtra with a CAGR of about 8.57%. However, it is neither very efficient in terms of area intensity of economic output or water intensity of economic output. But it is being grown in the drought-prone regions of Vidarbha and Marathwada replacing even more inefficient crops in terms of area intensity and water intensity of economic output such as Jowar, which has shown negative growth of about -3.58% in the last decade.

The graph below compares the requirement of water in litres to produce a unit value of output for selected crops.

Figure 4: Water Requirement for Unit Value of Output of Selected Crops



Source: Socio Economic Survey of Maharashtra 2013-14, FAO crop water requirements, MOSPI Report, Deloitte Analysis

The above chart shows that although the total water requirement for crops like Jowar and Tur may be less as compared to others, but when compared with respect to the value of output derived, it requires large amount of water to produce a unit value of output. However, crops like Horticulture, Gram, Sugarcane, Soyabean etc. which consume high quantities of water overall, require less water to produce the same value of output.

Horticulture stands out as most efficient both in terms of area intensity and water intensity of economic output, justifying further investments in promoting the horticulture crops. Horticulture itself comprises of a large variety of plantations and similar trade-offs could be analyzed within the horticulture category itself.

The analysis also shows why farmers prefer crops such as Sugarcane or Horticulture which consume high quantities of water over crops such as coarse cereals and pulses which require lower water. Every farmer would like to maximize his return under the constraint of the area available to him for agriculture and hence considers shifting to higher value crops. However we do not see a mass shift to these high value crops and continued prevalence of low value crops for two reasons. First being the ability to create a secure infrastructure for water delivery through either formal irrigation systems or through private bore-wells and the second reason being the ability to sell the produce at attractive prices in the market. Thus the farmer considers these risk factors before taking any decision on crops.

However, it is suggested that policy inferences should be drawn carefully from this analysis. It is difficult to suggest large scale changes in cropping pattern based on the trade-offs. In a democratic country like India where each farmer is free to make choice of the crop in his land, such a strategy is neither practical nor desirable. Farmers should be free to make the choice of the cropping mix in his farm based on several factors such as availability of water, seeds, fertilizers, cash flow pattern of the crop, investments required, his previous experience with the crop, promotion efforts by the government, his own consumption requirements, confidence in being able to sell excess produce etc.

However, this analysis provides policy-makers with a macro understanding of the impact of the cropping pattern changes underway and make broader policy decisions with respect to their strategy for promoting a certain crop over the others through variety of instruments such as higher subsidy for seeds, fertilizers or higher focus in capacity building and awareness generation programs etc.

The State's agriculture output is supported by more water than is generally considered

Most statistics related to water consumption in agriculture tend to focus on consumption of water from surface water or ground water which is explicitly made available to the farms by diverting them through either irrigation systems or through groundwater abstraction structures such as wells and bore-wells. However, water use in agriculture sector also comes from a third source, which is soil moisture created through rainfall. This is called the Green water. Predominant source water consumed in rainfed agriculture is through this Green water. However, the formal planning instruments of the State do not account for the Green water. For example, Water Resources Department of Maharashtra, which is in-charge of planning and development of water resources in the State, in its account of water resource availability of the State, mentions only the surface and the ground water (The Blue water). Inclusion of Green water in water resource planning could improve the planning process as will be presented subsequently.

In the Maharashtra context, it is not the absolute quantum of rainfall, but the variability and regional spread disparity of the same which is an issue. In addition, other socio-economic conditions such as low average land holdings size, poor agriculture productivity, quality of market linkages etc. contribute to create the stress that exists in the state.

As a first step, we present the overall average water balance of the State of Maharashtra. It is clarified that preparation of a water balance of such a large State is a complex exercise and the aim of our balance is not to achieve a high degree of accuracy but understand the macro picture which could facilitate high level policy implications.

Figure 5: An initial estimate of the overall Water balance for Maharashtra for an average year

Catchment Water Balance		In BCM
IN	Rainfall	366
USE	Estimate of Rainfall in Rainfed Areas	84
	Estimate of Rainfall in Irrigated Area	10
	Forests and others	74
OUT	Ground water Recharge	32
	Streamflow	167
	TOTAL	**199**

Water Resources Water Balance			In BCM
IN	Ground water recharge		**32**
	Streamflow		167
	TOTAL		**199**
USE	Surface Water Irrigation diversions	39	
	Losses (Distribution (16) and On-farm (7))		23
	Productive ET		16
	Ground water irrigation extraction	17	
	Losses		5
	Productive ET		12
	Base Flow		18
	Urban / Industrial water diversion	15	
	Water Use		5
	Return Flow		10
	TOTAL		**79**
LOSS	Natural losses (Evap/ET)		**10**
OUT	Minimum Flow to Down Stream states (as per Tribunal Awards)		38
	Flow to sea		62
	Unaccounted for flows		10
	TOTAL		**100**

Source: MWRRA, GSDA, Economic Survey of Maharashtra 2013-14, Preliminary Deloitte Estimates

Note: Assumptions used to prepare the water balance are presented in Appendix - VIII

Following are some of the salient observations from the water balance.

- The overall water resource availability through rainfall in the State is substantially more than surface and ground water estimates.
- The total water use in agriculture, which would be estimated at around 56 BCM (39 BCM of surface water and 17 BCM of groundwater) by traditional method of only accounting for Blue water, is actually substantially more (84 BCM of rainfall in rainfed areas and 10 BCM in irrigated areas). This increases the total use of water in agriculture from about 56 BCM to 150 BCM. This is also confirmed through calculating crop water requirements per unit area based on normative estimates from crop water consumption norms and area under various crops in Maharashtra. Not factoring in such substantial component of water use in agriculture in water related discussions could lead to sub-optimal solutions.
- Share of water requirements in urban and industrial sector, which are the economic engines of Maharashtra, reduces even further from about 20% of freshwater withdrawals as estimated today to less than 10% if green water is also included in the equation.

There are significant limitations to further irrigation development from the perspective of overall water resource availability.

Even though total Blue water available to the State from stream flow and groundwater is close to 200 BCM, there are several limitations to utilization of these resources. For example, water availability is very high in West Flowing Rivers (Konkan River Basin) towards the western sea-cost. However most of the water is available through small streams which traverse very short distance from the Western Ghat mountain range before reaching the Sea. The Irrigation and Water commission constituted in 1999 assumed use of only 15.4 BCM out of 69.2 BCM of West Flowing Rivers in the Year 2030, due to this difficulty of utilizing this water for any economic activity.

Similarly other large river basins such as Godavari and Krishna are constrained for water use by the respective Tribunal Awards for water sharing with riparian States. Considering these factors, the further potential for development of irrigation facilities in the State appears highly constrained from the water resource perspective. Even optimistic estimates do not place the total potential area that could be under irrigation by developing all water resources at more than 50% of total agriculture area; this number is presently at about 20%. The State has to therefore plan for supporting agriculture growth for the remaining farmers which are unlikely to receive benefits from the irrigation systems despite heavy investments. This is important as rainfed farmers in drought prone areas of Maharashtra are some of the most vulnerable sections of the society.

2.3 Summary

In this chapter we have explored some of the connections of agriculture growth performance with water consumption in agriculture sector. Realizing lasting importance of rainfed agriculture in Maharashtra is critical for planning future course of policy in supporting agriculture growth. In the next chapter, we present a forecast for agriculture growth in Maharashtra that has been prepared for this study and analyze key results.

3 Understanding Agriculture Growth in Maharashtra

3.1 Introduction

In this chapter, we present results of the agriculture growth forecast model prepared for this engagement. Detailed assumptions used in the model are presented in Annexure IX. The model uses the existing trends visible in agriculture sector in Maharashtra in terms of area expansion under different Rabi and Kharif crops, productivity improvements in each crop and normative water requirements of each crop to prepare a growth forecast for agriculture sector in Maharashtra.

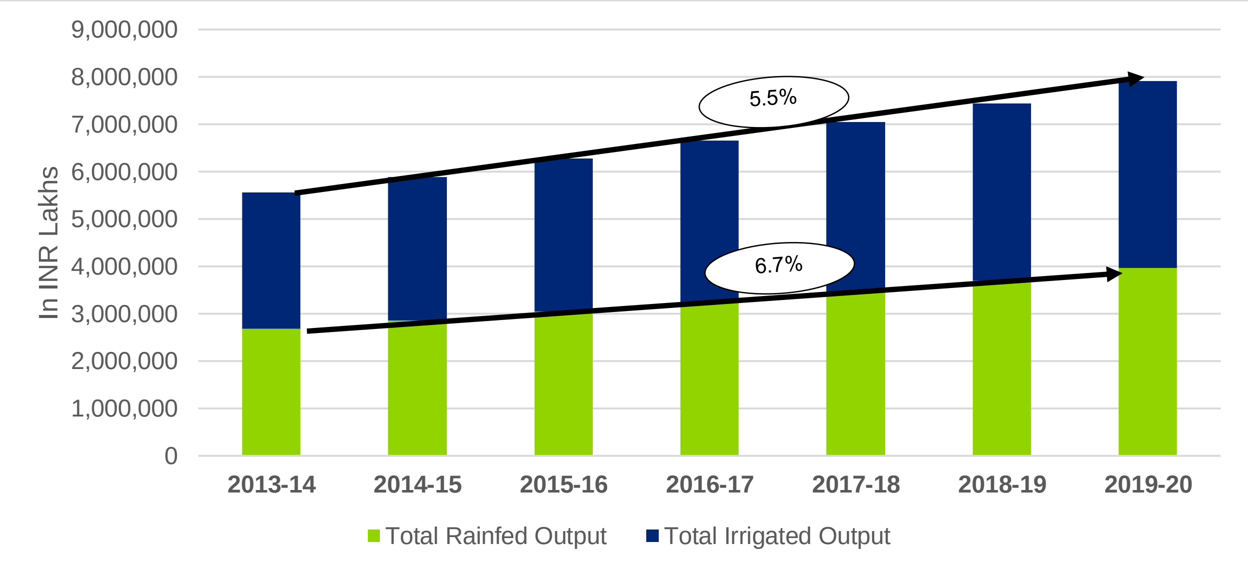
3.2 Exploring results of agriculture growth forecast in Maharashtra

As briefly mentioned in the last chapter, there are three pillar supporting agriculture growth output (in physical quantity terms) in any State or Country. These are a) Shift to Higher Value Crops b) Growth in productivity in the same crops and c) expansion of gross area under agriculture. Additionally, the economic growth could emerge from increases in relative prices of agriculture produce with respect to other commodities, but this variable has been kept above the scope of analysis for this engagement. Following are some of the key results from the agriculture growth forecast model.

Growth of output in rainfed areas could be faster than growth of irrigated areas

Following chart presents the agriculture growth forecasts for agriculture sector in Maharashtra based on growth trends observed in the last decade.

Figure 6: Forecasts for agriculture output in Maharashtra – 2013-14 to 2019-20

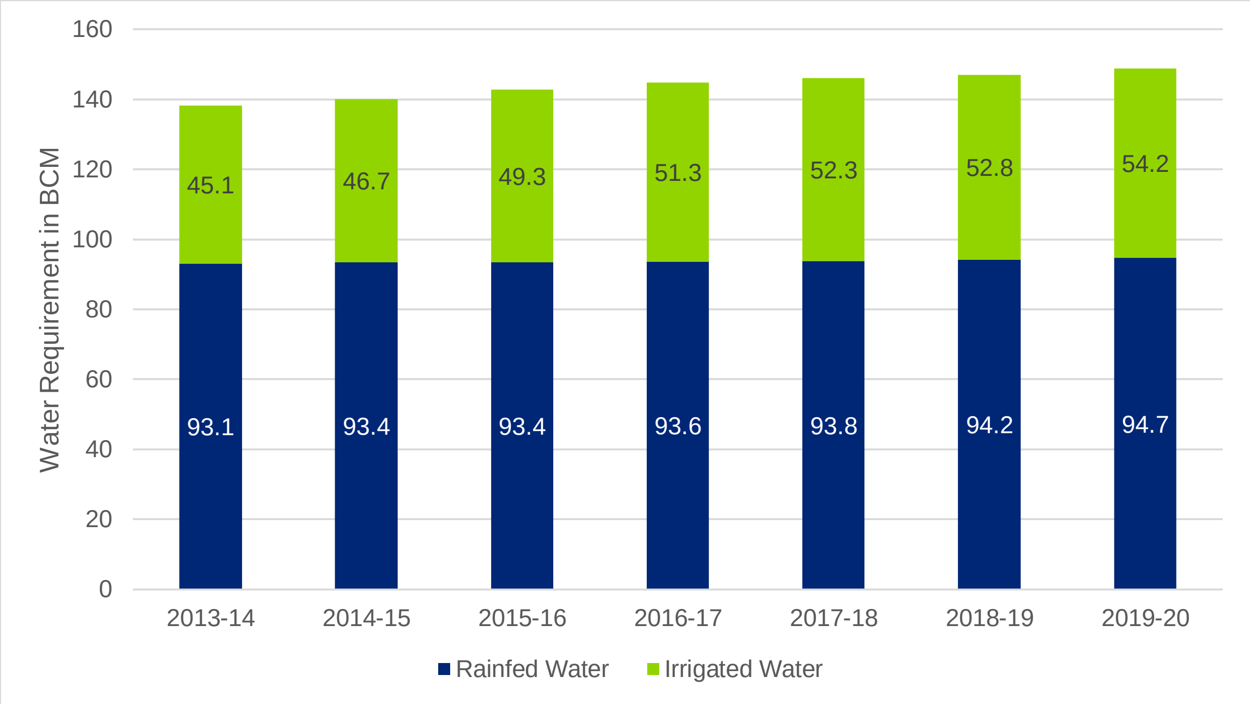


Source: Deloitte Estimates based on data from MOSPI report and Socio Economic Survey of Maharashtra

As shown in the graph, the total rainfed output could potentially grow by 6.7% by 2019-20 which is faster than the total output from irrigated areas. The overall agriculture growth could increase by 6.1% by 2019-20.

The following diagram presents the water requirement in rainfed and irrigated agriculture in Maharashtra.

Figure 7: Forecast for water requirement in agriculture sector in Maharashtra – 2013-14 to 2019-20



Source: Deloitte Estimates based on data from Socio Economic Survey of Maharashtra and FAO crop water requirements

As can be seen from the diagram the total water requirement in rainfed agriculture grows at a much slower rate than the total water requirement in irrigated agriculture. This is despite the fact that rainfed output is growing at a rate faster than irrigation as shown earlier. Some of the reasons for these trends are explained subsequently in this chapter.

Irrigated agriculture uses Blue water which has competing demands from urban and industrial sector while rainfed agriculture uses Green water which has little alternative uses.

This agriculture growth forecast model presented interesting results for water use and agriculture output in rainfed agriculture versus irrigated agriculture.

Figure 8: Relative share in area, value of output and crop water requirement in irrigated and rainfed areas in Maharashtra – 2013-14

Parameter	Rainfed Agriculture	Irrigated Agriculture
Total Area Share (%)	**80%**	**20%**
Total Agriculture Output (In INR Lakhs)	**2,685,560 (48%)**	**2,873,059 (52%)**
Total Crop Water Requirement (BCM)	**93 (67%)**	**45 (33%)**
Estimated Green Water Supply (BCM)	**84 (90%)**	**10 (10%)**
Estimated Blue Water Supply (BCM)	**9 (20%)**	**35 (80%)**
Output / Unit of Water (INR Lakh / BCM)	**28,876**	**63,845**
Output / Unit of Blue Water (INR Lakh / BCM)	**298,395**	**82,087**

Source: Deloitte Analysis based on data from MOSPI report, Socio Economic Survey of Maharashtra and FAO crop water requirement

Stakeholders consulted were of the opinion that policymakers face an interesting trade-off when comparison is made between rainfed and irrigated areas. Irrigated areas produce output much more efficiently from the perspective of area. For example, with about 20% of total area, irrigated areas produce almost 50% of the output, while rainfed areas use up 80% of area under agriculture to produce the remaining 50% of output. Irrigated areas are also more water efficient (if one examines the total water used in agriculture). The total value of output per unit of water is more than double in irrigated areas as compared to rainfed areas. However, value of output per unit of Blue water for rainfed areas is almost 4 times than that of irrigated areas. Considering that competing demands are rising for Blue water from urban and industrial sector (and where economic output per unit of water is far higher than in agriculture sector), this becomes an interesting trade-off for policy-makers in terms of where to put emphasis on agriculture growth.

Boosting productivity is the most water efficient way to increase agriculture growth, while increasing area under agriculture is the most water intensive way to increase agriculture growth.

All the three pillars of agriculture growth have different water intensities. One of the key objectives of this growth forecast model was to understand the implications of each of these pillars on water requirements. This is presented in the diagram below:

Figure 9: Contribution of different pillars to agriculture growth in Maharashtra by 2019-20

Pillar for Agriculture Growth	Shift to Higher Value Crops	Growth in Agriculture Productivity	Area Expansion
Contribution to Agriculture Growth	~35%	~50%	~15%
Contribution to Water Requirement	~50%	<10%	~40%

Source: Deloitte Estimates

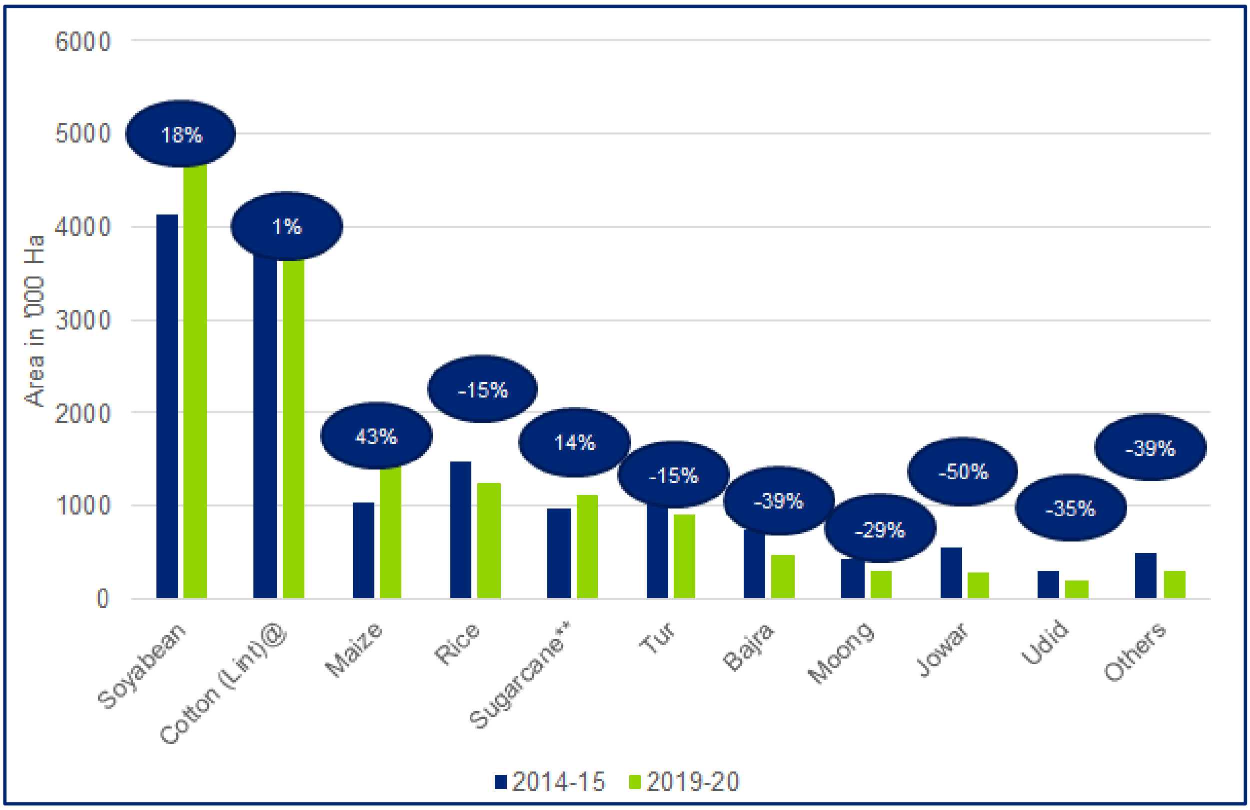
As the diagram shows, shifting to higher value crops could contribute about 35% of the agriculture growth but it could take 50% of the additional water required. On the other hand growth in agriculture productivity could boost growth by about 50% by 2019-20 with less than 10% of water. Area expansion is the most water intensive growth strategy (We have assumed that there is no area expansion in Kharif and all area expansion is under Rabi).

In the sections to follow, we explain the various trends and assumptions which would further elaborate on why each pillar for growth has different water intensity and what are the implications emerging from this analysis.

3.2.1 Understanding Pillar I: Shifting to Higher Value Crops

As mentioned earlier in the report, Maharashtra has been shifting to higher value crops. Based on historical trends, area under various crops has been projected till 2020 to gauge the shift in crops as well as the crop water requirement. The graph below shows the area projected in the Kharif season which is the principal agriculture season during the monsoon in India. For preparing the forecast, it is assumed that the total area under Kharif season is constant. The box on top of each crop shows the total increase or decrease in area under Kharif crops by 2020 based on our forecast model.

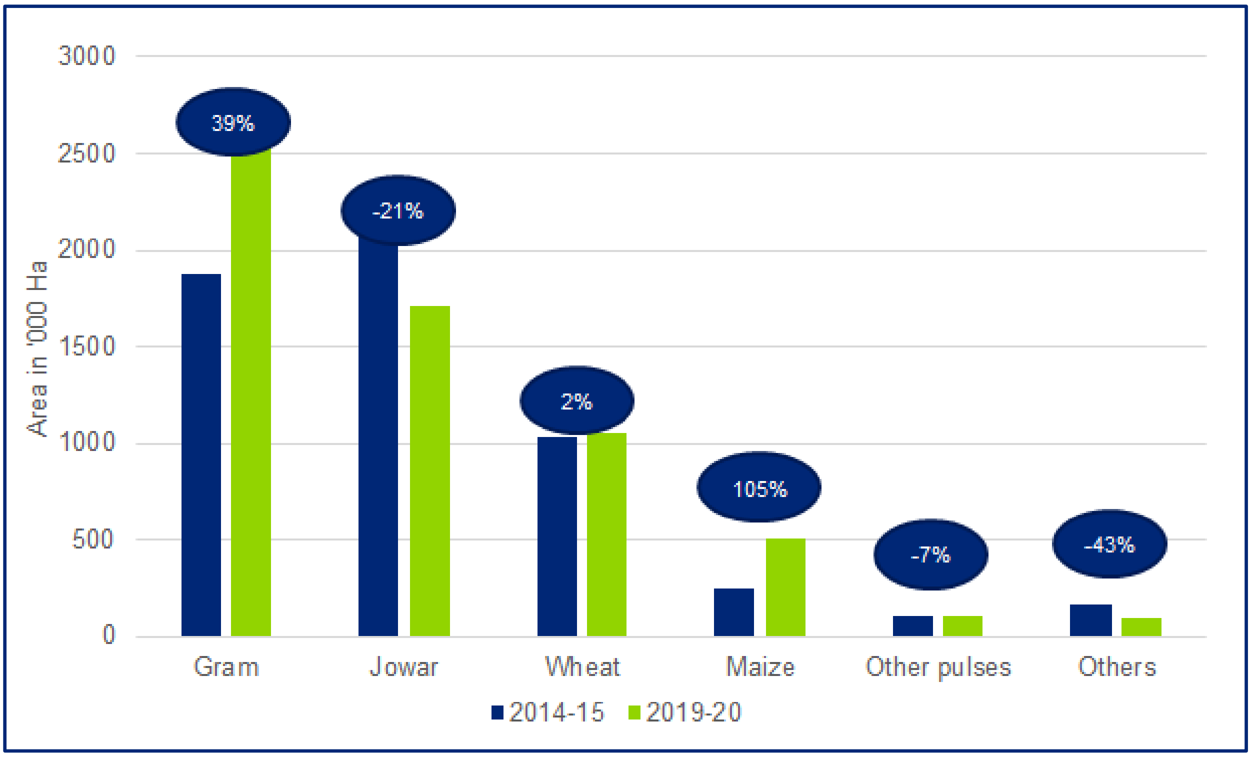
Figure 10: Projections for area in Kharif season for principal agriculture crops in Maharashtra



Source: Deloitte Analysis based on data from Socio Economic Survey of Maharashtra

The graph shows that crops such as Soybean, Maize and Sugarcane are growing rapidly in the State. Cotton, which grew rapidly in the last few decades, has more or less stabilized in the last decade and therefore it is forecast that area under cotton cultivation may not increase substantially. The crops which are reducing rapidly are Tur, Bajra, Moong, Rice, Jowar, Udid etc. In the graph below we present the result of forecast model for cropping pattern in the Rabi season. Since, for most areas under agriculture in Maharashtra Rabi season is the second cropping season, total area under Rabi season has been increased based on the historical trends.

Figure 11: Shift in cropping pattern – Rabi (Projections)



Source: Deloitte Estimates based on data from Socio Economic Survey of Maharashtra

In Rabi season, crops such as Gram and Maize are expanding rapidly while strong drought resistant crops such as Jowar have decreased rapidly. In addition to the Kharif and Rabi agriculture crops, the total area under horticulture could also expand by about 30%. The table below shows the water requirements and drought sensitivity of some of these crops.

Figure 12: Water Requirements and sensitivity to drought of different crops

Crop	Water Requirements in mm	Sensitivity to drought
Wheat	450-650	low-medium
Sorghum/ Millet	450-650	low
Soybean	450-700	low-medium
Sunflower	600-1000	low-medium
Cotton	700-1300	low

Crop	Water Requirements in mm	Sensitivity to drought
Bean	300-500	medium-high
Cabbage	350-500	medium-high
Pea	350-500	medium-high
Onion	350-550	medium-high
Melon	400-600	medium-high
Tomato	400-800	medium-high
Rice (paddy)	450-700	high
Potato	500-700	high
Maize	500-800	medium-high
Pepper	600-900	medium-high
Sugarcane	1500-2500	high

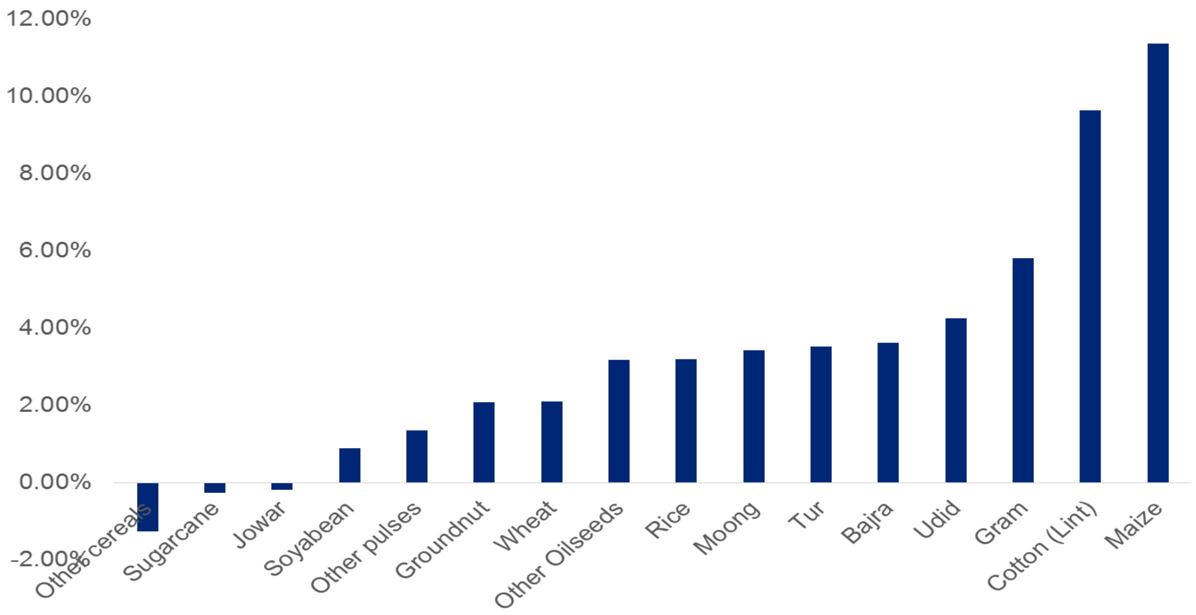
Source: Food and Agriculture Organization

As can be seen from the table above, the majority of the crops which are growing rapidly (Maize, horticulture, Sugarcane etc.) have medium to high drought sensitivity. Highly drought resistant crops such as sorghum, wheat, cotton are either reducing in area or stabilizing. From an overall perspective, the forecast model estimates that this pillar would consume 50% of additional water required while producing 35% of additional growth. This implies that while strengthening this pillar is significant for agriculture growth, it may not be the most water efficient strategy.

3.2.2 Understanding Pillar II: Growth in Agricultural Productivity

Historically, Maharashtra's performance in improving productivity of agriculture crops is mixed. In the chart to follow, agriculture yield growth rate of different crops is presented for the period 2000-01 to 2013-14.

Figure 13: Historical productivity growth of different crops in Maharashtra for the period 2001-02 to 2013-14



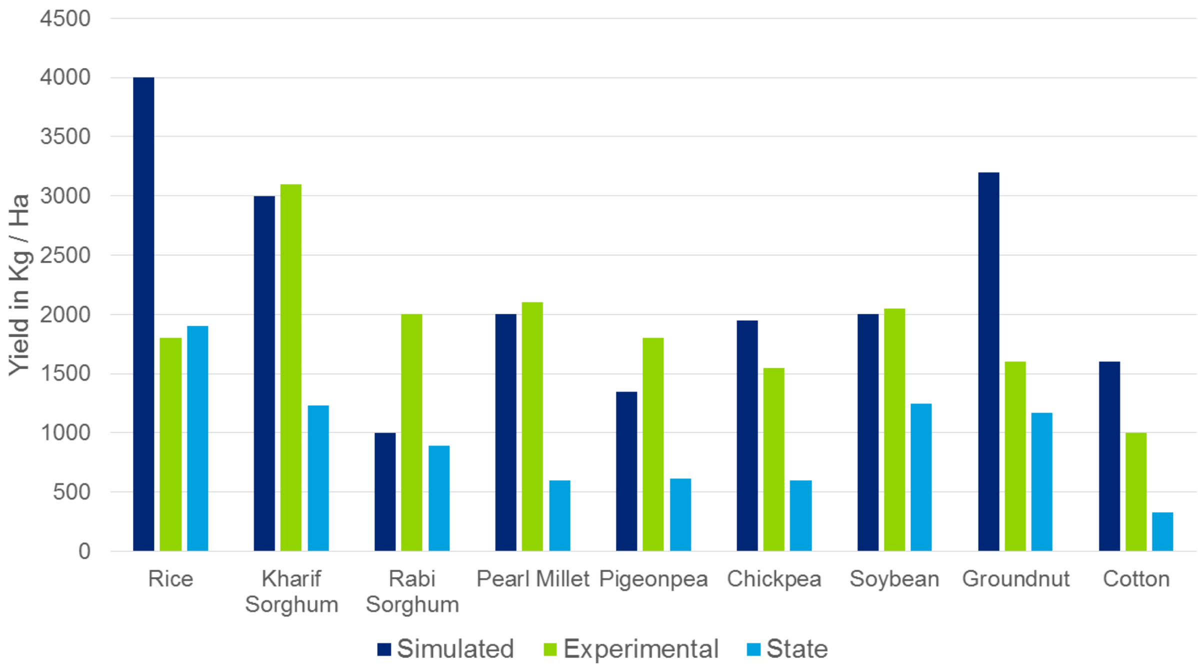
Source: Socio-economic survey of Maharashtra – 2013-14

The diagram shows that for crops such as Sugarcane, Jowar, Soybean the yields have almost stagnated, while for crops such as Maize, Cotton and Gram the state has consistently improved yields at a CAGR of over 6 to 10%.In addition to the historical growth of yields, it is important to examine the potential for further improvement through comparison with other States and scientific studies. Average yields of most crops in Maharashtra are lower than those of other states.[9] However, Stakeholders consulted were of the opinion that considering the different climatic conditions, available irrigation facilities and different soil types, it is not easy to estimate opportunities for improvements in productivity through inter-state comparisons. Instead it would be beneficial if comparison is done within the state and accordingly a yield gap analysis study as depicted below is taken as a reference to show the existing scenario. This provides opportunities to focus on yield improvement techniques and contribute towards the overall growth targets.

The diagram presented next shows comparison of actual average yields of various crops in Maharashtra, with simulated yields (under constraints of water availability) and yields from experimental stations located in Maharashtra. The analysis shows that for most crops the average yields are about half of those in experimental stations. Therefore it can be inferred that there is an opportunity to at least increase average yields by 50% even under constraints of existing water availability in the next few years.

[9] Socio-economic Review of Maharashtra – Chapter 7

Figure 14: Yield gap analysis – Modelling of achievable yields in Maharashtra



Source:

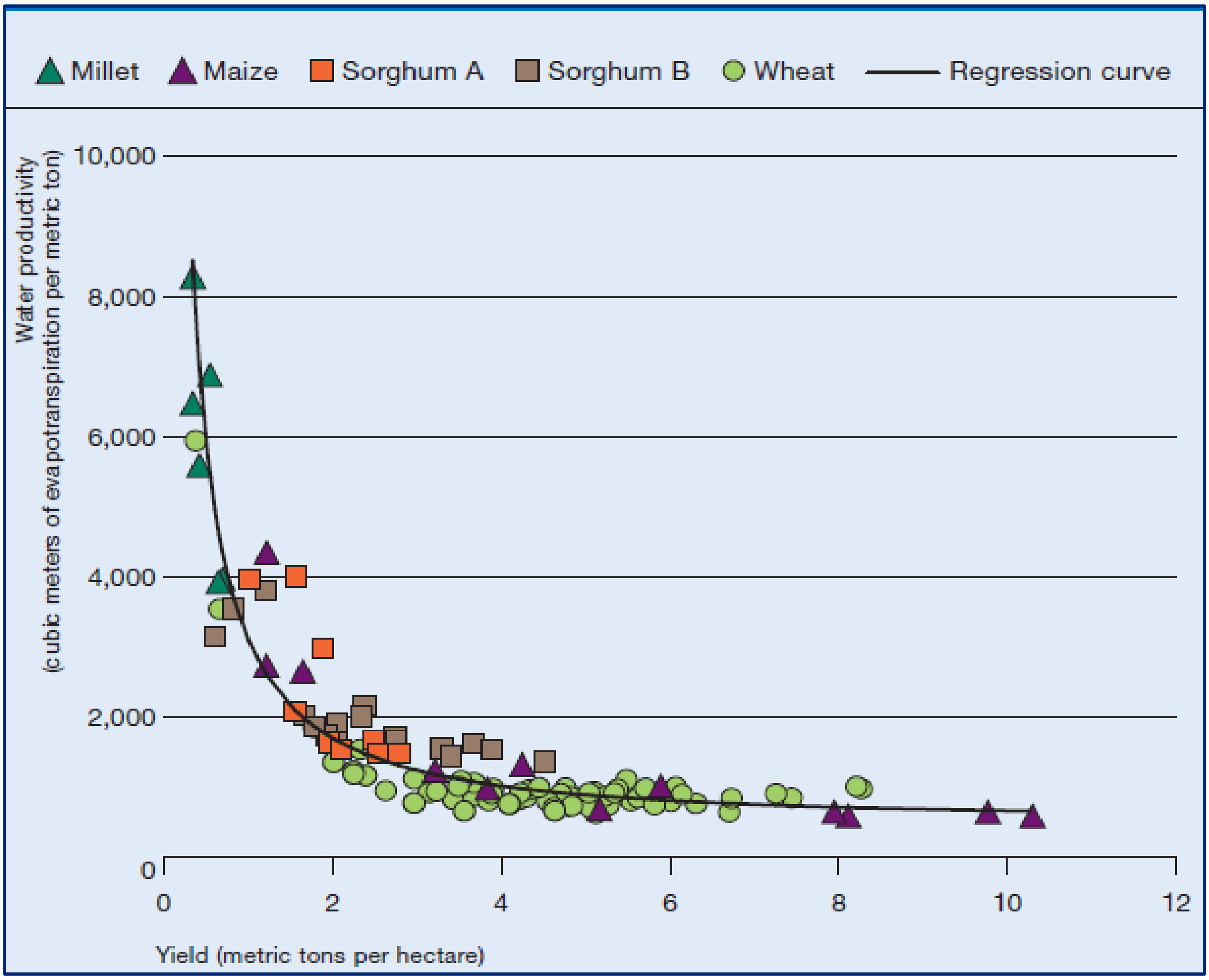
1) Yield gap analysis: Modelling of achievable yields at farm level by P. Singh, P.K. Aggarwal, V.S. Bhatia, M.V.R. Murty, M. Pala, T. Oweis, B. Benli, K.P.C. Rao and S.P. Wani

2) Economic Survey of Maharashtra – 2013 -14 for Actual yields of select crops

Improving productivity of crops is a very effective strategy to promote agriculture growth since it has the potential to increase agriculture output without bringing additional land under agriculture or without promoting large scale changes in cropping pattern. But it is also equally important to examine whether the yield improvement can be achieved with the water available.

In this context, the following graph shows the relationship between the yields of select agriculture crops with water productivity in the context of rainfed areas.

Figure 15: Dynamic relationship between water productivity and yield for cereal crops



Source: Managing Water in Rainfed Agriculture, IWMI 2007 – Rockstrom et al

The graph indicates that when yields double from 1 to 2 metric tons per hectare in, water productivity could improve from approximately 3,500 cubic meters per metric ton to less than 2,000 cubic meters per metric ton, a result of the dynamic nature of water productivity improvements when moving from very low yields to higher yields. This happens because at low yields evaporation losses of water from the soil are high because the sparse canopy coverage over the soil. When yield levels increase, soil shading improves (as a result of thicker canopies) and hence the water productivity also increases. This indicates that large opportunities for improving water productivity are found in Maharashtra, particularly in rainfed agriculture (water productivity is already higher in irrigated agriculture because of better yields). Based on our forecasting model, it is estimated that this pillar could potentially contribute about 50% of additional growth with about 10% additional water requirement.

3.2.3 Understanding Pillar III: Area Expansion

As mentioned earlier, agriculture is primarily practiced in Maharashtra in two major seasons – Kharif and Rabi. Few farmers also take a third crop in the summer season, but it forms a very small part in the overall output. Considering the fact that most of the area suitable for agriculture is already in use, the scope for area expansion in Kharif season is limited, however with provision of irrigation facilities more area can be brought under agriculture in Rabi season. Area under horticulture is also expected to grow in the future. However this also depends largely on making safe and assured supply of water for irrigation.

Since, growing crops in Rabi season in Maharashtra would require providing almost entire water requirement of the crop through irrigation (either public or private arrangement), this is a very water intensive strategy. Based on the forecasting model, it is estimated that this pillar can contribute close to 15% additional growth required for the overall agricultural growth but would require 50% additional water.

3.3 Summary

Maharashtra can achieve 6% annual growth in agriculture sector. However, this would require increase of water consumption in agriculture sector by about 8% till 2020. The State is making substantial investments in developing irrigation facilities and utilizing its water resources. Irrespective of that, the State can achieve 4% GSDP growth in agriculture sector overall and more than 6% growth in rainfed if it focusses on improving productivity of its key crops and strengthening the trend of shifting to higher value crops.

Stakeholders consulted were of the opinion that improving productivity and shifting to higher value crops in rainfed areas is a complex challenge and there are several issues that hamper the productivity growth. Lack of investments in local water conservation and management systems is one of the many challenges (but perhaps the most critical one) that farmers face in rainfed areas. In the next chapter we examine some of the challenges faced by farmers in Maharashtra and provide recommendations to overcome them.

4 Challenges and Opportunities for Agriculture growth in Rainfed areas

4.1 Introduction

As seen in the last chapter, improving productivity and enabling shift to higher value crops in rainfed areas of Maharashtra are important pillars for meeting the growth targets. However, there are several challenges across the value chain of agriculture in Maharashtra which constrain growth. In this chapter we explore these challenges, examine current initiatives to overcome these and provide recommendations for tackling the challenges going forward.

4.2 An overall framework to view the Water Challenges in Maharashtra

Agriculture in Maharashtra, as also in India, is practiced through smallholder farmers. The landholdings are increasingly getting fragmented due to rapid increase in population. For example, in 1970 only about 40% of landholdings were 2 Ha and below which has increased to about 75% in 2010 as per various agriculture censuses conducted. Therefore, an agriculture farm as an economic unit has become smaller as the time has progressed and this has reduced its viability for long-term investment from the perspective of the farmer. The figure below shows a summary of the challenges and development priorities presented in this report for growth of rainfed agriculture in Maharashtra.

Figure 16: Summary of challenges and development priorities for rainfed agriculture in Maharashtra

Challenges	Priorities
Poor Water Management and Soil Erosion ❑ High variability of Output due to very high dependence on rainfall ❑ Soil erosion	**Watershed Development** ❑ Developing local sources for supplementary irrigation through Watershed Development which will also arrest soil erosion
Poor water-use efficiency ❑ Lack of modern technology for water delivery systems	**Water-use Efficiency** ❑ Aggressively promote Micro-irrigation in Rainfed areas
Outdated farming practices ❑ Sub-optimal rainwater management practices ❑ Lack of Availability of Quality Inputs (Seeds, Fertilizers and Pesticides ❑ **Inadequate access to Market** ❑ Need for Storage and processing facilities ❑ Need for assured market ❑ Collective bargaining for smallholders	**Increase productivity of Agriculture through scientific planning** ❑ Agriculture extension to promote measures to increase productivity ❑ Promote Practices for rainwater harvesting and management to achieve higher water-use efficiency **Access to Market** ❑ Facilitate market linkages ❑ Invest in storage and processing facilities ❑ Promote formation of agriculture collectives
Lack of convergence of efforts ❑ Insufficient co-ordination of efforts within the Agriculture Department ❑ Need for convergence of initiatives with Department of Water Resources	**Convergence** ❑ Create a few crop specific clusters where all efforts converge with Watershed as a starting point ❑ Develop integrated river basin plans for holistic economic development based on water availability

4.2.1 Poor water management and soil erosion

Challenges

Increasingly it is recognized that total availability of water is not the key limiting factor for improving agriculture yields. Maharashtra has rainfall levels varying from 500 mm to 1000 mm per growing season for most of its area under cultivation which is comparable to many European countries in the temperate zone. However, yields are much lower as the State faces major challenge in terms of managing the variability in rainfall, characterized by low rainfall events, high-intensity storms and high frequency of dry-spells and droughts.

A closely linked challenge relates to Soil erosion and degradation. This occurs due to loss of top fertile soil during the high intensity rainfall events in the face of any intervention to prevent such a loss. In addition, soil fertility is further compromised due to excessive nutrient depletion and loss of organic matter. Both of these factors are closely linked to rainwater productivity as they affect the water availability for crops through poor rainfall infiltration in the soil and plant water uptake due to weak roots.

Development Priorities

India's response to both managing rainwater variability and soil erosion has been through investments in Watershed Development programs. When implemented well, Watershed development projects have shown good results. In fact, Watershed development has been recognized as the single most critical intervention to improve the lives of farmers in the rainfed areas.

The process of watershed development encompasses building of check dams, nallas, field bunds to reduce the speed of water flow during rainfall events. This helps in higher recharge of ground water as water gets more time to seep through to underground sources. The reduced speed due to bunds and check dams also reduces soil erosion leading to higher fertility and lesser impact of siltation in dams.

The rainfall pattern in the state is highly erratic. Delays in monsoon leads to wastage of sown seeds and many a times forces farmers to change the crop midway. As impact due to climate change increases, the irregularities may increase and lead to further damages. Watershed program can mitigate such risks as increased soil moisture created through the program can support agriculture in case of dry-spells. In India, watershed programs have been documented to increase yields, enable a shift to higher value crops (since farmers have more control over water) and increase in cropping intensity. Thus development in watershed strengthens all the three pillars of agricultural growth.

Researchers have argued that several droughts in India could be avoided if local water balances are better managed. Even in drought years, villages benefitting from watershed development programs increased food production and market value by 63% compared with those without such projects[10]. Study on the economic impact of Kachhighati Watershed, one of the micro watersheds of the Godavari Basin located in Aurangabad District of Maharashtra State revealed an average annual benefit to cost ratio of 3.14 based on present values during the first 5-year block period (1997-2001) and 5.29 in the second 5-year block period (2002-2006) after the implementation of project[11]. Impact on ecosystem and livelihood impacts on many aspects have been documented and they range from bio-physical impacts such as rise in water table to wide ranging changes in the economy and even social changes in certain places. Data have been reported on various parameters like increase in crop area, increase in yields, change in

[10] Wani, et all, 2006 "Issues, Concepts, Approaches and Practices in Integrated Watershed Management: Experience and Lessons from Asia."

[11] G.D. Kale, V.L. Manekar & P.D. Porey 2012 "Watershed development project justification by economic evaluation: a case study of Kachhighati Watershed in Aurangabad District, Maharashtra"

cropping pattern, improvement in water and soil quality etc[12]. Studies of the drivers of collective action in successful watersheds have found tangible economic benefits to farmers through in-situ rainwater conservation[13].

Initiatives by Government of Maharashtra

Government of Maharashtra is therefore taking Watershed development in a big way and has an ambitious plan in this regard. Considerable progress has already been made with about a third of the State's treatable area has been taken up already under various watershed projects.

Figure 17: Progress of Watershed works in Maharashtra

Year	Number of Watersheds	Treatment Area (Hectares)	Total Investment (Rs. Crores)
2009-10	239	957,534	1,149
2010-11	359	1,468,478	1,762
2011-12	212	883,621	1,060
2012-13	120	526,545	632
Total	930	3,836,177	4,603

Source: Vasundhara, Government of Maharashtra

Recommendations

Despite significant investment of financial resources, the achievements of the programs could be further improved. Following are some of the recommendations for improvement of the watershed program.

- ❑ **Review financial norms for investment for watershed development -** The present norm for watershed development is INR 12,000 per hectare. Based on consultation with various stakeholders, it appeared inadequate to completely treat the watershed from the perspective of executing all the desired works with the present norms. A consideration for higher allocation could support engineering solutions which would improve equitable distribution of water in the watershed. It is also learnt from stakeholder feedback that not only higher financial norms but also procedures involved in availing the funds need to be streamlined.
- ❑ **Consider more focus on on-field works in place of drainage line treatment works –** Based on discussions with NGOs, watershed experts and local field practitioners it emerged that there

[12] Watershed Development in Maharashtra: Present Scenario and Issues for Restructuring the Programme Abraham Samuel, K. J. Joy, Suhas Paranjape, Sowjanya Peddi, Raju Adagale, Prafull Deshpande and Seema Kulkarni Society for Promoting Participative Ecosystem Management (SOPPECOM), Pune Forum for Watershed Research and Policy Dialogue

[13] Wani, et all, 2003. "Efficient Management of Rainwater for Increased Crop Productivity and Groundwater Recharge in Asia

is excessive focus on drainage line treatment works in many cases. The on-field water conservation is many times neglected (perhaps due to lack of funds), however this is a critical area for preventing soil erosion and maintaining soil moisture which is important for plant water uptake.

- **Assess ways to gain a fuller understanding of local water balance and its relation to overall water balance of the sub-basin –** In many cases it is observed that a holistic and scientific approach in computing the local balance and understanding its implications for the cropping pattern may be beneficial. For example, if the local water balance does not support high water consuming crops such as Paddy in the Rabi season, then there needs to be efforts from government to actively promote other water efficient crops in the watershed. There is also limited understanding of the impact of watershed works on downstream users. For example, many stakeholders believe that watershed development would reduce the in-flows into downstream reservoirs. However, there are many benefits also to downstream users of watershed works such as increased sub-surface flows due to higher groundwater recharge, better quality of water (less siltation of dams) and availability of water at a more appropriate time. Watershed works also reduce the intensity and likelihood of flooding since more water is stored locally. A more scientific understanding of the water balance using latest technologies would help manage water balance locally and its relation to overall water balance optimally.
- **Consider increasing the capacity of the watershed program implementing agencies –** There is a wide variation in the outcomes of the watershed programs due to significant dependency on and variation in the capability of the project implementing agencies (NGOs and government agencies) to design and implement interventions. There is a need to ensure quality of program implementation in all agencies.

Key Stakeholders

Vasundhara Watershed Development Agency, NGOs, Research Institutes like WALMI-Aurangabad, Department of Agriculture, Local Government Agencies, Private Sector - Support through CSR

4.2.2 Poor water use efficiency

Challenges

The second challenge relates to poor water use efficiency of supplemental irrigation systems developed through groundwater use. Most of the groundwater used is applied through flood irrigation system which results in significant water losses due to unproductive evaporation. Considering the scarce nature of water available, it is imperative that water is used with maximum possible efficiency which would require technological interventions.

A related challenge is the emerging inequality in access of water. Inefficient water use allows farmers in lower lying areas or with high capacity water abstraction structures (bore-wells, deeper wells etc.) to exhaust locally available ground water depriving usage by other farmers. If water is used with higher efficiency it is likely to be able to provide supplemental irrigation to more number of farmers in the watershed.

Development Priorities

Micro-irrigation has been recognized as the single-most effective solution for improving on farm water use efficiency. Both drip and sprinkler irrigation systems have water use efficiencies much higher than traditional flood irrigation systems. In addition to higher water use efficiency micro-irrigation systems offer several other advantages which are capture in the table below:

Figure 18: Advantages of Micro-irrigation system over conventional system - Generic

Parameter	Conventional System	Micro-Irrigation System
Water Saving	Wastage of water due to percolation, runoff and evaporation	40-70% of water can be saved compared to conventional system
Water Use Efficiency	30 – 50% because water losses are very high	60-70%
Power Saving	More power requirement due to more hours of pumping for irrigation per unit of area	Less power requirement
Efficient use of fertilizer	Low efficiency because of heavy losses to leaching and run-off	30 – 40% fertilizer can be saved
Less labor requirement	Labor required to remove weed; higher monitoring required	No labor required to remove weed; Less effort required to monitor irrigations

Initiatives by Government of Maharashtra

Recognizing the need to promote micro-irrigation systems, Government of India has created a National Mission on Micro Irrigation (recently subsumed under National Mission for Sustainable Agriculture) to promote drip and sprinkler systems by providing capital subsidy to farmers. Government of Maharashtra has actively implemented this scheme through Department of Agriculture to provide benefit to its farmers. The Government provides capital subsidy of 50% to 60% for installation of Drip and Sprinkler systems. Maharashtra has one of the highest rates of adoption of Micro-irrigation systems in the country.

Recommendations

Rapidly expand coverage under Micro-irrigation: Despite the focus of the Maharashtra government, the gross area under micro-irrigation is around 1 Million Ha, with average area expanded by about 100,000 Ha in the last five years. Considering that the State’s total area under agriculture is more than 20 Million Ha and only about 20% of it is covered under formal irrigation system, at the present rate it would take decades before micro-irrigation systems can be installed in every farmer’s field in the State. The government needs to ramp up coverage of the micro-irrigation systems by channelizing more investments in this space.

Develop smart subsidies to increase leverage of public investments: Many stakeholders including micro-irrigation companies have raised concerns that the present subsidy scheme is in-fact hindering the faster spread of micro-irrigation systems in the State (since farmers wait for their turn to avail subsidy). Therefore, in addition to provision of higher outlays for this scheme, one of the other potential solutions is to develop smart subsidies where the Government’s contribution is leveraged through much better financial instruments to achieve much higher leverage and therefore much faster rates of adoption.

Key Stakeholders

Department of Agriculture, Micro Irrigation Companies, National Mission on Micro Irrigation

4.2.3 Outdated farming practices and inadequate access to markets

Challenges

Evidence from water balance analysis on farmers' fields have shown that only a small fraction of rainfall (as low as 30%) is used as productive water for plant growth. Considering this there is ample room for improving agriculture productivity by promoting better rainwater management practices.

Agriculture productivity is a function of several variables out of which water is only one (albeit one of the most important variables). Productivity also depends on soil fertility, quality of seeds, adequate and balanced fertilizers including micro-nutrients, pest control etc. Agriculture in small-holder rainfed systems of Maharashtra is practiced using traditional farming practices. Modern advancements in science and technology have yet not been widely adopted in Maharashtra, as in several other States. The modern practices developed in public or privately funded research labs need to reach every farmer through appropriate extension efforts.

Reaching out to such large number of farmers, who are either too poor or risk averse in making investments in modern agriculture, is a huge task. Perhaps this is one of the most critical challenges in increasing agriculture productivity in Maharashtra. In addition, the farmers which are not near any urban demand centers for their produce also face difficulty in establishing effective links with the market.

Development Priorities

There is a need to fully understand various strategies for improving rainwater productivity in agriculture. The following figure gives a snapshot of such strategies presented in an IWMI publication on rainfed agriculture.

Figure 19: Rainwater Management Strategies and Management Options to increase Yields in Rainfed agriculture

Aim	Rainwater management strategy	Purpose	Management options
Increase plant water availability	External water harvesting systems	Mitigate dry spells, protect springs, recharge groundwater, enable off-season irrigation, permit multiple uses of water	Surface microdams, subsurface tanks, farm ponds, percolation dams and tanks, diversion and recharging structures
	In-situ water-harvesting systems, soil and water conservation	Concentrate rainfall through runoff to cropped area or other use	Bunds, ridges, broad-beds and furrows, microbasins, runoff strips
		Maximize rainfall infiltration	Terracing, contour cultivation, conservation agriculture, dead furrows, staggered trenches
	Evaporation management	Reduce nonproductive evaporation	Dry planting, mulching, conservation agriculture, intercropping, windbreaks, agroforestry, early plant vigor, vegetative bunds
Increase plant water uptake capacity	Integrated soil, crop and water management	Increase proportion of water balance flowing as productive transpiration	Conservation agriculture, dry planting (early), improved crop varieties, optimum crop geometry, soil fertility management, optimum crop rotation, intercropping, pest control, organic matter management

Source: Managing Water in rainfed agriculture – IWMI

All the above measures help in reducing the water requirement on fields. Discussions with stakeholders have revealed that most of these practices have been field tested in research organizations in

Maharashtra and India but most have not reached farmers' fields. Clearly investment in using the knowledge by converting it into practices through policies, programs, trainings etc. is a clear development priority for the State.

Initiatives by Government of Maharashtra

Government of Maharashtra through agriculture department has been running several programs for agriculture extension. These programs aim to educate farmers on several aspects such as suitable crops, seeds, nutrients and fertilizers, pest control etc. These programs are run through a network of agriculture universities, NGOs, Government staff, farmer field schools and agriculture extension workers among others.

In addition, Government of Maharashtra has been pioneer in leveraging private sector expertise for agriculture extension and establishing market linkages. Through a program supported by World Economic Forum, Agriculture Department of Government of Maharashtra runs a program called "Public Private Partnership for Integrated Agriculture Development". The program has following objectives:

- ❑ Share and demonstrate new technologies to increase productivity
- ❑ Aggregate farm produce to link it to markets
- ❑ Develop crop specific value chains
- ❑ Complement investments from public sector with investments from private partners and farmers

The following table summarizes the achievement of the PPP-IAD program in the last two years:

Figure 20: Progress under PPP-IAD scheme of Government of Maharashtra in 2012-13 and 2013-14

PPP – IAD	2012-13	2013-14
No. of Projects	20	20
No. of Farmers	1,15,525	1,79,690
Area (Ha)	78,138	1,44,700
Project Cost (INR Crore)	97.90	279.33
Government Share	41%	35%
Share of Farmers	44%	34%
Share of Private sector	15%	31%

Source: PPP-IAD Brochure issued by Government of Maharashtra

However, one significant component where focus has not been given in any of the existing interventions is in promotion of appropriate rainwater management practices.

Recommendations

Use ongoing PPP – IAD program as a vehicle for promoting rainwater management and water efficiency improvement practices – As part of the package of practices which are being developed for each value chain under the PPP – IAD program, there is a need to include a suitable component of rainwater management practices. The Government may think on establishing a package of practices related to rainwater management for each crop value chain through collaborations with suitable research universities. The private partners should be encouraged to promote these practices in their project areas.

Key Stakeholders

Department of Agriculture, NGOs, Agriculture Universities, Farmer Field Schools, Private Sector Companies, Civil Society Representatives

4.2.4 Lack of convergence in efforts in Rainfed Agriculture Development

Challenges

State Government's efforts and investments in watershed development, micro-irrigation and PPP- IAD program are all independent of each other and not coordinated. While there are clear benefits of such an approach as it benefit of public investment reaches more number of farmers, there are clear disadvantages as well. For example, it would help if watershed development program is complemented by investment in water use efficiency measures through micro-irrigation so that there is much larger benefit of the water source being created. If in the same project, investments are also made to develop capacity through PPP-IAD intervention and linkage to market is being provided then clearly a significant shift to higher value crop is possible in that area. Since all investments are concentrated in one region, it would also attract investment in physical infrastructure such as transportation, storage and processing facilities providing an overall uplift to the local economy.

In the present approach, creating such "crop specific growth clusters" is difficult, if not impossible. It would require informal co-ordination between different programs of the State government, which has proven difficult in India across many development sectors.

Development Priorities

Considering the benefit of the convergence approach, it emerges that development of a few crop specific growth clusters is an emerging priority. The state has significant development potential in a few crops such as Soybean, Cotton, Maize and a few Horticulture crops such as Oranges, Bananas etc. High investment in such crop specific clusters through a convergent approach can also potentially lead to higher exports if farmers can be trained to cultivate produce that can meet international standards and requirements. Many crops such as Soybean and Cotton have high international demand and State's economic growth would get substantial boost if it can serve this demand through rainfed areas.

Recommendations

4.2.4.1 Create a Watershed++ Model

Context

Investment in watershed development is the logical entry point for such an investment plan since it provides the necessary source of water and control over its variability. It is suggested that the watershed investments (duly enhanced with higher norms as recommended earlier) are complemented by investments in micro-irrigation and investments in PPP-IAD scheme through a corporate partner. Such a project would need to be a long gestation project as watershed development itself is a 3 to 5 year exercise. Since the corporate partner is involved from the beginning, it can facilitate necessary complementary investments provided for through watershed program specifically for the value chain planned to be promoted.

Objectives

The watershed++ model would have the following objectives:

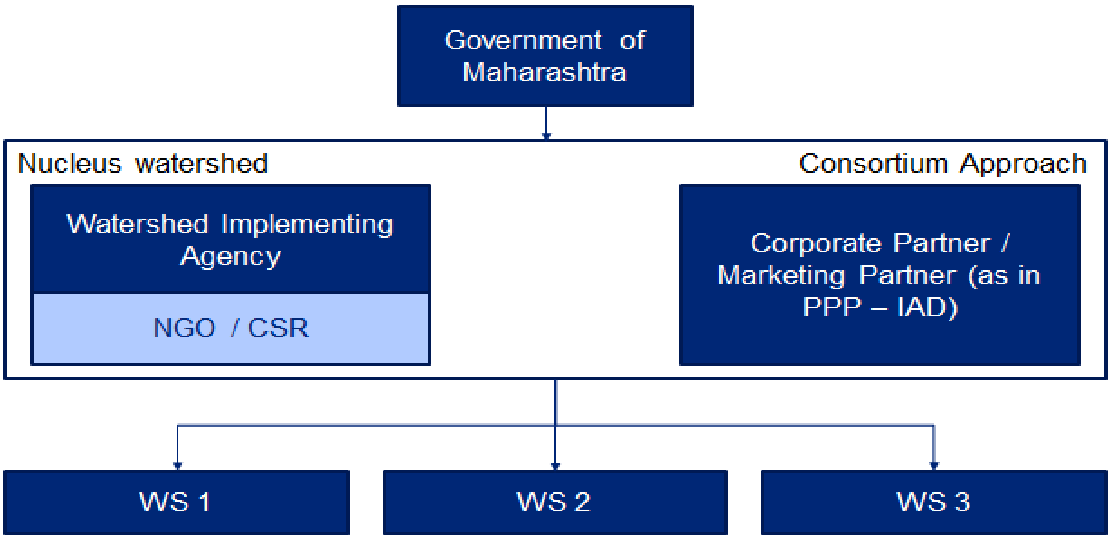
- **Scientific and saturated development** of the watershed
  - Use of techniques such as Remote sensing, GIS, Digital terrain modelling, crop simulation modelling for planning
  - Higher Investment in the watershed development activities focusing on equity of water distribution
- **Water balance** of the watershed should keep in perspective impact downstream
- **Higher agriculture growth** based on
  - Higher agriculture productivity (due to better water management)
  - Shift to higher value crops – Promote horticulture crops in select areas
  - Increase in cropping intensity – Few farmers can take more than one crops
- **Efficient use of water**
  - Micro Irrigation Systems for farmers which have access to secure water source
  - Water efficient agriculture practices focusing on soil moisture security for other farmers
- **Value chain specific objectives** – Area, productivity, quality, other standards and specifications

Roles and responsibilities

Since watershed development requires significant time and investment in mobilizing the community and building trust, it is suggested that the responsibility for watershed development vest with the NGO or CSR arm of a company. The corporate partner should work with the NGO in a consortium approach to implement the project. This consortium would be responsible for promoting activities related to watershed development, adoption of micro-irrigation, promotion of sound agriculture and rainwater management practices and facilitating end market linkages. In principle, this would be an effort led by organized, capable and mature public, private and civil society actors to facilitate economic development of some of the weakest and most vulnerable sections of the society by upgrading their (farmers') assets and capabilities for addressing the needs of the complex, globalized market for agriculture commodities. This would be impossible for such small-holder farmers without a guiding and handholding support.

The following diagram shows the implementation model for such a program.

Figure 21: Project Implementation Framework for the Watershed++ Model



The program would be under the overall guidance and co-ordination of Government of Maharashtra. The nucleus watershed is where all investments of different programs are made through a coordinated set of activities. To build on the economic momentum generated it is suggested that a few watersheds nearby are developed as satellite watersheds where the same NGO or CSR partner should take up watershed and other complementary activities. In these satellite watersheds, it may not be possible to channel investments in all programs through outside investments but it would still benefit from the knowledge, expertise and market linkages being developed for the nucleus watershed.

The following table provides select salient features of the Watershed ++ models on four building blocks of a) Watershed Development b) Water Use Efficiency Investments c) Good agriculture and water management practices and d) Market linkages with their respective timeline for intervention.

Figure 22: Key Features of the Watershed ++ model

Item	Watershed Development	Water Use Efficiency Investments	Good agriculture and water management practices	Market Linkages
Time frame	Five years	One – two years	Two to three years	One year
Parameters to be monitored	❑ Increase in water storage ❑ Increase in groundwater levels ❑ Soil loss ❑ Rate of run-off ❑ Cropping intensity	❑ Area under Micro-irrigation ❑ Area under supplemental irrigation	❑ Better seeds ❑ Micro-nutrients based on soil health survey ❑ Field Conservation, No tillage agriculture, Mulching, other techniques	❑ Total area under focus crop ❑ Total value of procurement
Investments required	❑ 12,000 / Ha – IWMP ❑ 13,000 / Ha – RKVY	❑ INR 70,000/Ha for drip ❑ 50% subsidy by Government of Maharashtra	❑ INR 1 lakh/ farmer ❑ 50% contribution by Government	❑ None
Total Investment for 5000 Ha watershed	❑ INR 12.5 crore	❑ INR 5 crore for 15% area under drip	❑ INR 50 crore (assuming total 5000 farmers)	❑ Any investment in marketing infrastructure as per requirement

Business Case for Involvement in Watershed++ Model

Investing significant time and resources in rainfed agriculture can be an important area for a range of private sector companies. In this section we identify four different categories of companies which can benefit from such a program.

- ❑ **Agriculture Input Suppliers –** Companies which are in the business of producing agriculture inputs such as fertilizers, seeds, pesticides etc. routinely engage with and train farmers for their business development activities. Such companies stand to benefit when farmers move up the value chain and produce crops which are of international quality as it would require the farmers to access high quality products from the market. The good will generated by the firm through its association in the project would act as a natural marketing advantage when the farmers decide which company's products to buy.

- **Food and agro processing companies:** Several companies use agriculture produce as a critical ingredient for their business and manufacturing operations. Such companies need control over raw materials in terms of quality, quantity and reliability. Partnering in a value chain intervention from conceptual stage (where decisions related to package of practices for production of the value chain crop are being made) would give such companies adequate influence to ensure that the end produce meets their requirements. Again, goodwill generated by the company would ensure that farmers are loyal to the company when they decide on selling their produce.
- **Micro-irrigation equipment supplier companies:** As can be seen from the table above, the micro-irrigation is a significant component of the investment in watershed++ model. Therefore companies engaged in providing equipment for micro-irrigation have a business case for involvement in such a project.
- **Heavy users of water or other resources in the watershed:** Companies which are heavy users of water or other mineral resources in the watershed need the social license to operate in the watershed. Being partner of such a significant economic development project would generate good-will that would enhance the reputation of the company and provide it with necessary social reputation capital to operate in the region.

Key Stakeholders

NGOs, Civil Society Representatives, Vasundhara Watershed Development Agency, Department of Agriculture, Private Sector Companies

4.2.5 Need for convergence with Water Resource Department and other water user sectors

Challenges

Water resource management historically has focused on the visible component which is "Blue Water". Water Resources Department of Maharashtra as elsewhere in the country has focused on development of large scale irrigation, drinking water systems and hydro-power projects. This has resulted in a focus on development of areas downstream of the dam with upstream areas where rainfed agriculture is practiced seen as more of blue water generating run-off zone. Department of agriculture usually has jurisdiction over the rainfed areas and its focus traditionally has been on soil erosion control and other input oriented interventions. There is limited co-ordination between agriculture department and water resource department from the perspective of overall water resource planning.

Maharashtra government has also developed a large number of lift irrigation projects which aim to irrigate areas up-steam of the dam by "lifting" the water through pumping. This type of projects place significant demand on the State's energy grid. At the same time many of the State's irrigation systems which irrigate downstream of the dam operate on very low water use efficiency. A joint framework would analyze an optimal development path considering various alternatives available. For example, it would consider whether storing water locally in upstream areas through intensive watershed development program would be more cost effective overall than providing irrigation in upstream areas through lift irrigation. State's urbanization and industrialization also place heavy demands on water resources especially for urban drinking water supply and energy production. A peace-meal approach to water resources development planning could lead to several sub-optimal choices.

Development Priorities

Clearly an integrated river basin approach which guides development of economic activity based on efficient utilization of water resources available, is crucial to achieve faster economic growth. Such plans would also need to cater to the needs of industry and domestic requirements. Therefore, such a plan would require interfaces between various departments such as Department of Agriculture, Water Resources Development, Urban Development, Industry, Energy etc. as well as representatives of private sector and civil society. Evolving a structure which enables formulation of such plans is a crucial development priority.

Recommendations

Create Integrated River Basin Development Plans – It is suggested that an active interface is developed between agriculture department and water resource department to develop Integrated River Basin Development Plans which would plan for all water resources (groundwater and surface water and rain water stored in soil moisture) by creating a water balance which accounts for Green water explicitly in the framework. It will also require continuous and coherent interactions across departments to guide the preparation and implementation of the plans. If such plans exist or are under formulation, they need to duly incorporate the needs for water usage in rainfed areas by channelizing more investments as this will not only pave the way for faster economic growth but also more equitable and sustainable economic growth.

Create a Multi-stakeholder Platform – A state level platform to facilitate dialogue between different stakeholders in the water resources development agenda is crucial to develop integrated plans. Choices related to investments of time and resources could be optimally made based on informed decisions taken by all the stakeholders jointly on sound and reliable data and analysis. This platform can drive the recommendations in this report as well as any subsequent analysis done in the water resources sector through creation of dedicated work-streams of concerned stakeholders.

Key Stakeholders

Department of Agriculture, Water Resource Department, Private Sector Companies, Research Institutes, NGOs and Civil Society Members, Vasundhara Watershed Development Agency

4.2.6 Summary of Recommendations and Role of Key Stakeholders

The table below presents our recommendations, primary responsibility of each recommendation and key stakeholders. It also indicates the time-frame for implementation by each stakeholder.

Recommendations	Time Frame	Vasundhara Watershed Development Agency	Department of Agriculture	Department of Water Resources	NGOs and Civil Society	Private Sector Companies	Research Institutes
Review Financial Norms of Investment for Watershed Development	Short Term						
Consider more focus on on-field works in place of drainage line treatment works	Short Term						
Assess ways to gain a fuller understanding of local water balance and its relation to overall water balance of the sub-basin	Medium Term						
Consider increasing the capacity of the watershed program implementing agencies	Ongoing						
Rapidly expand coverage under Micro-irrigation	Short Term						
Develop smart subsidies to increase leverage of public investments	Short Term						
Use ongoing PPP – IAD program as a vehicle for promoting rainwater management and water efficiency improvement practices	Ongoing						
Create Watershed ++ Model	Short Term						
Create Integrated River Basin Development Plans	Ongoing						
Create a Multi-stakeholder Platform	Short Term						

Primary Responsibility

Key Stakeholders

Indicated time frame for implementation by various stakeholders is based on following categorization:

- **Ongoing** – These are initiatives which are currently being implemented by the Government and need to be strengthened or expanded in scope at the earliest
- **Short Term** – These are measures that need to be implemented by Government in the next 1 to 2 years
- **Medium Term** – These are measures which should be evaluated more carefully and implemented in the medium term after careful diligence and planning. The Government could target to implement these measures in the next 3 to 5 years

5 Summary and Way Forward

Sustainable economic development of Maharashtra would require faster, more inclusive and sustainable economic growth. Investment in Rainfed areas of Maharashtra can contribute to all the three objectives. Studies have shown that investment in rainfed agriculture (through watershed programs for example) can provide higher economic returns on investments than in irrigation systems[14]. Since the majority of the poorest citizens of the State depend on the rainfed agriculture for their livelihood, interventions to promote growth of rainfed areas would be perhaps the most inclusive growth interventions. Even from the perspective of sustainability, increasing productivity of rainfed agriculture can contribute to meeting the food security challenges of rapidly growing population of Maharashtra without bringing additional area under agriculture (perhaps through conversion of forest land).

Facing the food security and poverty challenges in Maharashtra will therefore require a new emphasis on smallholder rainfed farming. This would require large scale investments in rainwater management and renewed policy focus. The report has shown that the primary challenge facing Maharashtra (apart from a few isolated pockets) is the higher risk posed due to variability of monsoon rather than absolute scarcity of water. Therefore interventions designed to manage and store rainwater, combined with interventions to use the stored water efficiently and linking the agriculture produce to market can be very effective in promoting rainfed agriculture growth. The report has examined existing interventions of Maharashtra in this regard and provided recommendations to provide further impetus.

The report also argues for an end-to-end Watershed++ approach as high intensity investment in select value chains and regions to act as drivers for local economic growth. Such experiments would not only provide indirect stimulus to similar regions in the nearby region, but also provide useful feedback for planning development interventions using private sector skills and expertise in other programs. Integrating small-holder farmers in national and global value chains would require concentrated efforts over a long period of time, but it is perhaps the only way in which benefits of economic growth through liberalization and globalization can reach the poorest of the poor of Maharashtra.

Lastly, this report focuses on a small but relatively neglected part of the water resources challenge facing Maharashtra. Clearly there are other pressing areas where focussed policy attention is required as well such as water demand from urban, industrial, energy and irrigation systems in the next few decades. A multi-stakeholder platform which can clarify the challenge facing the State based on an estimate of water demand - supply situation, assess the resulting gap and identify solutions for closing the gap based on most effective solutions would be an important step towards securing a safe water future for the State.

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[14] Fan, S., P. Hazell, and T. Haque. 2000. “Targeting Public Investments by Agro-ecological Zone to achieve growth and Poverty Alleviation Goals in Rural India.” ; Unlocking the Potential of Rainfed Agriculture

Fox, P., J. Rockstrom, and J. Barron. 2005. “Risk Analysis and Economic Viability of Water Harvesting for Supplemental Irrigation in Semiarid Burkina Faso and Kenya.”

Ngigi, S.N., H.H.G. Savenije, J. Rockstrom, and C.K. Gachene. 2005. “Hydro-Economic Evaluation of Rainwater Harvesting and Management Technologies: Farmers’ Investment Options and Risks in Semiarid Laikipia District of Kenya.”

Panigrahi, B., S.N. Panda, and A. Agrawal. 2005. “Water Balance Simulation and Economic Analysis for Optimal Size of On-farm Reservoir.”

Progress So far

The findings of the report have been presented to the Sounding Board constituted to oversee water sector reform in the agriculture sector in Maharashtra as mentioned earlier. The key findings have also been shared with a select group of technical committee members for their comments. This report has been prepared by incorporating observations made by both groups of key stakeholders. Based on the discussions during Sounding Board Meetings, the 2030 WRG and Department of Agriculture, Government of Maharashtra have decided to pursue the following working streams:

a) Linking govt. funding schemes with private sector investment through a watershed++ PPCP model
b) Viable (low-cost) water saving technologies & smart financing
c) An integrated water management approach for Aurangabad area

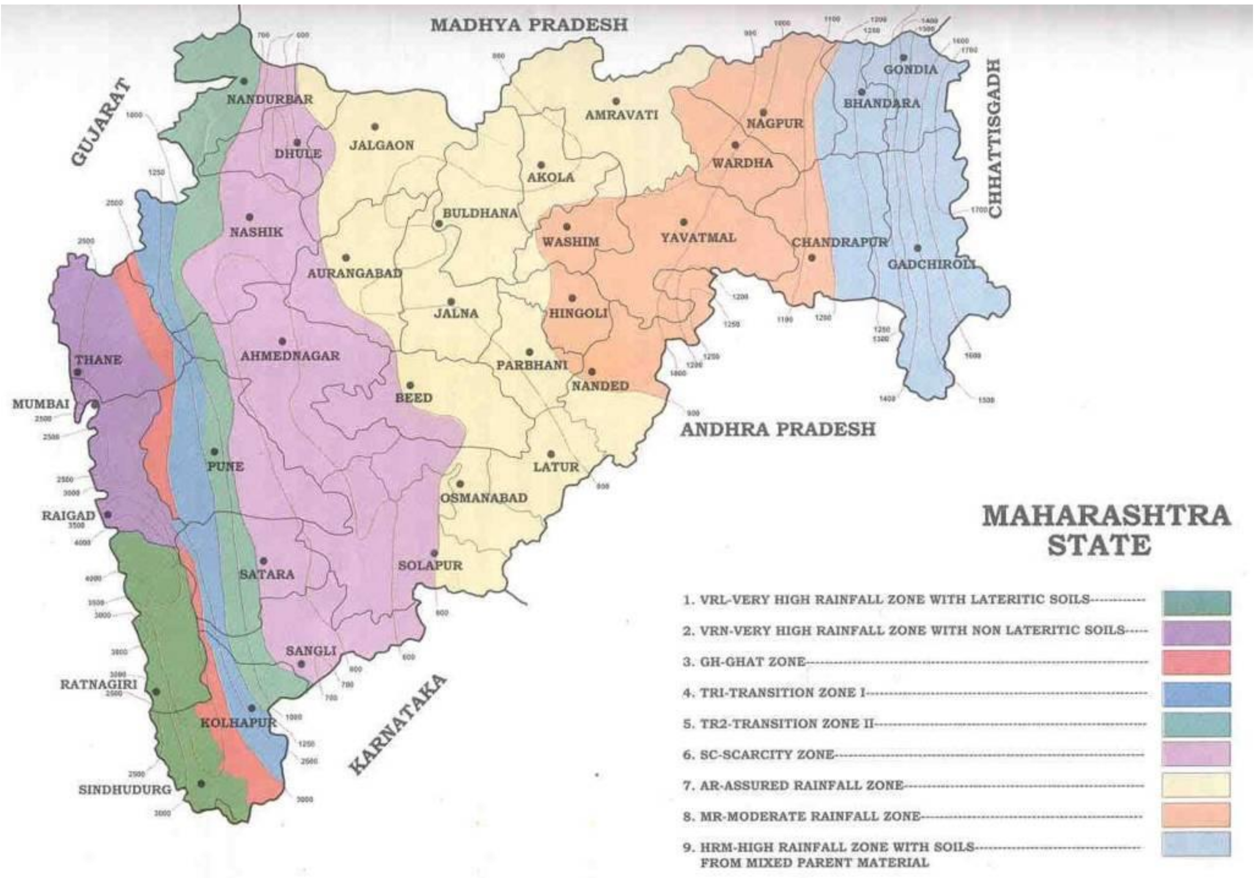
Presently the conceptualization and formation of the work-streams is underway.

Way Forward

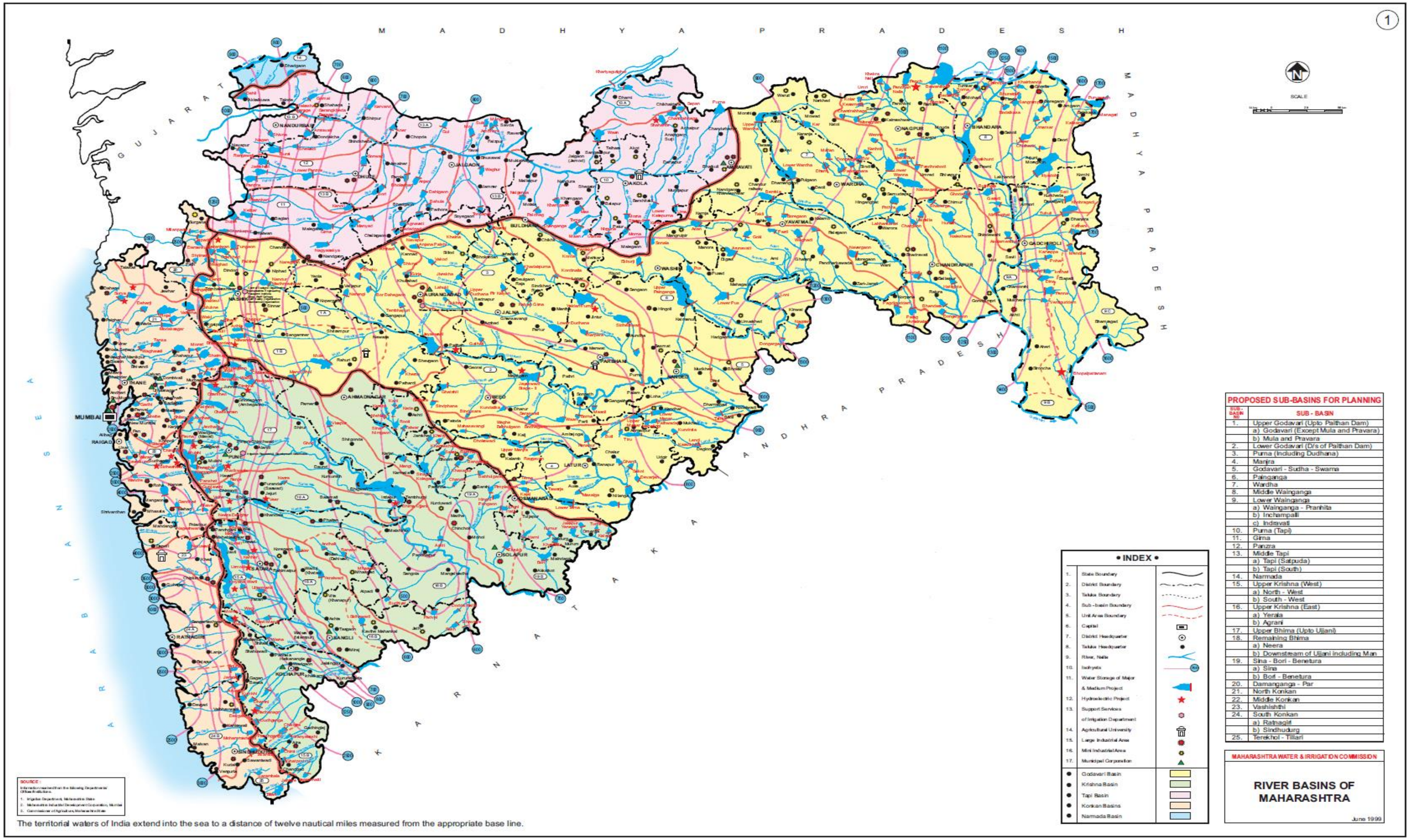
The report presents a broad analysis of water sector interventions required in rainfed agriculture in Maharashtra. In addition to the recommendations provided in the report, there are certain areas where there is a need to strengthen understanding which could facilitate the holistic water sector transformation process. It is suggested that a fuller Hydro-economic analysis comprising of water demand-supply estimates for 2030 for agriculture (irrigated and rainfed), domestic (urban and rural) and industry (including power) is conducted to obtain a comprehensive picture of the State's water security scenario. The analysis should include identification of solution-set and a comprehensive methodology to prioritize the solutions based on sound economic principles. The analysis should also present a comprehensive roadmap of interventions including prioritized solutions and governance mechanisms to oversee the implementation.

6 Annexure I: Agro-climatic Zones and River Basin Map of Maharashtra

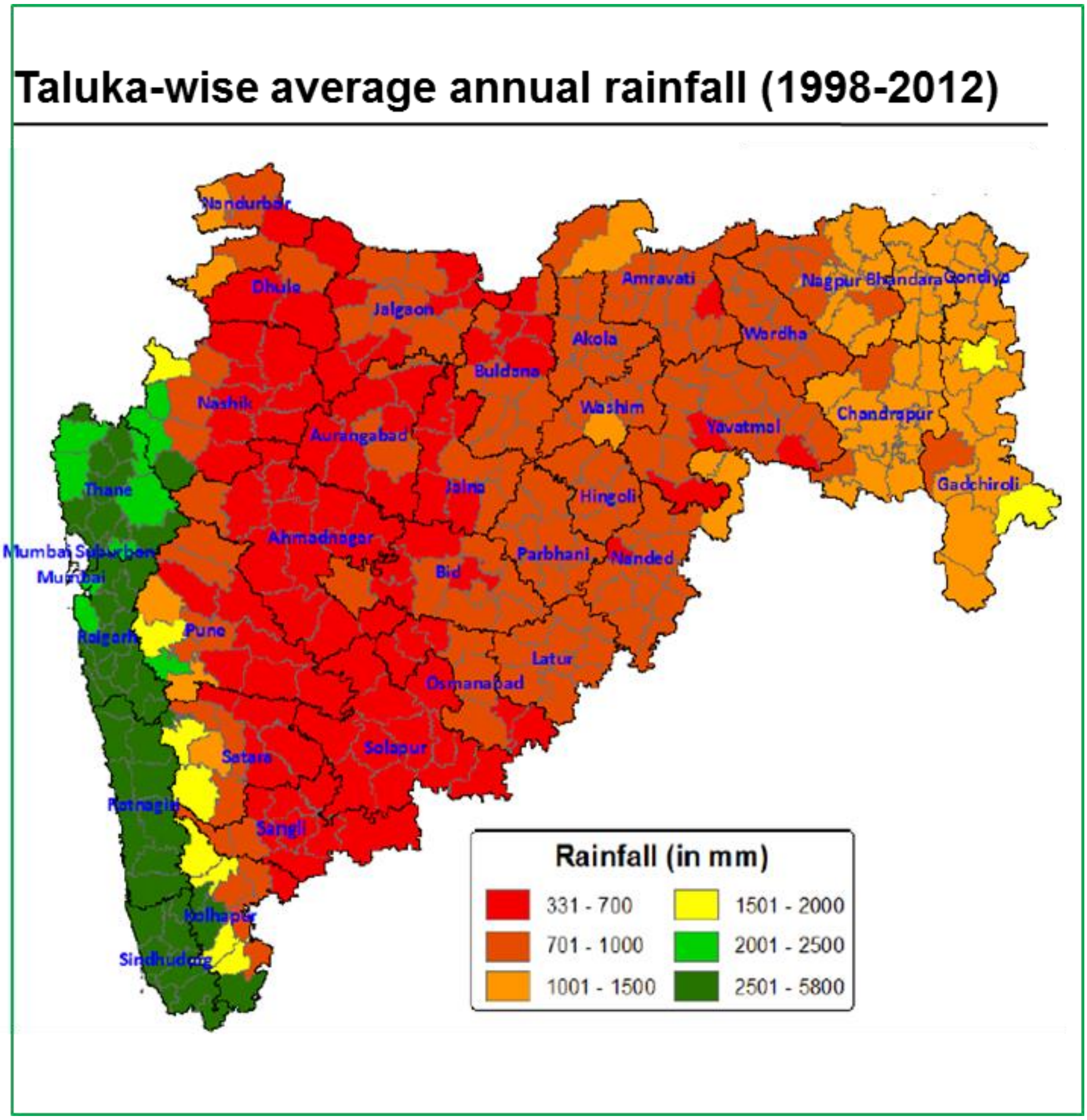
Agro-Climatic Zones of Maharashtra



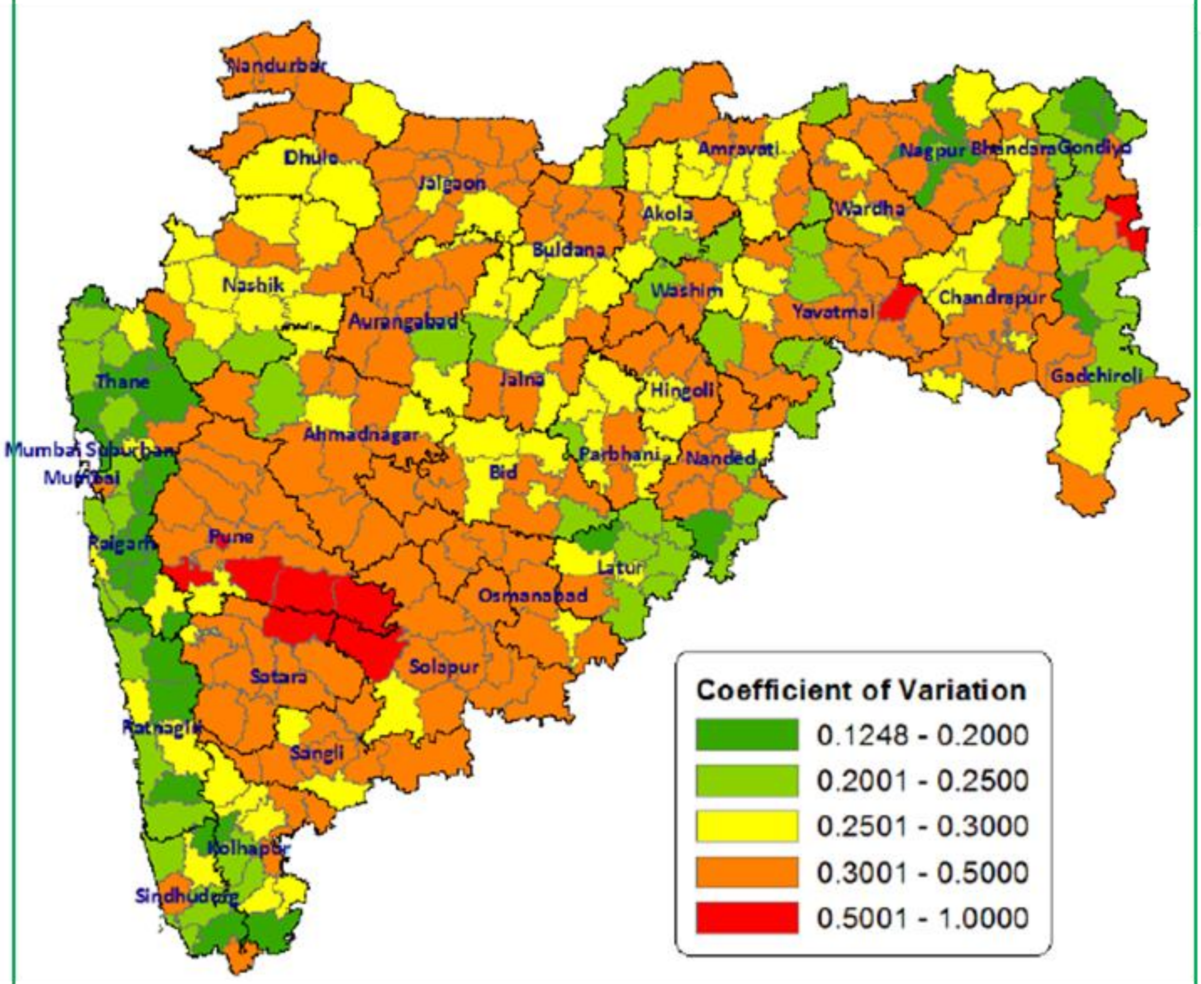
River Basin Map of Maharashtra



7 Annexure II: Rainfall Variability Maps of Maharashtra



Taluka-wise variation in annual rainfall (1998-2012)



8 Annexure III – Aurangabad Deep Dive

8.1 Aurangabad District - An Overview

Aurangabad is one of the important districts of Maharashtra state located in the central part of the state. The district comprises of 9 talukas and 1344 villages, covering an area of 10,100 sq. km with a population of 36.95 lakhs. According to 2011 census Aurangabad district stands tenth in Maharashtra state in terms of population. Out of the total area of the district only 141.1 sq. kms is urban area. Roughly triangular in shape, the southern side is bound by river Godavari and the northern side to the northeast by trending arm of the Ajanta ranges. The district is bounded by Jalgaon District on the north, Buldana and Jalana districts on the east, Beed and Ahmednagar districts on the south and Nashik district on the west.

Average rainfall of the district as a whole is at 612.38 mm. The net sown area is 7.2 lakh ha and the irrigated area is about 2 lakh ha of which 30.4% is irrigated through canals and tanks and 65.1% through open and bore wells. The major crops in the district are maize, bajra, cotton among others.

8.2 Water Supply and Demand based on existing planning in the District seems unsustainable

The following table shows the total water availability in the District as per Aurangabad Water Vision 2020.

Item	Unit	Value
Total Rainfall	Mm	612
Total Precipitation	Mm3	6189
Total Surface Water Available	Mm3	1200
Total Ground Water Available	Mm3	432
Total surface and ground (Blue Water)	Mm3	1632
Water Available from other District (Nandur Madhmeshwar Irrigation Project)	Mm3	285
Reuse and Recycling	Mm3	174.24
Total	Mm3	2091
Total Estimate for Green Water available for agriculture	Mm3	NA

Source: Aurangabad Vision 2020 – Chapter on Water

As can be seen from the table, the Aurangabad Vision does not estimate the total green water availability for crop growth. It only mentions surface water demand. This is a key lacunae in the planning framework of the State.

The following table shows the estimate of present and future water demand of the State.

Sector	Unit	Demand Now	Demand in 2020
Agriculture	Mm3	982	1180
Domestic	Mm3	60 (Aurangabad) NA(Total)	143(Aurangabad) 182(Total)
Industry	Mm3	26.28	81.03
Livestock	Mm3	NA	15.40
Return Flows	Mm3	NA	-174.24
Environment	Mm3	NA	20
Evaporation Losses	Mm3	NA	370
Total	Mm3	NA	1848.83

Source: Aurangabad Vision 2020 – Chapter on Water

As can be seen from the table, the total demand is estimated to growth substantially for both urban and industrial sectors. The growth of agriculture demand (Blue water) component is also increasing. While it appears to be within the total supply estimated in the previous table, the ground realities are different. For example, to meet the demand of 60 Mm3 of water to Aurangabad city, it is necessary to provide 148 Mm3 water today considering the various losses (evaporation and within the city). This shows that there would be tremendous water stress in the district in just next five years unless some decisive measures are taken.

Even today, the industrial water demand from four major industrial areas of Aurangabad which is 26.28 Mm3 is not fulfilled. There is a deficit of about 25% (6.8 Mm3) in supply to these four industrial areas which are an important source of employment generation for the district. This is seen as one of the major inhibitors for industrial growth of the district. Considering that industrial demand is increasing so rapidly, it is felt that water would become a key constraint for industrial growth going forward.

The overall demand –supply scenario is therefore highly stressed. It would require major investments in urban water supply, industrial water supply and irrigation to meet the district's water requirements. The district also need to plan beyond 2020 as water requirements would continue to rise and the entire supply would almost be planned for.

8.3 The inflows into Jayakwadi Dam, which is a key reservoir for water in the district are highly erratic

The major dam in Aurangabad is the Jayakwadi dam whose catchment area includes Nashik, Ahmednagar, Jalna and Aurangabad. Gross storage of Jayakwadi is 2909 Mm3 however the utilizable water stock is 2171 Mm3. This project was originally intended to address the need of irrigation in this area and therefore there is no provision to allocate the water to non-irrigation purposes like industry and drinking. But because of the change in social scenario the original policy and principles were reinterpreted and revised for non-irrigation purpose. At the minimum over 15 % of the storage is reduced due to sedimentation.

In addition, there is a serious issue of variability of actual storage due to variability in rainfall pattern. Much of the catchment area, barring the Nashik region where it origins is a drought prone or low rainfall region including the effective catchment of the Jayakwadi reservoir. For example, on January 2010 at the end of the monsoon period and before the start of the summer season, the live storage was only 18% while on the same date in 2009 it was 71%. Similarly in July 2009 the live storage was 11% but on the same date in 2008 it was 23%. The previous 5 years average for the same date was 35.65%. This shows the apprehension of key stakeholders in urban and industrial sectors which depend on Jayakwadi for their daily survival and operations. The Reservoir, over a life span of 35 years as in 2009, has overflowed only 17 times. During the 31 years till 2006 the reservoir had filled up to 75 – 100% of capacity only 11 times. In fact, recently a judicial intervention was required to meet the drinking supply needs of the city by releasing water from upstream Nashik.

8.4 Present emphasis in Agriculture Development is on irrigation and area expansion which are both water intensive growth strategies

At the time of preparation of Aurangabad Vision, the rainfed area was estimated at 5 lakh Ha and irrigated area was estimated at 0.58 lakh Ha. The vision estimates to meet the need for growing population's food requirements, total area under agriculture would have to increase from 5.5 lakh Ha to 6 lakh Ha with 1.33 lakh Ha under irrigation and 4.75 lakh Ha under rainfed. The report estimates that this would increase the water demand for irrigation from 982 Mm3 to 1180 Mm3. As we have discussed earlier, the water demand from competing activities (which generate higher economic output per unit of water) is also rising very rapidly and therefore the district need to re-evaluate its present strategy for meeting the food production demand through conversion of rainfed areas to irrigated areas.

8.5 Can Watershed ++ model be an alternative imagination for Aurangabad's water future?

One possible solution in this scenario is to attempt massive productivity expansion in rainfed areas by taking help of private sector actors which require surface water sources. This could be done through the Watershed ++ framework as discussed earlier. This strategy would lead to higher agriculture output and saving of precious Blue water for industrial and urban growth which are the true economic drivers for the district.

8.6 Discussion on Way Forward

The demand supply gap in the future can perhaps only be arrested with focusing on rainfed agriculture development in the district (instead of irrigation). The resources outlined for irrigation development are substantial (estimated at 1860 crore for irrigation construction projects). The watershed ++ model is far less resource intensive and further utilize the green water available in the district for higher agriculture production. With watershed development, the quality of water reaching in the Jayakwadi dam will also improve as a result of reduced soil erosion and the problem of siltation of the dam will be reduced. Additionally the sub-surface flows may compensate for the reduced surface flows (if any)to the dam due to watershed development. This also needs to be ascertained through further analysis of the overall water balance of the key river sub-basins in the district.

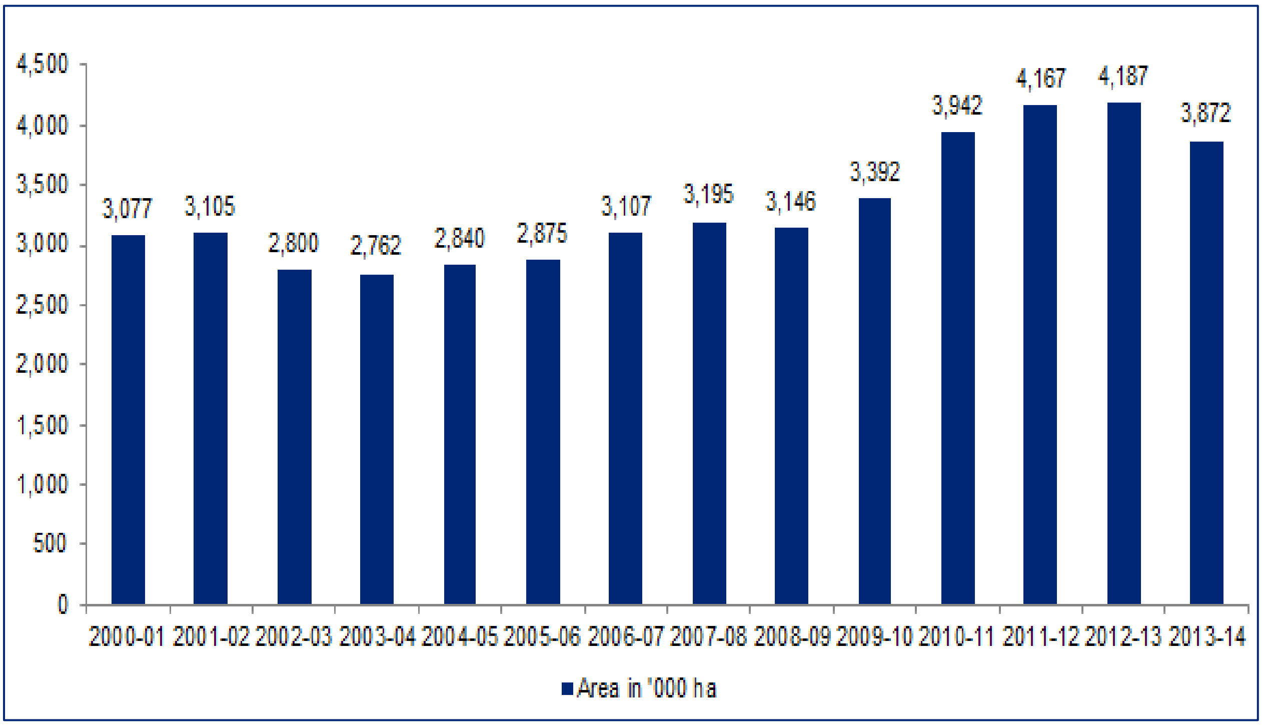
Thus water scarcity situation in Aurangabad provides an interesting example where industrial stakeholders from water user industries would be keen to implement the watershed ++ model. The increased water availability (due to avoided irrigation development) with help in improving the current domestic water supply as well as provide opportunities for the growth of industrial sector in the region. The agricultural sector will also benefit with increased production of higher value crops and increased market linkages with development of various agricultural industries as envisaged in the watershed ++ model.

9 Annexure IV – Cotton Deep Dive

9.1 Cotton is an important cash crop for Maharashtra

Cotton is an important fibre crop of global significance, which is, cultivated in tropical and sub-tropical regions of more than seventy countries. India had the largest acreage under cotton at global level and ranked second in production after China during 2009-10. Maharashtra accounts for about 30% of the area under cotton and about 20% of cotton production in the country. It covers roughly an area of 3.8 million hectares and is the most important cash crop in the Western Vidarbha region with eight of the eleven districts primarily growing cotton. It plays a key role in the National economy in terms of generation of direct and indirect employment in the Agricultural and Industrial sectors. The following graph shows growth of area under cotton cultivation in Maharashtra.

Figure 1: Area under cotton over the last decade



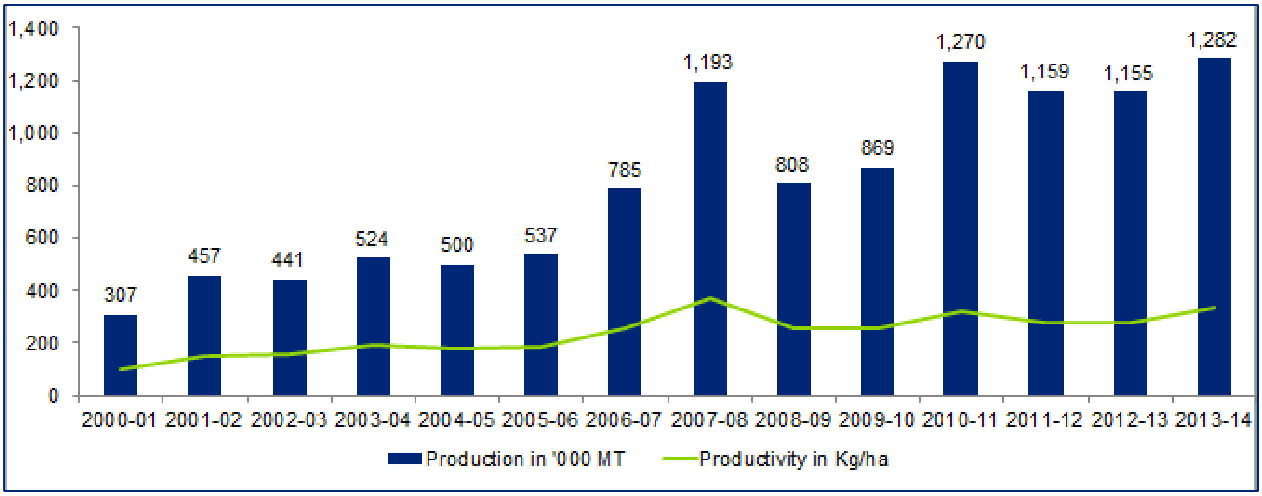
Source: Economic Survey of Maharashtra

Over the past decade, area under cotton has grown at a marginal CAGR of 1.8%, but production has shown a CAGR of 11.6% which can be attributed to the steady rise in productivity. However when we look at the productivity figures, they still lag behind the National average by 40% in 2013-14.

One of the reasons for the productivity gap is that in Maharashtra cotton is grown mainly in the rainfed regions where the soil is poor in fertility as it is subject to runoff, erosion and nutrient losses. The northern cotton growing areas of the country are almost entirely irrigated which leads to much higher productivity. This also shows the centrality of water in ensuring higher productivity of cotton. Apart from the total quantity of water, the variability in rainfall events (leading to dry-spells) plays an important part in lower productivity of cotton in Maharashtra.

The graph below shows the total production and productivity of cotton in Maharashtra.

Figure 2: Production and Productivity of cotton



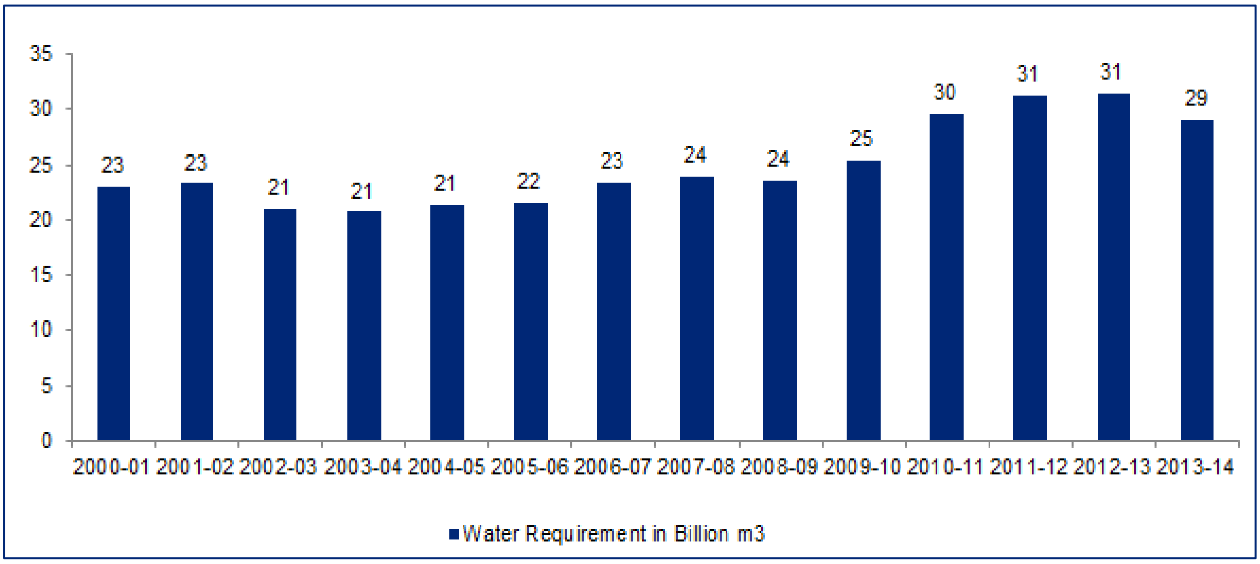
Source: Economic Survey of Maharashtra

As can be seen from the graph the total productivity of cotton has increased from less than 200 Kg / ha in 2000-01 to more than 300 KG / Ha in 2013-14. This has been achieved in rainfed areas through active support from the agriculture department as the area under irrigation in cotton has hardly increased in Maharashtra. The watershed development works would also have contributed to this increase in productivity however, the exact reason for productivity increase are hard to quantify as the agriculture department invests in improving productivity through improvement in seeds, fertilizers, pesticides as well as implementation of Micro-irrigation programs.

9.2 Water Requirement in Cotton is very high and is increasing

Cotton is a water intensive crop having a water requirement of close to 72.5 cm per hectare as per data obtained from WALMI, Aurangabad. Considering that the major cotton growing areas of the State have rainfall between 700 mm to 1000 mm, it can be inferred that the crop does not get the sufficient water in the State as it is grown in rainfed condition primarily. This also explains its lower productivity. Based on this estimate the water required for cotton in the state would be close to 30 billion cubic metres (close to 1/4th of total agriculture water consumption (green and blue water). The following diagram shows normative demand for water in cotton in the recent past.

Figure 3: Water Requirement of cotton crop in Maharashtra



As the graph shows the water demand has increased on 23 BCM in 2000-01 to 30 BCM in 2013-14. With this enormous consumption of water, it becomes imperative to introduce water practices which are water efficient as well as rewarding for the farmers.

Considering that almost 95% of area under cotton is rainfed, any variability or delay in the rainfall can cause substantial damage to the crop. It is important that cotton receives sufficient quantity of water at regular intervals for its production. So in the absence of irrigation facilities, it becomes necessary to develop alternative means to supply water to the crop for supplemental irrigation. Groundwater is an important source for meeting the water demand during the dry-spells. However, excessive reliance on Groundwater can lead to depletion of the water source which has been witnessed across cotton growing areas of Maharashtra.

In this context, Watershed development becomes an important developmental intervention for the cotton crop. It not only helps in increasing the soil moisture required by the cotton crop but also increases the ground water levels to support the crops during dry spells in the monsoon season. With the introduction of micro irrigation, the scarce ground water resources can be used efficiently and it also increases productivity of the crop leading to better income for the farmers.

9.3 Globally recognition is increasing on the water stress caused by Cotton

Cotton is recognized as a thirsty crop by WWF in India and globally. Additionally, cotton cultivation often requires large quantities chemicals. This results in negative effects on the groundwater quality and environment. Thus the focus in the cotton world is now shifting towards organic cotton and development of a sustainable and environmentally friendly supply chain. Industry leaders from the Indian organic cotton sector have also started working towards creating a credible Indian organic brand. In addition to organic cotton, the industry has developed several other standards such as the Better Cotton Initiative or REEL (an in-house standard of CottonConnect – an important player in cotton value chain in India) which are not only targeted at water but also on many other cotton growing practices.

With increasing demand for cotton grown through appropriate sustainable standard (any of the standards mentioned above) in the international market, the supply is not being able to match the demand. This portrays a great opportunity for Maharashtra to tap into this market. However, developing organic cotton would require handholding assistance to build the requisite capacity in the farmers. Although brands play a key role in the development of standard cotton by generating the demand, yet at the grass-roots level collaboration between public sector, private sector, cotton experts, local community is important to realize its full potential

Organizations like Cotton connect and Better Cotton Initiative plays a key role here which brings various stakeholders onto a single platform to promote a sustainable ecosystem. They help in creating connected and committed supply chains which are sustainable through farmer training programmes, connecting buyers and sellers, encouraging stakeholders to be a part on various development programmes. This helps in growing cotton in a way that reduces stress on the local environment and improves the livelihood and welfare of cotton growers.

9.4 Watershed ++ Model can be an important vehicle to upgrade Cotton farmers

In order to understand the importance of Watershed ++ Model, a sample model with cotton as the crop is taken into consideration. This model envisages an area developed through watershed and introduction of micro irrigation techniques to enhance the water productivity in the area. It includes the various norms for watershed development, PPPIAD scheme and the subsidy provided by the government for the micro irrigation scheme.

As a sample model, an area of 5000 hectares is taken up and investment projections for developing the watershed along with investment through PPPIAD scheme for promoting modern agriculture practices is undertaken. Micro Irrigation through subsidy schemes by the state government is also incorporated in the model to promote water use efficiency.

Following assumptions have been considered while developing the watershed ++ model

- Pre and Post watershed area under cotton remains constant at 60%
- Productivity of cotton without the intervention of watershed and micro irrigation is taken as 300Kg/hectare
- Water saving with micro irrigation is 50%
- Productivity increase with watershed development and micro irrigation is 50%
- MSP of cotton is taken as Rs 40/kg

The following table shows projections for investment for developing the watershed through enhanced financial norms.

Table 1: Investment projection for developing watershed in an area of 5,000 hectares

Watershed Development		
Parameters	**Unit**	**Value**
Area	**Ha**	**5,000**
Investment Required per Ha	**Rs**	**25,000**
Contribution from IWMP per Ha	**Rs**	**12,000**
Contribution from other sources (RKVY) per Ha	**Rs**	**13,000**
Total Investment by IWMP	**Rs**	**60,000,000**
Total Investment by other sources	**Rs**	**65,000,000**
Total Investment in Watershed	**Rs**	**125,000,000**

This table demonstrates the investments required for developing a watershed in an area of 5000 hectares. Through various stakeholder consultations it was understood that the present IWMP norm for watershed development was not sufficient to completely saturate the watershed and hence a source of additional funds (RKVY Scheme) was required. The total investment in developing a watershed of 5000 hectares comes out to around Rs 12.5 Crores.

The following table shows projections for investment for promoting better agriculture practices in the watershed through investment in PPPIAD Scheme of Government of Maharashtra.

Table 2: Investment in PPPIAD Scheme

PPPIAD Scheme		
Parameters	**Unit**	**Value**
Investment Under PPPIAD Scheme per Farmer	**Rs**	**100,000**
Government Contribution	**Percent**	**50%**
Contribution from Corporates	**Percent**	**50%**

No of Farmers Involved	**Number**	**1800**
Total Contribution by Government	**Rs**	**90,000,000**
Total Contribution by Corporate	**Rs**	**90,000,000**

The PPP-IAD Scheme can help in supporting the farmer to implement a better package of practices where the government supports half of the expenditure and remaining half should come from corporates. The corporates are also required to tie-up with end buyers to insure that sufficient market linkages are created for absorbing the farm produce.

The following table shows investment in Drip Irrigation system.

Table 3: Investment in Drip Irrigation Systems

Micro Irrigation Scheme		
Parameters	**Unit**	**Value**
Cost of Installing Drip Irrigation for Cotton per Ha	**Rs**	**70,000**
Government Subsidy Available	**Percent**	**50%**
Investment by Farmer per Ha	**Rs**	**35,000**
Government Subsidy	**Rs**	**35,000**
Percent Area Under Cultivation in the Watershed	**Percent**	**60%**
Area Under Cultivation	**Ha**	**3,000**
Area Under Cotton Cultivation (60% of area under cultivation)	**Ha**	**1,800**
Area Under Drip before Watershed Development	**Percent**	**1%**
Area Under Drip after Watershed Development	**Percent**	**30%**
Additional Area brought Under Drip	**Ha**	**522**
Total Investment Required by Farmers	**Rs**	**18,270,000**
Government Subsidy	**Rs**	**18,270,000**

Watershed works will bear limited results if farmers continue the unsustainable use of water in the fields through flood irrigation. Thus introduction of drip irrigation becomes necessary as it saves close to 50% water. The table above depicts the investments required to introduce drip irrigation in the farms. The cost of drip system is assumed to be Rs 70,000 / Ha for which the government provides 50% subsidy. Here we have assumed that currently only 1% area is under drip irrigation, however post watershed development this increases to 30%.

The results which can be achieved from the above interventions are depicted below.

Table 4: Pre watershed scenario

Cropping Pattern - Pre Watershed							
Crop	Type	Area in ha	Productivity in Kg/ha	Production in MT	Water Requirement	MSP per Kg	Value of Produce in Lakhs
Cotton	Drip	18	450	8.1	65,250	40	3.2
	Rainfed	1782	300	534.6	12,919,500	40	213.8
	Total	1800	301.50	542.7	12,984,750	40	217.1

Table 5: Pre watershed scenario

Cropping Pattern - Post Watershed							
Crop	Type	Area in ha	Productivity in Kg/ha	Production in MT	Water Requirement	MSP per Kg	Value of Produce in Lakhs
Cotton	Drip	540	450	243	1,957,500	40	97.2
	Rainfed	1260	300	378	9,135,000	40	151.2
	Total	1800	345	621	11,092,500	40	248.4

It can be seen from the tables above that watershed ++ development and introduction of micro irrigation techniques leads to an increase of 14.4 % in the value of produce for the farmers at the same time the water requirement reduces by about 10%. The farmers can use the additional water saved to move to higher value crops such as horticulture. This has been the experience of many watersheds in the country. Additionally, the farmer would also save on electricity charges, labor, fertilizer etc.

9.5 Discussion on Way Forward

Improving productivity of cotton which is largely a rainfed crop would continue to be an important priority for the State. The recent demand for cotton produced through various standards provides an opportunity for the State to upgrade capabilities of its farmers through private sector participation. The private sector actors in cotton value chain can benefit from this arrnagement as they can be assured of reliable supply of cotton that meet their standards and the investment is shared by contributions from the public sector and farmer. Even suppliers of inputs to cotton such as seed companies, fertilizer companies or pesticide companies may be interested in such arrnagements as their investment would win them goodwill in the farmer community. Drip irrigation companies also have direct business interests in promoting their products through such a model.

Watershed ++ model appears to be a win-win situation for all stakeholders concerned. It is suggested that the Government invite some of the key stakeholders for a discussion on the possible modalities for execution based on the initial ideas presented in this report through a workstream.

10 Annexure V – Organizations represented in the Sounding Board

Organizations represented in the Sounding Board
Department of Agriculture, Government of Maharashtra
Confederation of Indian Horticulture & Grape (CIH)
Jain Irrigation Systems Ltd.
Mahindra & Mahindra
National Bank for Agriculture and Rural Development (NABARD)
Rallis India Limited
SABMiller India
Syngenta Foundation India
Federation of Indian Chambers of Commerce and Industry
TATA Chemicals Limited
Hindustan Unilever Foundation
WWF-India
Secretariat PPP-IAD Programme
The 2030 Water Resources Group

11Annexure VI: List of Select Stakeholders met

Organization	Representative	Designation
Department of Agriculture, Government of Maharashtra	Dr. S.K. Goel (chairperson)	Principal Secretary for Agriculture
Department of Water Conservation and Employment Guarantee Scheme	Mr. V Giriraj	Principal Secretary (Ex) Chairman Vasundhara
Confederation of Indian Horticulture & Grape (CIH)	Mr. Sopan Kanchan	President
Federation of Indian Chambers of Commerce and Industry (FICCI)	Mr. Arnab Kumar Hazra	Director
Hindustan Unilever Foundation	Mr. Ravi Puranik	CEO
National Bank for Agriculture and Rural Development (NABARD)	Dr. A R Khan	Deputy General Manager
Syngenta Foundation India	Mr. Baskar Reddy	Executive Director
Jain Irrigation Systems Ltd.	Dr. D.N. Kulkarni	President (Agri Food Division)
Mahindra & Mahindra	Ms. Beroz Gazdar	Vice President
Rallis India Limited	Dr. Veeramani Shankar	Managing Director & CEO
SABMiller India	Ms. Meenakshi Sharma	Vice President Sustainability and Communications
TATA Chemicals Limited	Mr. Ramakrishnan Mukundan	Managing Director
Secretariat PPP-IAD Programme	Mr. Prasun Sarkar	Manager
GSDA	Mr. Deshpande	Joint Director
The World Bank	Mr. Animesh Shrivastava	Lead Agriculture Economist – South Asia Agriculture and Rural Development
The World Bank	Mr. Manivannan Pathy	Sr. Agriculture Specialist

Organization	Representative	Designation
Rallis India Private Limited	Mr. K R Venkatadri	Chief Operating Officer – Agri Business
OLAM Agro India Limited	Mr. Roshan Tamak	Business Head – Sugar
OLAM Agro India Limited	Mr. Rajiv Kumar	Corporate Cane Head - Sugar
Hindustan Unilever Limited	Mr. Vijay Sachdeva	Procurement Manager – Supplier Development South Asia and Africa
Coca Cola India	Ms. Neelima Khetan	General Manager – Public Affairs and Communications
Federation of Indian Chambers of Commerce and Industry (FICCI)	Mr Arnab Kumar Hazra	Director
CottonConnect	Mr. Arvind Rewal	General Manager – South Asia
Earthwatch Institute India	Mr. Pradeep Mehta	Research and Program Manager
Earthwatch Institute India	Mr. Raghuvansh Saxena	Country Director
NABARD	Mr. C. S. R. Murthy	DGM – Business Initiatives
NABARD	Mr. C. V. Reddy	DGM – Business Initiatives
NABARD	Mr. V Sundararaman	AGM – (in Charge of PMU Pune)
NABARD	Mr. V Mashar	AGM – Development Policy Department
GIZ	Mr. Vikas Sinha	UPNRM Project – Technical Expert
Agriculture Department, Aurangabad	Mr. Lonare	Superintendent Agriculture Officer
Dilasa Janvikas Partishthan	Ms Vaishalee Khadilkar	Vice President
Vasundhara	Mr. Jayant Patil	Sr. Advisor and Information Officer

12Annexure VII: Technical Review Committee Members

Organization	Representative	Designation
The World bank	Mr. William Young	Lead Water Resources Management Specialist
ICRISAT	Mr. Suhas Wani	Principal Scientist (Watersheds) and project coordinator (Integrated Watershed Management Projects)
Confederation of Indian Industry (CII)	Mr. Raju Damle	Senior Advisor
ACWADAM	Mr. Himanshu Kulkarni	Head
WOTR	Mr. Crispino Lobo	Managing Trustee

13Annexure VIII: Methodology for preparing the Water Balance

13.1 Introduction

This annexure presents the methodology used for preparation of the Water Balance. Since this is an initial water balance, the focus is on presenting an overall framework and achieving a reasonable level of accuracy. Ideally, the water balance needs to be prepared in close consultation with Water Resource Department staff (which was not done presently) and therefore the numbers should not be taken as approved from Government of Maharashtra. It is an indicative water balance to illustrate the nature of challenges Maharashtra faces from the perspective of its water resource availability, present and future utilization. It is also suggested that water balance be prepared separately for each river basin which would highlight areas under water stress in the State as overall picture tends to mask key regions facing water scarcity.

The following table presents the source / methodology used to estimate each number in the water balance and its likely accuracy as judged by our team.

Catchment Water Balance		Source / Methodology	Accuracy
IN	Rainfall	Estimated based on district wise average rainfall of last five years	Medium
USE	Estimate of Rainfall in Rainfed Areas	Estimated based ratio of total area in rainfed agriculture and total area of the State	Medium
	Estimate of Rainfall in Irrigated Area	Estimated based ratio of total area in irrigated agriculture (inside CCA of surface water irrigation schemes, excludes private groundwater irrigation) and total area of the State	Medium
	Forests and others	Estimated based ratio of total area in forests and other uses and total area of the State. It is recognized that co-efficient of run-offs will be quite different in different areas of the State (Very low in forests, very high in wastelands) but it is expected that it will average out when both these are combined.	Low
OUT	Ground water Recharge	Data input from GSDA	High
	Streamflow	Data input from MWRRA	High
	TOTAL	**Derived from above two figures**	**High**

Water Resources Water Balance		Source / Methodology	Accuracy
IN	Ground water recharge	Data input from GSDA	High
	Streamflow	Data input from MWRRA	High
	TOTAL	**Derived from above two figures**	**High**
USE	Surface Water Irrigation diversions	Derived figure from summation of Productive ET and Losses	Low
	Losses	Calculated at 30% for on-field losses and 40% for conveyance system losses Some of this water maybe available for reuse in agriculture, however it is difficult to determine the quantum of this reuse without further analysis and hence it is not considered for the present analysis. But the same should be refined based on studies of actual irrigation systems	Low
	Productive ET	Calculated based on ratio of area irrigated by ground water and area irrigated by surface water in the State.	Low
	Ground water irrigation extraction	Data input from GSDA	High
	Losses	Estimated as on-field losses (30%), No losses in the conveyance system Some of this water maybe available for reuse in agriculture, however it is difficult to determine the quantum of this reuse without further analysis and hence it is not considered for the present analysis. But the same should be refined based on studies of actual irrigation systems	Medium
	Productive ET	Derived from above two figures	Medium
	Base Flow	Data input from GSDA	High
	Urban / Industrial water diversion	Total estimated from data published by water-lab minus estimate of water use in rural areas	Low
	Water Use	Estimated at 33.33% (Average for water consumption in domestic (20%) and industry (50%))	Low
	Return Flow	Derived figure from above two figures	Low
	TOTAL	**Derived Figure**	**Medium**
LOSS	Natural losses (Evap/ET)	Two times the evaporation losses from reservoirs as provided in Socio-economic Survey of Maharashtra (to include for losses from rivers and streams)	**Low**

Water Resources Water Balance		Source / Methodology	Accuracy
OUT	Minimum Flow to Down Stream states (as per Tribunal Awards)	Tribunal Awards	High
	Flow to sea	Estimate based on utilizable potential from the West Flowing Rivers	Low
	Unaccounted for flows	Balancing Figure	Low
	TOTAL	**Derived Figure**	**Medium**

14 Annexure IX: Methodology for Water Demand Forecast

14.1 Introduction

In this appendix we present the key assumptions and methodology used to project the demand of water for agriculture sector in 2020.

14.2 Area and Productivity Projections

The area and productivity projections for the agricultural crops grown in Maharashtra have been done based on the data obtained from yearly publications of Economic Survey of Maharashtra.

The data for area is compiled separately for kharif as well as rabi seasons for the last 10 years (2003-04 to 2013-14). The projections for the next five years are calculated based on 10 years moving CAGR of the area under different crops. The total area for kharif is kept constant while for rabi it is allowed to grow based on historical CAGR.

For each crop the estimate for area under rainfed condition and under irrigation is done based on the data obtained from district contingency plans and water resources department publications.

In case of Productivity, the CAGR is calculated based on period between 2000-01 and 2013-14. This growth rate is used to calculate the productivity figures for the next five years. The segregation into rainfed and irrigated productivity is done on the basis of ratio of these productivities obtained from Maharashtra State Development Report. The ratio is not available for all the crops and hence the average figure for these crops is used to calculate the values of other crops.

Sources: Economic Survey of Maharashtra, Maharashtra State Development Report, Agriculture Contingency Plan for the District, Publications by Water Resource Department

14.3 Water Requirement Calculations

The normative crop water requirement data is taken from various sources as the data for all the crops is not available from a single source. In the case of some crops the data is not available for which suitable assumptions have been taken to determine the water requirement. The crop water requirement data is available in the form of centimeter (height) of water required if the crop is grown in a hectare of area. The crop water requirement for each crop is calculated based on the area under which the crop is grown and the crop water requirement norm in terms of million cubic meters.

Source: Food and Agriculture Organization of the United Nations Document Repository, Publication from WALMI, Aurangabad

14.4 Value of Output of Crops

The value of output (crops) is determined from the data taken from publications of Ministry of State and Program Implementation of Government of India, where the value of output for different crops at 2004-05 prices is given. A norm of output value per Tonne is calculated and used to determine the value of output (crops) going forward. It is assumed that the relative prices of the crops would not change during the planning period.

Source: State-wise Estimates of Value of Output from Agriculture and Allied Activities 2013

14.5 Horticulture

The data for horticulture crops is taken from National Horticulture Board website. The area and productivity projections for the period 2014-15 to 2019-20 are done on the basis on CAGR which is calculated based on period between 2001-02 and 2012-13. Water requirement norms are taken from UNESCO-IHE Institute of Water Education Publication. The norms are combined in the form for fruits, vegetables, spices and plantation crops. The norms present here are in the form of water requirement per tonne of production and hence the projected production values (obtained from projected area and projected productivity values) are used to calculate the water requirement in horticulture crops. Value of output is calculated in a similar fashion as in agricultural crops.

Source: National Horticulture Board website, The green, blue and grey water footprint of crops and derived crop products – UNESCO-IHE

15Annexure X: Mapping of key stakeholder initiatives

Organization	Project / Scheme / Initiative	Public / Private / CSR	# of Farmers	Total Project Cost	Description and Relevance for the Study	Impact on Agriculture Growth	Impact on closing water gap - through demand side management
Department of Agriculture, Government of Maharashtra	PPP - IAD Scheme	Public Private Partnership	4,13,750	INR 250 crores for 2014-15	The present PPP - IAD program is focused on agriculture productivity improvement and the focus is very low on water efficiency. However, the framework for PPPs in water-use efficiency under this study could possibly built on PPP - IAD framework as this is a good example of how public and private sector can come together for interventions in agriculture sector.	High	Low
Department of Agriculture, Government of Maharashtra	IWMP - Integrated Watershed Development Program	Public	Not Applicable	INR 12,000 per ha in plains INR 15,000 per ha in hilly areas	Recently treated watersheds under IWMP can be used as building blocks on which further watershed works, water efficiency solutions and market linkages can be built. This will reduce the funding requirements of the project substantially. In addition, the social capital created in the watershed works can be channelized for the project.	High	Low

Organization	Project / Scheme / Initiative	Public / Private / CSR	# of Farmers	Total Project Cost	Description and Relevance for the Study	Impact on Agriculture Growth	Impact on closing water gap - through demand side management
Department of Agriculture, Government of Maharashtra	VIIDP - Vidarbha Intensive Irrigation Development Program	Public	Not Applicable	Not Applicable	VIIDP provides financial assistance for watershed development activities and development of irrigation facilities (with focus on micro-irrigation in Vidarbha region of Maharashtra. This is a special package created for the region by centre. Since cotton is the primary cash crop in the region with about 10 lakh ha under cotton cultivation, this is an important program that can be leveraged for water efficiency in cotton in Maharashtra	High	Medium
NABARD	UPNRM projects related to drip irrigation in cotton and sugarcane	Public	Varies from project to project (general scale of about 1000 farmers in each project)	Varies from project to project (about INR 1 to 5 crores)	This is an important model that demonstrates willingness of farmers to take loans for drip irrigation projects. An additional important characteristic is the on-lending model adopted by some sugar-cooperatives which take loans from NABARD and lend further to farmers in their catchment areas.	High	High
NABARD	Various Watershed development program (Watershed plus, Indo-German watershed development program etc.)	Public	Varies from project to project	Varies from project to project	Recently treated watersheds of NABARD can be used as building blocks on which further watershed works, water efficiency solutions and market linkages can be built. This will reduce the funding requirements of the project substantially. In addition, the social capital created in the watershed works can be channelized for promoting PPPs	High	Low
The World Bank	Maharashtra Agriculture Competitiveness Project with the	Public Private Partnership	3300 farmer groups of about 15	USD 100 Million	The project provides a useful mechanism for creating market linkages and development of alternative marketing channels. Additionally, since project is spread across the State and more	High	Low

Organization	Project / Scheme / Initiative	Public / Private / CSR	# of Farmers	Total Project Cost	Description and Relevance for the Study	Impact on Agriculture Growth	Impact on closing water gap - through demand side management
	objective of improving productivity, profitability, and market access of the farming community in Maharashtra		farmers each		than 30 companies have been tied up under the project, there is a useful "agriculture stakeholder network" that has been created which can be tapped into for facilitating the engagement.		
Sakal Group	Water lab	Public Private Partnership	Not Applicable	Not Applicable	Waterlab is an interesting initiative by the Sakal group to bring together all stakeholders related to water sector on one platform. The total duration of waterlab is about six weeks in which three parallel work-streams related to a) Supply side water conservation measures b) Agriculture and c) Industrial and Urban would be operational. At this stage it is unclear on what is likely to be the focus of interventions on the agriculture side. Once the lab's outcomes are in the public domain, more clarity would emerge on areas of synergy with the present engagement of 2030 WRG.	Not a project based intervention	Not a project based intervention
Jain Irrigation	Water storage structure across Girna River near Jalgaon	Public Private Partnership	1200	INR 45 crores	This is an interesting project by Jain irrigation (which is also the largest supplier of Micro-irrigation systems in India) to create a water storage structure on PPP mode with Government of Maharashtra. Jain irrigation created a water reservoir and obtained the right to use 50% of the water for captive purposes. The reservoir also supplies water to farmers in the catchment area efficiently through MIS. This can be an important case study when developing PPP structures in the current engagement.	High	High
Jain Irrigation	PPP - IAD Scheme - Cotton	Public Private Partnership	40000	INR 12 crores	Jain Irrigation has also commenced a large project to raise awareness of Drip Irrigation system in cotton in Maharashtra. The project	High	Medium

Organization	Project / Scheme / Initiative	Public / Private / CSR	# of Farmers	Total Project Cost	Description and Relevance for the Study	Impact on Agriculture Growth	Impact on closing water gap - through demand side management
					would create several demonstration farms and educate farmers in the vicinity about raising productivity in cotton through water efficiency and agriculture productivity measures. While the project does not envisage installing MIS in all the farmers' fields, it is hoped that through awareness, farmers themselves will take initiatives to install MIS. For the cotton deep dive, this is an important initiative which can be studied in further detail to identify interventions that can enhance focus on water use efficiency.		
Cottonconnect	Implementation of BCI, REEL and Organic Cotton programs	Private	About 30000 to 50000	NA	CottonConnect works with large number of smallholder agriculture farmers in cotton and has strong business linkages in the entire cotton value chain. They implement cotton standards (BCI, REEL (their own framework) and organic cotton) primarily in Gujarat and Maharashtra. They have linkages with many international major fashion retailers such as C&A, H&M etc. Because of their relationship with end buyers, they are aware of the shifts in global procurement trends in cotton. This knowledge and their experience in Maharashtra can be leveraged for in any intervention in cotton value chain.	High	Medium

Organization	Project / Scheme / Initiative	Public / Private / CSR	# of Farmers	Total Project Cost	Description and Relevance for the Study	Impact on Agriculture Growth	Impact on closing water gap - through demand side management
SAB Miller - CII	Neemrana Project	CSR	1500	INR 50 crores	SAB Miller has worked with CII in Neemrana, Rajasthan to carry out a scientific analysis of water use in agriculture on a watershed level. The project assessed availability of water from all sources and suggested measures to harvest and store water through conservation structures. The project also advocated MIS for higher water efficiency and changes in cropping pattern to ensure sustainability of agriculture. This is a very important initiative on planning agriculture for sustainability considering the resources available in the watershed through scientific analysis. Elements of the program can be brought in the general framework for PPP program development under the present engagement.	Medium	High
Olam	Water efficiency in Sugarcane	Private	To be defined	To be defined	Olam is one of the companies which is consciously looking at water footprint of its operations. They have measured the water footprint of their own plantations and farms as well as those of their suppliers. This has made them aware that about 90% of water used by Olam is in farms of their suppliers. In India they have decided to focus on water efficiency in Sugarcane with IFC and WWF as partners.	Medium	High
HUL	PPP - IAD Scheme - Tomatoes	Public Private Partnership	1500	INR 2.9 crore	HUL procures several agricultural commodities from Maharashtra such as wheat, onion, turmeric, chili, garlic etc. Unilver has a "Unilever Sustainable Agriculture Code" which emphasizes the need to be water efficient.	High	Medium

Organization	Project / Scheme / Initiative	Public / Private / CSR	# of Farmers	Total Project Cost	Description and Relevance for the Study	Impact on Agriculture Growth	Impact on closing water gap - through demand side management
Syngenta Foundation	Market Led Extension Program	CSR	40000	NA	Syngenta Foundation is carrying out market led extension program in Jawhar in Thane district of Maharashtra. In the project they form groups of about 20 farmers which approach the market collectively. They are now launching entrepreneurs as extension workers who provide the services related to buying inputs and approaching markets leveraging the economies of scale created by the group formation exercise. These are local people who are trained by Syngenta Foundation for agriculture extension and they are now helping them link with the banking channel also. In the present program there is no focus on water use efficiency as the emphasis on agricultural productivity and market linkage. It may be possible to develop a model through these "entrepreneurs" for facilitating demand side water efficiency measures once the bank linkages are established.	High	Low
Rallis	PPP - IAD Scheme - Pulses	Public Private Partnership	50000	INR 12 crores	Rallis has been one of the important participants in the PPP-IAD program with a relatively large farmer outreach in the preceding years compared to other organizations. In the initial stakeholder meeting with Rallis, several insights emerged as to the challenges and benefits of existing scheme.	High	Low
Coca - Cola SAGP	Sustainable Agriculture Guiding Principles	Private	NA	NA	Coca Cola is an important buyer of Sugar in Maharashtra. Recently, Coca Cola has launched "Sustainable Agriculture Guiding Principles" of which water management is one key principle. The SAGP mentions the following related to water management: "Ensure long-term sustainability of water resources in balance with community and ecosystem needs by maximizing water use efficiency and minimizing water quality	Medium	Low

Organization	Project / Scheme / Initiative	Public / Private / CSR	# of Farmers	Total Project Cost	Description and Relevance for the Study	Impact on Agriculture Growth	Impact on closing water gap - through demand side management
					impacts from wastewater discharges and erosion and nutrient/agrochemical runoff." This is an important directive from one of the major players in Sugar value chain. Our discussions with Olam has revealed that while suppliers meeting the SAGP may not get direct financial benefit but this is clearly an important parameter for Coca Cola which influences its preference of suppliers and negotiations for pricing.		
Hindustan Unilever Foundation	Watershed management program in Maharashtra	CSR	NA	NA	HUF has wide range of experiences in water management through its programs in Maharashtra and other States. They primarily work through NGO partners and their overall approach is to engage with multiple stakeholders in to create a larger impact through collaboration.	High	Low
Mahindra & Mahindra	Watershed management program in Damoh, Madhya Pradesh / Foray into MIS business	CSR	20000 Indians	NA	Mahindra has facilitated watershed works in Damoh in Madhya Pradesh through their CSR funds. In addition, they have recently forayed into micro-irrigation business as well. Both of these initiatives, along with their focus on water which is reflected through the Sustainability Report - 2012-13 for Mahindra Group highlights the higher level of consciousness pertaining to water in the management.	High	Medium

Deloitte.