
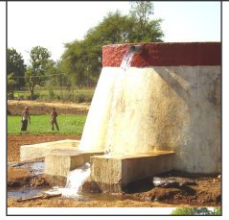

Wealth from Water

The pioneering contribution of Sadguru Foundation in Rajasthan

Sunderrajan Krishnan • Rajnarayan Indu

INREM Foundation, Anand, Gujarat

About Authors

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Dr Rajnarayan Indu is Director of INREM Foundation since 2007. He has a MA degree in Economics from Jadavpur University, Kolkata and a Ph D degree in Economics from Gujarat University, Ahmedabad – his thesis was “Problems and Prospects of a Decentralized Industry – a case of Handloom Industry in India”. He worked with Agro Economic Research Centre, Vallabh Vidyanagar, Gujarat for a long time and IWMI–Tata Programme before joining INREM Foundation. He worked in diversified area of research from agriculture, irrigation, poverty, handloom, fisheries, water quality and health – especially in fluorosis mitigation programme for the last fifteen years. He has several research papers in his credit. His interest is in solving problems in society through research and intervention.

Wealth From Water

The Pioneering Contribution of N M Sadguru Water and Development Foundation in Rajasthan

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Arvind Singh

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Acknowledgement

We offer our sincere gratefulness to Shri Harnath Jagawat and Shrimati Sharmishta Jagawat for their confidence on INREM Foundation and entrusted this research project to us.

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Besides these persons we remember and convey our sincere thanks to all farmers of villages we met in both Banswara and Jhalawar districts while travelling for field work for this project.

We like to put into words of appreciation the work rendered by our staff members time to time for this project – Mr Harsh Dave for data, Mr Pritesh Patel for accounts, Mr M B Upadhyay for all logistics. We are also thankful to Mr Sachin Vani and Ms Kalpana Bilwal of our field office in Jhabua for their support time to time in this project.

Preface

As Founding Chairman of INREM Foundation, it is my pleasure and honour to write this preface to yet another rigorous research-based report documenting the socio-economic and hydrological impacts of Sadguru's pioneering work in Banswara and Jhalawar districts of Rajasthan. The first report which was published in 2014 documented the impact of Sadguru's work in a pre-dominantly tribal district of Dahod in Gujarat. I have been associated personally and professionally with the Sadguru for the last over 35 years and have documented its experience in the form of several papers and book chapters. A paper co-authored by me with KK Gupta, *The Sadguru Model of Community-Based Natural Resources Management*, was published as Occasional Publication No.14, by the Institute of Rural Management, Anand (IRMA) in 1998. The present study vindicates, like the earlier one, the conviction held by Shri. Harnath Jagawat that the key to initiate and foster the process of socio-economic well -being of people in tribal areas is 'distributed harvesting, storage and rational use of water for growing high value crops'.

The Sadguru's interventions in Banswara district include the construction of 107 check dams with the total storage capacity of around 320 mcft and 76 lift irrigation cooperatives organized in the command areas of the check dams providing irrigation to around 12,000 acres of land. Similarly in Jhalawar district, 37 check dams having the total storage capacity of 705 mcft were constructed by Sadguru.

The study revealed that in Banswara district which is dominated by tribal community, seed production of hybrid maize improved both the food security and economic status of farmers in the area. On the other hand, in Jhalawar, where most of the farmers are not tribals, increased availability of water from the check dams and lift irrigation projects upstream and recharged wells downstream made it possible for farmers to grow high value crops like coriander, garlic, mustard, lemon, mango, and orange crops and derive benefits from their sale. The total benefits from Sadguru's interventions in Banswara and Jhalawar districts

were estimated to be about Rs. 55.89 crore annually and with a multiplier of 3.0 was Rs. 167.69 crore. The wealth generated to this extent is by all means represents a significant contribution to the economy of the districts concerned.

On behalf of the INREM Foundation and on my own personal behalf, I sincerely thank Shri Harnath Jagawat for commissioning INREM Foundation to conduct this study and bringing out this report.

I congratulate the authors of the report and all those who helped directly or indirectly in conducting the study and bringing out this report.

Katar Singh
January 17, 2018

Executive Summary

The paradigm of development put forward by N M Sadguru Water and Development Foundation through numerous community based institutions on small scale water harvesting has inspired many such examples across India. In Banswara and Jhalawar districts of Rajasthan, the organization has been able to take forward similar achievement as in Dahod, Gujarat, where this effort has yielded significant results over the past 40 years. In Banswara alone, there are around 107 check dams constructed by Sadguru Foundation with a total storage of around 320 Mcft. The concentration of much of these is in the tribal region of Kushalgarh block where around 230 Mcft of storage has been created. Most of these check dams also have Lift Irrigation (LI) cooperatives associated with them. Some have more than one such LI cooperative. A total of around 76 such LI schemes operate in Banswara district covering around 12,000 acres of irrigated land with Maize, Wheat, Soya, Cotton, Paddy, Gram and Maize Seed production. In Jhalawar a total of around 37 check dams on the Chambal, Kshipra, Chhoti Kalisindh, and Ahu river and nearby with a storage 705 Mcft have been created. The maximum storage structure in Jhalawar is of 150 Mcft.

An in-depth hydrologic analysis is performed for the Hiren river basin in Kushalgarh block of Banswara district. It is observed that the decadal average rainfall has been reducing significantly for the past 40 years indicating climatic change leading to lower availability of water in this region. On the other hand, the extreme rainfall of 75 percentile of daily rainfall has seen an increasing trend over the past 20 years. This shows that as total rainfall is

Shiegarh check dam in Jhalawar, Rajasthan, constructed under Rastriya Krishi Sichai Yojana (RKSY) in 2006.

reducing, the distribution of rainfall within the year is becoming more extreme. Both these factors put together indicate the plight of farmers, thereby the need for mechanisms to combat this problem and hence the requirement of additional storage across years.

The Hiren river is taken as an example where the organization has constructed more than 15 check dams with a total storage of around 250Mcft. These support around 23 LI schemes with 5050 acres irrigated area. First we observe through satellite images that over a six year period from 2005 till 2011, the Hiren River has started to flow again because of the storage created with check dams. Next we use a River basin Model to analyze the flow of water and storage in the river basin over a 20 year period constructed using Rainfall data modeled for this area. The aspect of dependability of these storages is given focus for analyzing the impact of such small check dam construction. Comparing two sub-basins with higher and lower density of check dams, we conclude that during a continuous simulated drought period of 4 years, the dependability ratio of high density check dams is around 0.25 whereas the dependability of low density check dams is around 0.15. This shows the impact created by the interventions on check dam storage at a river basin level.

The scale of Sadguru's interventions in Rajasthan has been such that more than 3.8 lakh beneficiaries have been reached through various interventions in Banswara and more than 1 lakh beneficiaries reached in Jhalawar. Right from the basic cost of irrigation using lift irrigation as compared with pumping from groundwater, there is a benefit accruing to farmers (Rs 1.76 crores from Banswara and Jhalawar). The total benefit from Wadi and Vegetable crops is Rs 2.52 crores from Banswara. The cereal and other crops have a total benefit annually of Rs 24.68 crores in Banswara and Jhalawar together. The direct and indirect benefits of Seeds cultivation, and sale comes to Rs 24.7 crores in Banswara with the bulk of this benefit coming from the possible yield increases to farmers who buy these high yielding seeds. All of these benefits accrue to a total of Rs 55.89 crores in Banswara and Jhalawar, which with a multiplier effect of 3 could have a contribution of around Rs 167.69 crores annually to the economy. This is from the information analyzed taking one year data of

Jhumki Checkdam under Rastriya Krishi Vikas Yojana (RKVY) Tehsil, Kushalgadh, Banswara

Introduction

N M Sadguru Water and Development Foundation has been working for more than four decades in the tribal and interior parts of Gujarat, Rajasthan and Madhya Pradesh (MP) states, building resilient communities that manage their own natural resources. Water has been central to Sadguru Foundation's work and has been critical in achieving sustainability of the interventions that have been carried out for all these years. The impact of the organization's work in Dahod has been earlier documented by INREM Foundation through the report “Water to Economy” brought out in Dec 2014. Within that earlier study, the wide impact of the organization in Dahod and its influence on the agricultural economy was studied, starting from hydrologic interventions that the organization has carried out.

Here the focus is on Rajasthan and the districts of Banswara and Jhalawar where the organization has similarly worked on water resource management and further on agriculture and allied activities. The basic purpose behind these actions has always been that of reduction of poverty.

In Mr Harnath Jagawat's own words – “Our plan is to ultimately wipe out poverty from the face of these districts”, says Jagawat, with determination. This he told in an interview to India Today in 1996. [India Today, January 1, 1996]. Today's agricultural development in Banswara and Jhalawar are the results of their plan.

It is agreed by many social scientists that there is a strong connection between water and poverty. The two most important basic needs for food are 'land' and 'water' – one without the other cannot grow anything. The organization understood these basics and did a massive work among tribals of Dahod since 1970s by conserving water of small rivers or rivulets and using small and tiny land holdings of bhils. After a good success in Dahod the team of N M Sadguru Water and Development Foundation started work in Banswara in 1990 and in Jhalawar during 1998-99 in Rajasthan.

The Dahod study showed how the economy went up by pragmatic use of water in agriculture, and thereby increase in agriculture GDP of the district. This time in this 2016-17 study we have seen how the rural people of Banswara and Jhalawar are able to 'step out' of poverty by the 'holistic' intervention work of Sadguru, which is the prime goal of N M Sadguru Water and Development Foundation.

Alawa-1 check dam in Jhalawar, Rajasthan, on river Ahu constructed in 2006 under RSVY. There are 8 such water harvesting structures already constructed on this river Ahu and 2 more are proposed. This would optimize harvesting in this river for a great length.

Objective and Methodology

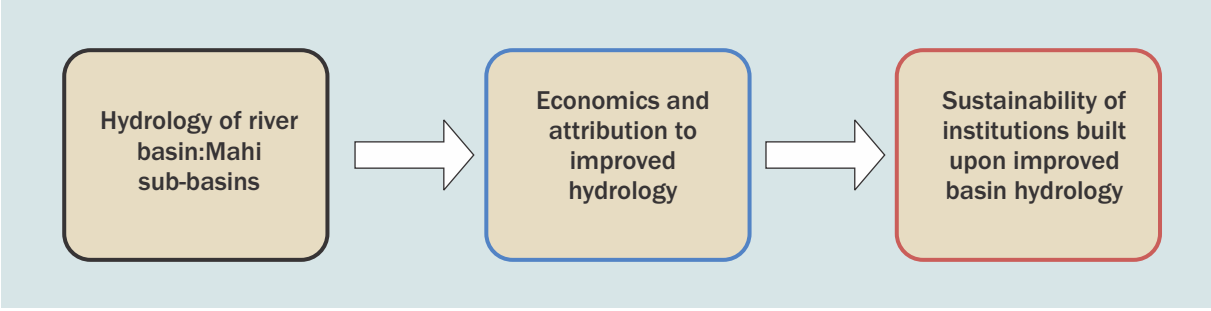
This study is focusing on the Sadguru's interventions in Banswara and Jhalawar with specific attention to Water related programmes and determining the hydrologic and economic impact of these interventions. The objective is stated as follows:

(I) *to determine the scale of hydrologic interventions of Sadguru interventions in Banswara and Jhalawar, and*

(ii) *to determine the overall economic impact of these interventions on the beneficiaries*

With these two objectives, a methodology for looking at both the hydrologic and economic impact has been developed. This is similar to the procedure followed in the Dahod study previously by INREM Foundation.

Figure 1: Linking Hydrology with Improved Economy and Institutional Sustainability

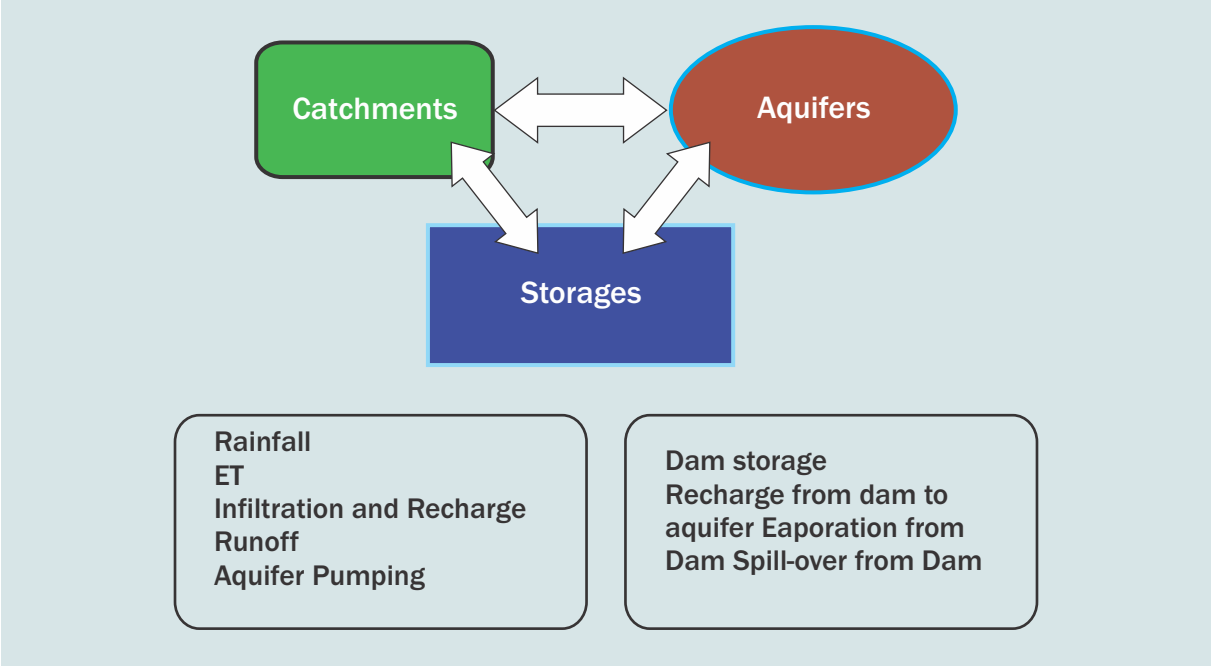


The overall thinking here is to connect the changes in hydrology of river basins to economic impact and finally to the sustainability of community based institutions such as Lift Irrigation cooperatives.

For the hydrologic study, we have looked at the particular case of a highly developed sub-basin of Hiren where a lot of dense water interventions have taken place. In this river basin, we have accounted for the total water harvesting performed through check dams, the overall

water balance of this river basin, modeled rainfall over 20 years in this area and through a model of hydrological modeling, projected the behavior of this river basin for 20 years. The hydrologic model 'RiverbasinSim' has been used here to simulate the stream flows, groundwater recharge and check dam behavior with a daily time interval.

Figure 2: The Conceptual Picture of River Basin Hydrologic Model



The conceptual picture of RiverBasinSim is presented in Figure 2. It drives rainfall on a daily time step accounting for three different entities ie catchments, aquifers and storages such as check dams. Within this, it accounts for ET (Evapo-transmission), pumping from the aquifer, and other usages. Similarly, it accounts for evaporation from the storages, spill-over from the dam and percolation and recharge from the dam into the aquifers. Rainfall data was obtained from IMD (India Meteorological Department) records on a daily basis. The main focus has been to see the resilience of the Hiren river basin to different rainfall patterns and especially to observe the changing climate and how it impacts the river basin storages. The concept of dependability of storages is utilized here to understand how such storage within the Hiren river basin affects the dependability of storage under stress from drought conditions of continuous years. With this analysis, we aim to show how such dense small water harvesting can not only help equity in water distribution to remotely located dryland tribal farmers, but also help in better resilience to extreme climatic conditions such as 3-4 years of continuous drought.

We have interviewed Sadguru beneficiaries who have been the recipient of various interventions for determining the economic impact of interventions. We have considered

Farmers taking irrigation from newly construed lift irrigation scheme on river Chambal for village Kundla, Dag block, Jhalawar, under Rashtriya Sam Vikas Yojana

farmers within the command area of lift irrigation schemes, those farmers who have benefited from Wadi programmes, farmers who have been part of the Seeds programmes, and other activities of Sadguru foundation. This methodology we have used to find that given some opportunities to people how they grew and could come up out of their poverty.

We travelled to villages in Banswara for collecting information from - Jhumki, Salon, Balasindoor, Borbhatod, Kevadiya, Borekhedi, Badvas Badi, Tandi Badi, Kesarpura, Cheeb, Bildi, Upla Ghantala, Ganeshi Lala Ka Padla, Jhari, Gagri, Bodvi, Nal, Chanawala, Nathpura, Kharwali, Ambapura, Samapada, Khodi Pipli Bijalpur Agoriya, Etala, Fatahpura,Wajva Amba, and some other villages in Kushalgarh, Sajjangarh, Kasarwadi and Bagidora clusters. Total 60 households have been selected from all these villages of Banswara.

Villages we travelled in Jhalawar are Padasali, Sindhla and Nishalkhedi in Rajasthan.

A set of questionnaires has been used for capturing information of benefits from different interventions, such as, (1) Checkdam (2) Lift Irrigation (3) Village Institution (4) Watershed (5) Wadi (5) Hybrid seed (6) Horticulture, (7) Floriculture (LI Coops and SHGs).

We have merged the interventions in 4 (four) groups

1. Irrigation intervention – lift irrigation systems along with coop institutions
2. High yielding variety of seed – especially of Maize
3. Advance Agricultural Practices includes in wadi (orchard) and vegetable growing-packages
4. Wadi – separately discussed about – Mango and Lemon orchard

This will clearly explain the contribution of Sadguru's contribution through their intervention activities.

LI at Bajwa Amba, Sajjangadh Tehsil, Banswra, Rajasthan

Impact of interventions

Water Resources and Hydrological Interventions

In the entire district of Banswara, Sadguru Foundation has constructed around 107 Check dams with a total capacity of around 320 Mcft. These check dams are distributed within the Talukas of Bagidora (46 Mcft), Kushalgarh (230 cft) and Banswara (44 Mcft). As it can be observed, much of this water resource development is in the Kushalgarh Tehsil which also happens to be one of the poorest Tehsils in the entire Rajasthan district in terms of developmental indicators. By concentrating within this Tehsil, Sadguru Foundation has been able to reach to a mainly tribal population which was previously much affected by basic livelihood issues, resorting to high rates of migration to neighbouring states.

Figure 3: Hiren River Basin

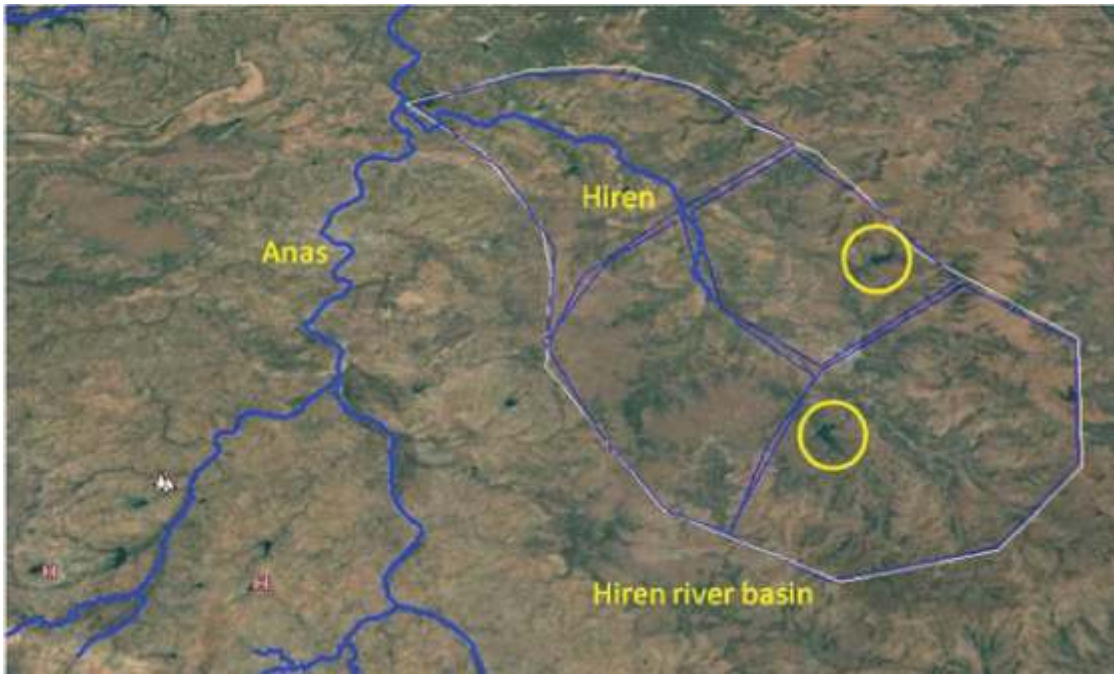
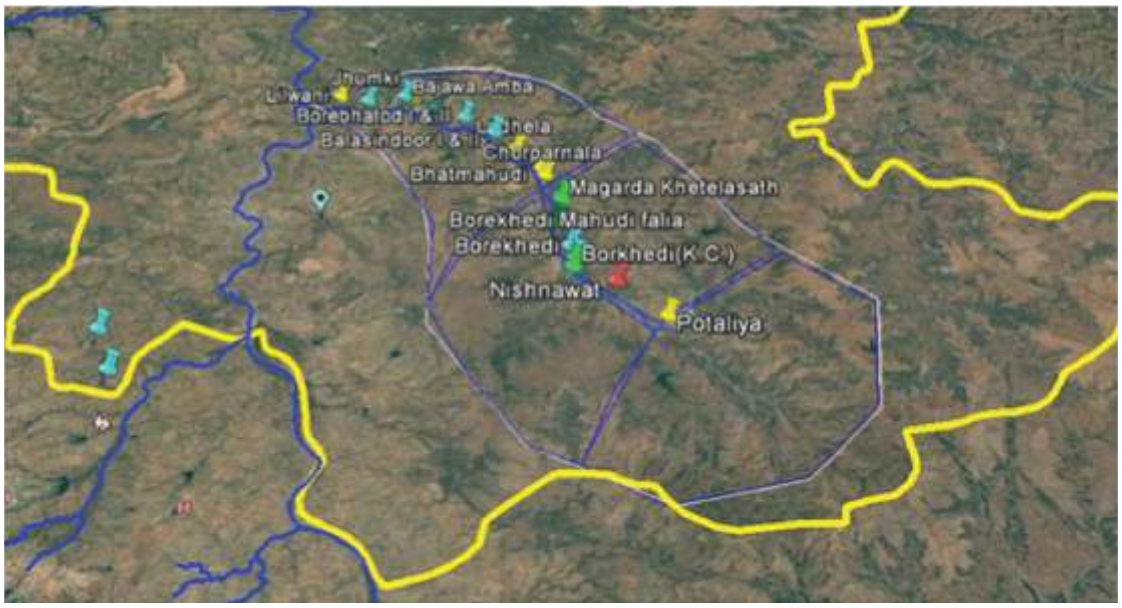


Figure 4: Check Dams in Hiren River Basin



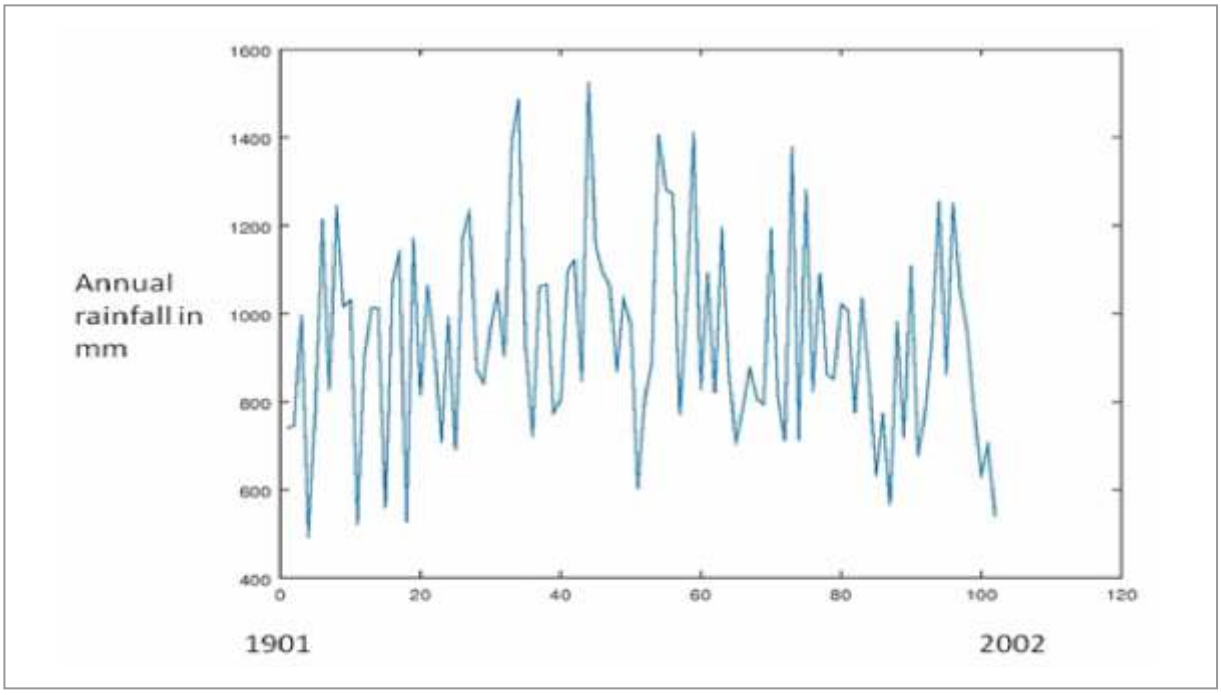
A total of around 76 Lift Irrigation (LI) schemes operate on these Check dams covering around potential gross 12,000 acres of irrigated land with crops such as Maize, Wheat, Soya bean, Pigean pea (Tur), Cotton, Wheat, Paddy, Gram, and for seed production, vegetable etc.

In Jhalawar, Rajasthan, also Sadguru Foundation has had large scale interventions of constructing check dams. Totally around 37 such check dams have been constructed, some even on the main Kshipra river, Chambal, Chhoti Kali Sindh. The capacity of these dams is much bigger than those of Banswara. Totally around 705 Mcft of capacity has been created in Jhalawar with a maximum capacity of 150 Mcft with the dam on Chhoti Kalisind at Magshi in Gangdhar Tehsil. As indicated in a internal note recording of the organization, river Kshipra was completely dry in summer of 2003, along its complete 250 kms stretch, but for 22 kms where Sadguru interventions where present, it was full of water round the year.

It is to be noted that Banswara district is one of the lesser developed districts of Rajasthan in terms of developmental indicators. However, there are two sides to the district ie the areas with canal irrigation from Mahi Bajaj Sagar dam, and those that do not have benefit from the dam, and in fact contribute as catchment areas to the flows of this dam.

The tribal parts of the Banswara district also receive very less benefit from the Mahi Bajaj Sagar dam, therefore making it very difficult to achieve basic water security and livelihood in these areas. Within these tribal areas are blocks such as Kushalgarh which happen to be one of the most backward blocks of the state and lie on the border with MP. The work of Sadguru foundation, being primarily focused in blocks such as Kushalgarh assume much importance

Figure 5: Annual Rainfall of 120 Years At Banswara



because of the effort in increasing the water availability and elevating the basic livelihoods of this area.

The Hiren river basin in Kushalgarh Taluka is one of the most densely water harvested rivers by Sadguru Foundation in Banswara. It is similar to the Khan River in Dahod where the organization has been able to harvest water with a series of structures and achieve high impacts. Here we focus on the Hiren River to understand the hydrology of the river basin and the potential impacts of the water harvesting work performed on this river. The Hiren flows from upland catchments close to the border of Rajasthan and Madhya Pradesh with a maximum elevation of catchment of around 1400 ft above mean sea level. The Hiren joins the Anas River at a height of around 550 ft above mean sea level giving an elevation drop of

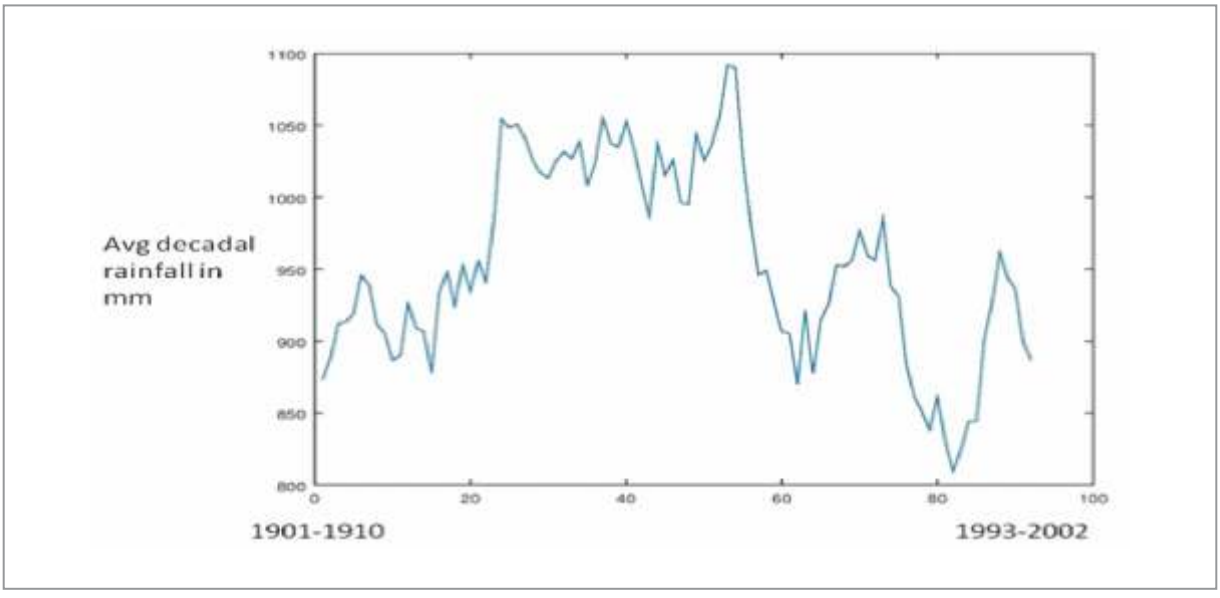
Table 1: Sub-basins of Hiren and their areas

Sub-basin	Area in Hectares
Kalinjara	14498
Kherda	9787
Churada	10984
Lilwani	16408

around 850 ft. The length of the river is around 51 kilometres. Here we divide in to four sub-basins, namely Kalinjara, Kherda, Churada and Lilwani, with a total river basin area of around 55000 Hectares.

LI distribution Pump House, Borkhedi in Banswara, Rajasthan

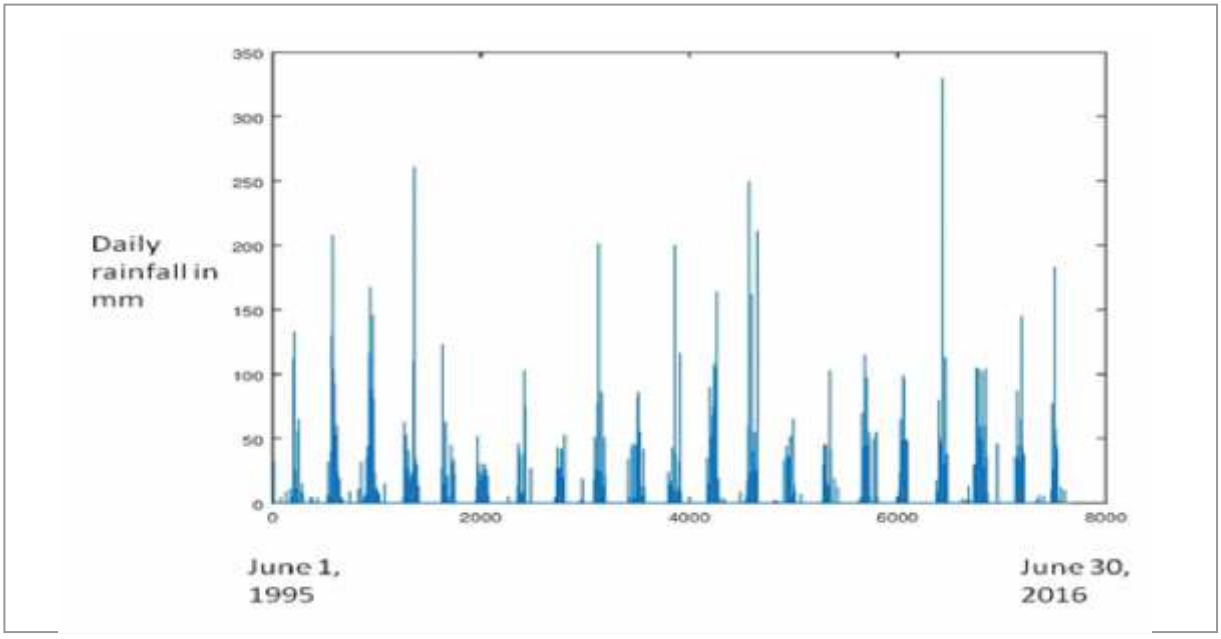
Figure 6: Average Decadal Rainfall in Banswara



The four sub-basins have areas respectively of around Kalingara (14500 Ha), Kherda (9800 Ha), Chudada (10100 Ha) and Lilwani (16500 Ha) [Table 1]. There are two reservoirs in the catchments of this river basin, within Kalingara and Kherda respectively that contribute significantly to the overall water storage capacity to the Hiren river basin. Kushalgarh is the semi urban area within this river basin, located at the centre of the river at an elevation of around 1100 ft.

On the Hiren River, a total of 15 check dams have been constructed by Sadguru Foundation with a total capacity of around 250 Mcft. They support 23 LI schemes with a total irrigated area of around 5050 acres. A total investment of around Rs 10.1 crores on check dams and around Rs 2.7 crores on LI schemes have been made, summing up to around Rs 12.8 crores as the total water resource capacity development for this River basin by Sadguru Foundation.

Figure 7: Daily Rainfall Records of 20 Years



Next, we undertake a Rainfall analysis of stations within this river basin and for the district. Daily rainfall data for local rainfall as measured by IMD has been synthesized for a period of 21 years from 1995 till 2016. Also, monthly rainfall data for 115 years from 1901 till 2016 for Banswara district as a whole as provided by IMD has been utilized here.

The average annual rainfall from the 21 year daily rainfall data set for Kushalgarh comes as 985 mm and for Banswara district from the 102 year record comes as 942 mm. These two averages do now show much difference, but the variability as measured by standard deviation of the annual rainfall is 385 mm for Kushalgarh and 227 mm for Banswara district. We observe that the local inter-annual rainfall variability is much higher for Kushalgarh rainfall station which corresponds most closely to the Hiren river basin. Also, this difference

in variability could be due to the averaging process involved in the entire district average for Banswara.

Next in order to observe the long term trend of rainfall in Banswara district, we conduct an exercise of a moving average of 10 year period to analyze the rainfall variations in the 102 year period.

Figure 8: Annual 75th Percentile of Daily Rainfall

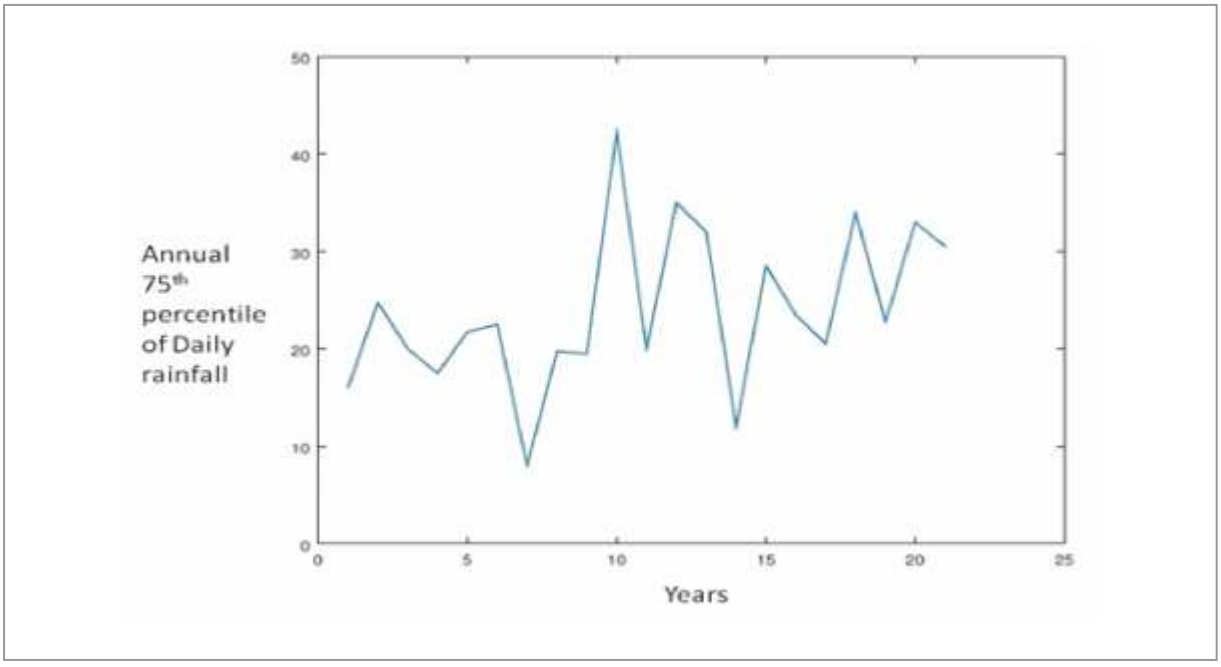
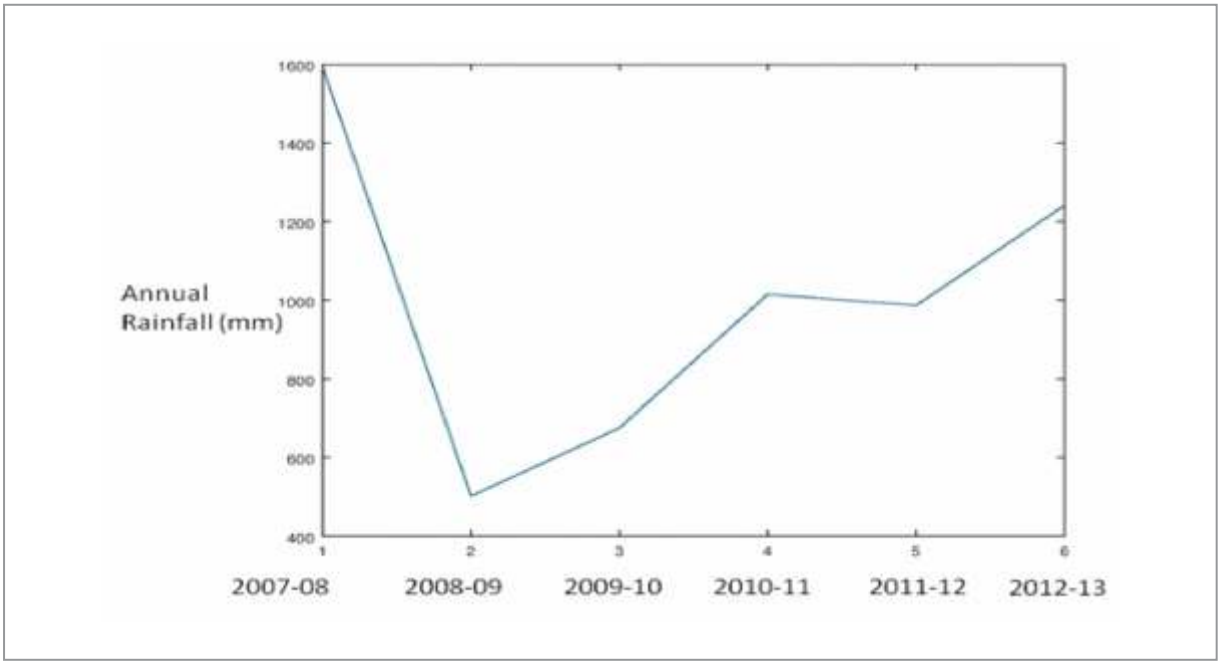


Figure 9: Annual Rainfall from 2007-08 Till 2012-13



This has implications for water storage and capacity of water harvesting within the Hiren River basin.

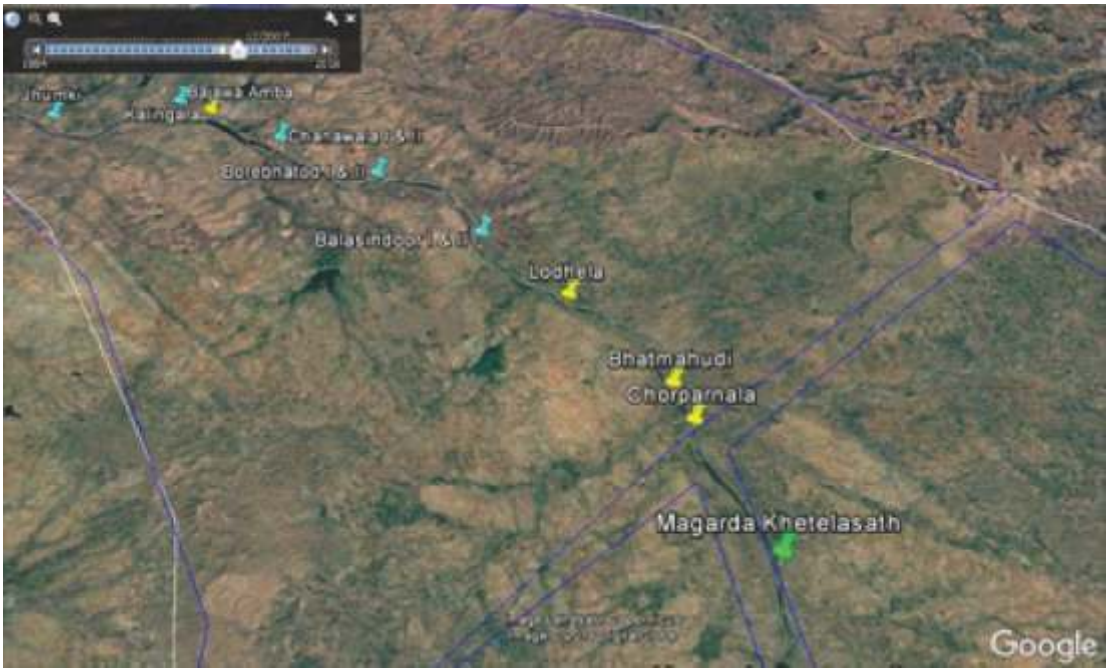
Next in this scenario of uncertain rainfall, we observe the Hiren River end stream location over a six year period and observe the effects of continuous drought and impact of a newly constructed check dam on the river. The Jhumki and Chanawada check dams were constructed in 2009-10 and their storage impacts are being seen from 2010-11 hydrologic year.

These two check dams have a cumulative storage of 35Mcft. The annual rainfall pattern from 2007-08 shows that after a very high rainfall of 1550 mm in 2007-08 there were two consecutive low rainfall years. As can be seen, in December of each of these years, the River Hiren is not flowing during 2007-08 and the two subsequent years. But from 2010-11, one can see the check dams in operation and the additional storage is now enabling the River Hiren to flow again. This can be seen from images of 2007 and 2012 as has been shown here, both having high rainfall as compared to the intermediate years. This example shows from observation that additional check dam storage has helped the Hiren River to flow again even in few months after monsoon.

In order to understand the entire impact of this water harvesting on the River Hiren as a

Figure 10: Google Earth Images: 2007-08 till 2011-12

2007 December



2012 December

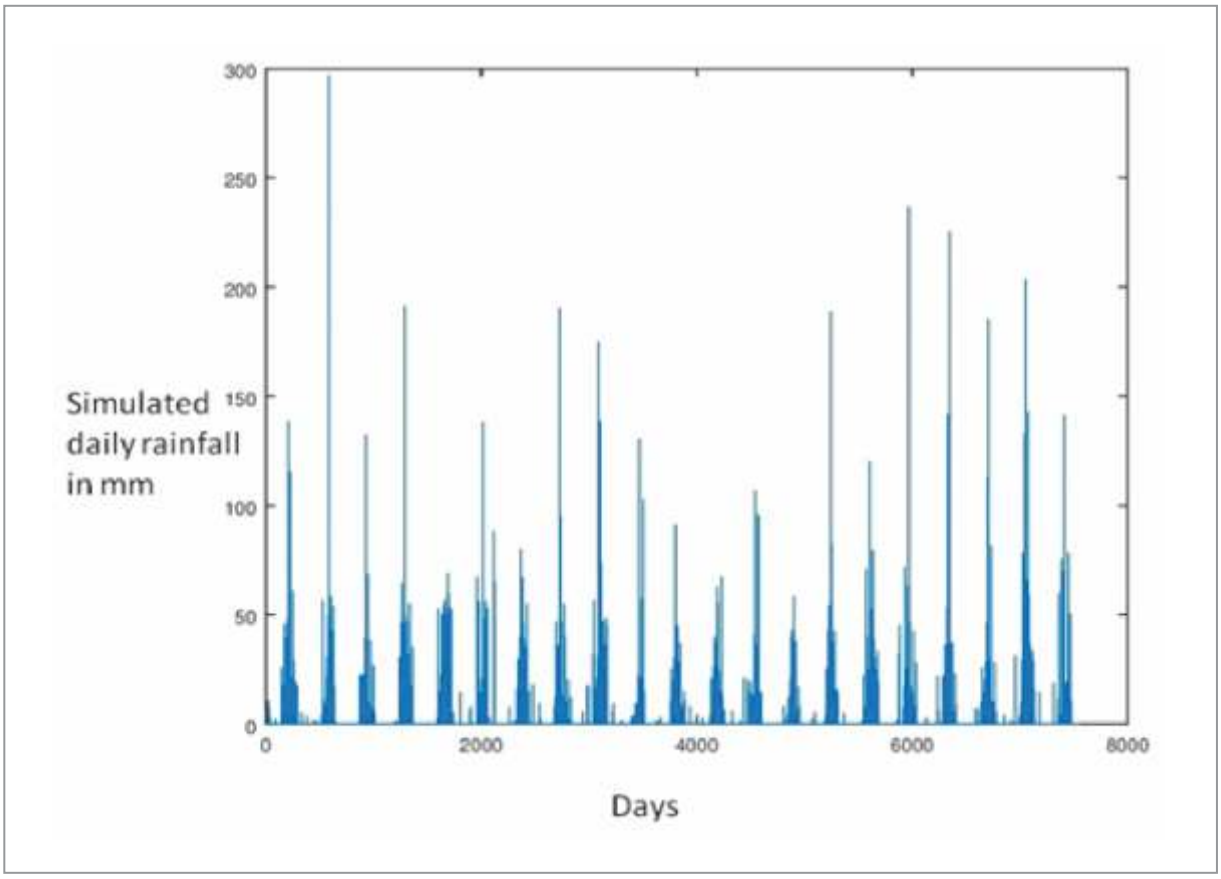
whole, we have undertaken an exercise of constructing a River basin model of the Hiren River. We have divided the river into four sub-basins as earlier pointed out. Also, we have constructed a simulated rainfall model for the river utilizing both the 102-year monthly rainfall record as well as the 21-year daily rainfall record for the district and Kushalgarh respectively.

In order to be able to run a river basin model, we have constructed this simulated daily rainfall record that can now be processed for as many years as needed. Also it can be incorporated impacts of climate change and extreme drought situations into the model. The rainfall model generates daily rainfall record drawn randomly from any of the 21 years for the same day. Once the entire daily rainfall record of one year is generated, a target annual rainfall is set, again drawn randomly from the 102 year record. The simulated daily rainfall for one year is then normalized to achieve this target annual rainfall.

With this process, we have generateda simulated 20 year rainfall record that is then provided as input into the Hiren river basin model. The simulated rainfall has similar characteristics of both the 102 year annual rainfall data set, as well as the 21 year daily rainfall data set, from which this is generated. Further, we also include variability within this model by introducing consecutive four year drought condition to observe how the storages in the Hiren River behave with such drought conditions.

The River Basin Model employed here is based on the HEC-HMS system and is coded within

Figure 11: Simulated Daily Rainfall of 20 Years



A pump house in Banswara, Rajasthan

the MATLAB environment and run within Octave which is an open source simulation system. Within this model, we develop the particular hydrology of the Hiren River that includes:

a) The four sub-basins of Kalingara, Kherda, Chudada and Lilwani

b) The simulated daily rainfall based on the two rainfall data sets

c) The dam storages within different parts of the sub-basin

d) The irrigation and other water requirement of the Hiren river land cover

e) Groundwater aquifer properties and storages

The model is then run on a daily basis driven by the particular input of rainfall on the day and the flow of water through the river basin. It simulated the storages of water within all the dams, and their recharge into respective aquifers and overflows down to the next downstream location. What we observe that the upstream reservoirs of Kalingara and Kherda act as a buffer for the downstream check dams, therefore providing much needed flows during the seasons with lesser water flow.

When we compare the two sets of check dams upstream and downstream ie Chudada and Lilwani, we again see a stark difference. Here we take the 70% dependability of each storage sets ie the percentage of time that each storage has at least 70% of the maximum capacity. We see here that between Chudada (upstream) and Lilwani (downstream), the downstream

A pump house in Taluka Kushalgadh, District Banswara

Figure 12: Simulated Annual Rainfall for 20 Years

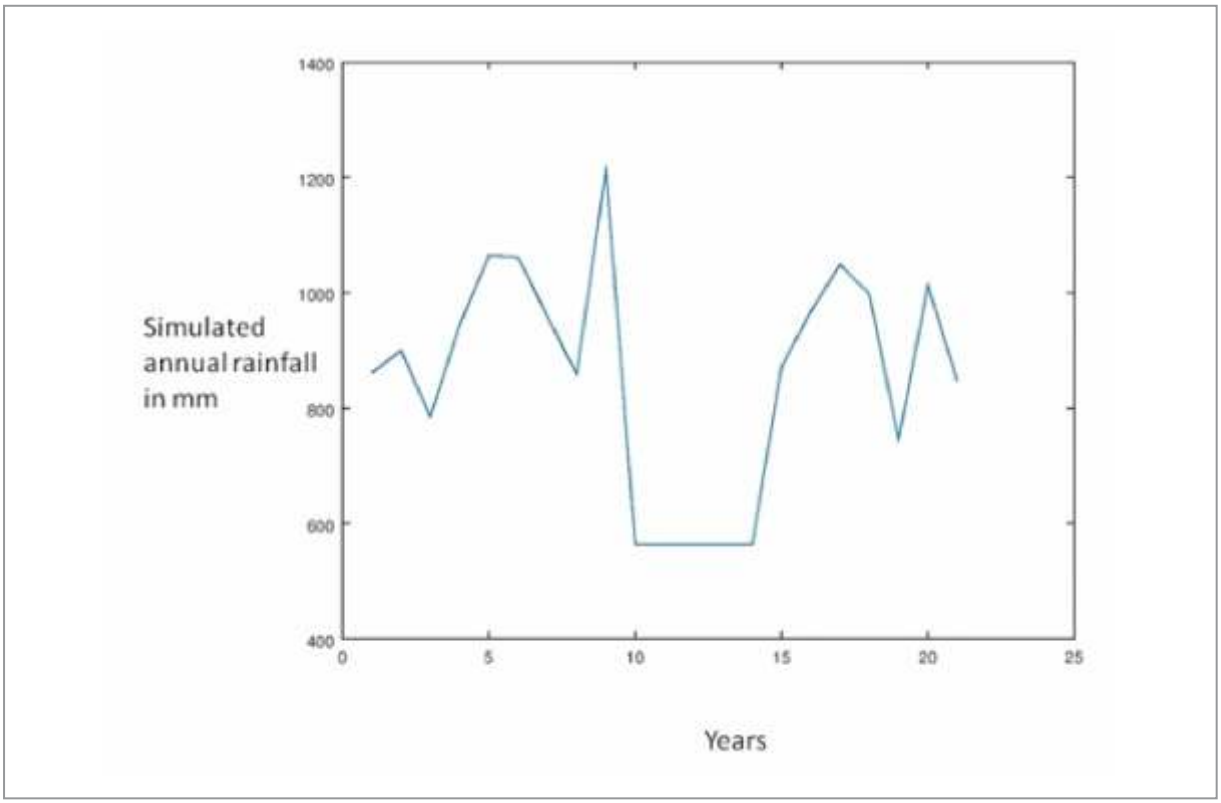
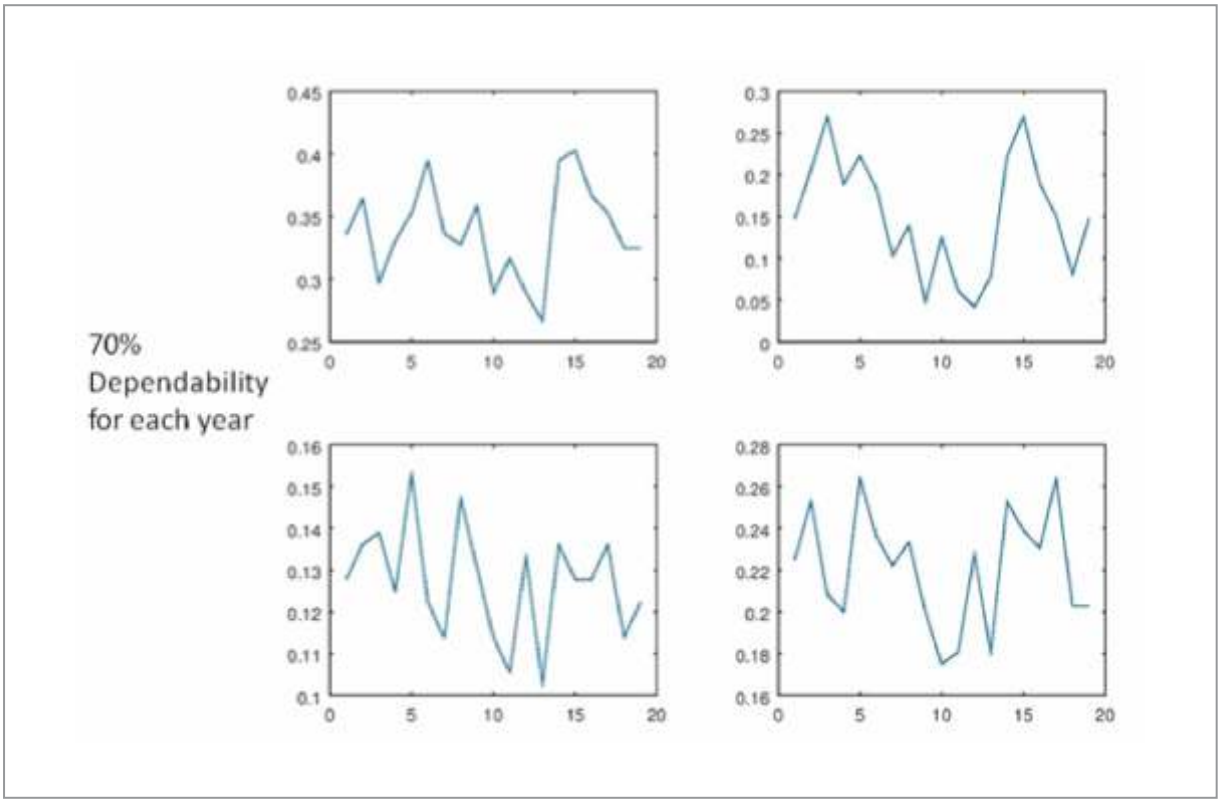


Figure 13: 70% Dependability of Storages



set that gets more of the baseflows from the upstream dam has greater range of dependability (around 20%) as opposed to lower range (around 13%) for the upstream set. We see here the impact of the flows from the catchment dams that help in the check dams getting filled up, therefore acting as a single system of the Hiren river basin.

Socioeconomic Impact of Interventions

The N M Sadguru Water and Development Foundation started their intervention work with watersheds, check dams and Lift Irrigation Lift Irrigation cooperatives. The check dams have been constructed on the rivers like the Anas, Hiran and Kagdi and others in Banswara and Kshipra, Chambal and Kalisindh in Jhalawar districts. Additionally, there are many other small rivers and rivulets on which they executed watershed programmes, check dams and lift irrigation systems. However, they did not stop only on irrigation but they introduced gradually other agri-allied activities eg using better seeds, use of better organic manure, growing long duration crop like orchards and introduced high value crop for better return and introduced vegetables and floriculture. All these are for generating income of the farmers. Following is the list of interventions in Banswara and Jhalawar.








As a result of sound watershed development programme ground water has increased enormously in large number of wells in all the 20 watershed villages in Tehsil Sajjangarh, District Banswara, Rajasthan

A cumulative progress of intervention activities, area and coverage of beneficiaries till 2016 by N M Sadguru Water and Development Foundation in Banswara and Jhalawar are shown in the following table [Table 2].

Table 2: Cumulative Achievement under various Activities in Rajasthan – upto March 2017

Sr. No.	Programmes	Physical Nos.	Area covered (Acre)	No. of Beneficiaries HHs	No. of Persons
1	Community Lift Irrigation Scheme	74	6,416	3,686	21,116
2	Community Water Harvesting Check dam	107	11,835	4,821	28,926
3	Wells Recharging	503	-	503	3018
4	Drinking water systems (No.)	10	-	530	3668
5	Intensive Watershed Development	-	29,858	9,526	57,156
6	Social Forestry	88,19,572	9,995	30,108	1,80,648
7	Planting of Horticulture saplings (Fruits nurseries) (Nos.)	25,558	335	3,015	18,090
8	Horticulture Development (No. of plots)	9,071	6,577	9,071	54,426
9	Vegetable crops (Long term)	3,848	1,480	3,848	23,088
10	Floriculture plots (Long term)	30	2.95	30	180
11	Bio gas (No. of plants)	710	-	710	4260
12	Rural sanitation blocks (No.)	60	-	60	360
Total of Banswara			**66,499**	**65,908**	**3,95,936**
1	Community Lift Irrigation Schemes	46	5,640	3,223	19,338
2	Community Water Harvesting Check dam	60	12,300	4,562	27,370
3	Social Forestry	15,70,294	1,658	5,465	32,790
4	Intensive Watershed Development		13,795	3,968	23,808
Total of Jhalawar			**33,393**	**17,218**	**1,03,306**
TOTAL of both districts			**97,611**	**81,332**	**4,88,538**

Data source: N M Sadguru Water and Development Foundation

Sadguru's water conservation structures are unique. They have a comprehensive programme of (a) Watershed development, (b) Water harvesting structure (check dam), (c) Lift irrigation scheme, (d) Lift irrigation co-operative Institution – all these can be explained as 'water conservation and its use' and thereby making 'Wealth from Water' in rural areas.

Analyses of primary data

Irrigation intervention *– lift irrigation systems along with coop institutions*

Both Baswara and Jhalawar have been blessed with network of rivers and rivulets, (Anas, Hiran, Kagdi etc in Banswara and Chambal, Kshipra, Choti Kali Sindh, Ahu and others in Jhalawar). An appropriate water harvesting mechanism was necessary since the entire water was washed away during monsoon and there was hardly any rabi crop. The farmers were mostly dependent on one single kharif crop. Some of the farmers used to go for black gram in rabi crop, wherever there was soil moisture. But most of the areas remained fallow. Significant number of farmers used to migrate to get their livelihood.

With the introduction of water resources schemes in the area – watershed, check dam and Lift Irrigation – farmers got assured irrigation for their agriculture field for two seasons and these schemes have been proved as life changing interventions for them. The income of the farmers increased many fold. And therefore, migration for livelihood reduced.

People have changed their crop cultivation from one season to two seasons – kharif and rabi – they have taken even third crop if it is vegetables which is a short duration crop. The pattern of crop cultivation has been changed as follows [Table 3]:

The Lift Irrigation (LI) is a process of lifting water from a lower level to a higher-level storage and distributed by gravitation through network of pipe lines. It may be lifted from river, canal, ponds, lakes, check dams or from any water bodies, which are flowing from a lower level from

Table 3: Crops grown in Sadguru intervention areas

Before irrigation intervention	After irrigation intervention
Rabi Crops: Wheat (less), Methi, , Gram	*Rabi Crops:* Wheat, Maize, Mustard, Corriander, Gram, Methi, Tulsi, Barley, Garlic, Brinjal, Lady's finger etc
Kharif Crops: Maize, Bajra, Jowar, Red Gram, Black Gram, Green Gram, Ground nut (less), Til, Chillies, , Cotton	*Kharif Crops:* Maize, Paddy, Black Gram, Green Gram, Ground nut (less), Til, Soyabean, and Vegetables – Garlic, Brinjal, Lady's finger etc

Table 4: Benefit from LI based Irrigation in Banswara and Jhalawar

	Method 1	Method 2
Banswara	Rs 1.32 crores	Rs 1.07 crores
Jhalawar	Rs 0.29 crores	Rs 0.60 crores
Total	Rs 1.61 crores	Rs 1.67 crores

the required agricultural land. In this context of NM Sadguru Foundation, sources of water are mostly check dams on small rivers, rivulets network in Banswara and Jhalawar – both the districts are in Rajasthan. The making of check dams is an engineering art which Sadgauru

Table 5: Benefit from Crops in LI command areas in Banswara and Jhalawar (in Rs crores for Year 2015-16)

	Kharif				Rabi					Summer			Total
Banswara	Maize	Soya	Cotton	Paddy	Wheat	Gram				Maize	Open field veg	Green Gram	
	6.61	2.64	0.60	0.96	9.45	1.09				1.18	0.70	0.59	23.81
Jhalawar					Wheat	Gram	Mustard	Corainder	Methi				
					1.46	0.16	0.19	0.93	0.38				3.12
Total													26.92

has acquired over period of 40 years. Sadguru's skill in this architect of LI irrigation has given water to the field which was waiting for even for the last 800 years in Jhalawar (Ref: Story Book of Shri Harnath Jagawat, N M Sadguru Water and Development Foundation).

LI needs – (1) A perennial water source eg., a river, a man-made check dam or a lake or could be dam. (2) A lifting medium – this is to lift water to the preferred location for storing in a high-altitude tank, lifting medium ie., pump sets and pipes are required according to the requirements. (3) A conveying system – for taking the water from higher altitude (a tank) by gravitation to the fields where water would be distributed in the command area of the system.

The distribution of water is a complex job, for many reasons. It is complex due to the undulated land area, too many fragmentations of cultivated land, multiple variety of cropping pattern where needs of water differ from crop to crop etc., plus timings of watering from one plot to other. This situation has developed certain mechanism of distribution for facing the challenges. Sadguru made the system rugged and unique through LI cooperative.

They have set up LI cooperative in each LI system for managing the total system from the hard-technical care to the soft system where distribution of water according to the crop, its area, distance from the hydraulic point of distribution – keeping in 'equity' built-in into the central mechanism of the system. Most important is the fees/pricing for one hour of water. This fee or water cost per hour is 'same' for all members, whether the land is situated far or near in the command area, irrespective of the plot's situation or crop cultivated. They could make the supply of water volume per hour same for all by developing a unique controlling of flow system. Therefore, the complex system has been made simple by Sadguru.

In Banswara – Sadguru started working for LIs in early 1990s, now there are more than 70 LI coops covering area of more than 7000 acres;and Check Dams numbering about 107 with command area of about 12000 acres. In Jhalawar, about 107 projects of community Lift Irrigation schemes and check dams have been made operational between 1998 and 2016.

Two methods of calculation were used to determine the relative benefit of LI based irrigation as opposed to diesel based irrigation that is in use otherwise. The first method is to look at the relative benefit per hour of irrigation with both techniques. Then, estimate the total hours of irrigation from all crops in the command areas, to get an overall estimated benefit. The second method is to look at the total revenue (cereals and pulses reported under LI cooperatives) from all LI cooperatives, and to determine the relative benefit given the total revenues.

The total with Method 1 comes to Rs 1.61 crores and with Method 2 to Rs 1.67 crores. We take an average of both of these as Rs 1.64 crores annually as the benefit from LI based irrigation in Banswara and Jhalawar taken together [Table 4].

We take the Cereal and Pulses production in Sadguru command areas in Banswara and Jhalawar and analyze them for the net annual benefit.

The crops grown reported in Banswara are Maize, Soya, Cotton, Paddy, Wheat, Gram, Vegetables, and Green Gram. In Jhalawar, the crops are Wheat, Gram, Mustard, Corainder and Methi.

The net benefit from Banswara and Jhalawar comes to Rs 26.92 crores [Table 5].

High Yielding Variety seed intervention

Improved varieties of seeds give higher economic returns per unit area. The higher production with sustainable approach and higher economic returns per unit area purport the logic of sustenance of livelihood even on a smaller portion of the land. Maize is the staple food of the tribal people of Dahod district in Gujarat and Banswara in Rajasthan. Food security is one of the major problems in this area. To achieve food security on sustainable basis it is important to increase maize production. And to meet this situation it is important to focus towards scientific cultivation of maize and to produce quality seeds to meet the requirement. As most of the time farmers do not get improved/certified seeds at proper time and required quantity. So to achieve sustainability of improved seeds, programme of seed production is important for stabilization of maize production.

Seed is a critical and basic input for enhancing agricultural production and productivity in different agro-climatic regions. It is estimated to account for 20-25 percent of productivity. Efficacy of other agricultural inputs such as fertilizers, pesticides and irrigation is largely determined by the quality of seed. Quality seeds with reasonable and affordable rate are a serious issue with most of our farmers. National and international players in seeds markets are exploitative.

The combination of achieving sustainable maize production and to start seed production to

meet the requirement of quality seed supported by village institutions is a unique one at the scale in the most backward tribal district. Uniqueness in this is that it is fully managed by beneficiaries and their organisations. N M Sadguru Water and Development Foundation is only a catalytic agent for introducing this intervention of improved Maize seed production.

Another important aspect of this program is that on a small patch of land a family can sustain itself for food sufficiency. Therefore with its replication this programme is capable of bringing transformation of tribal regions and tribal people. In subsequent replication on massive scale we have to envisage a situation the tribal farmers sustain both in seed production and maize productivity and reaching towards their staple food security.

Seed producers group has been promoted with a motive of institutionalizing the seed

Table 6: Fruit Orchard in Banswara district as on 31.dec. 2011

No of Villages Covered	Name of Block	No. of Beneficiaries	With the Assistance
32	Sajjangarh	2000	NABARD/TAD
23	Talwada	1000	NABARD
Total = 55		Total = 3000	

Source: N M Sadguru Water and Development Foundation office, Banswara

multiplication program and backward-forward linkage in this regard. There is one seed institution between one - two clusters (10 - 15 villages), which identify its producers, with criteria as suggested in the program, and channelize quality and timely inputs and other facilitation, as required in seed multiplication program. It also procures, process and later sells the seed to the farmers, ensuring easy availability at affordable price, in the village itself. Technical Facilitation and financial inputs is provided to enroll these producer groups in certification process. An agreement is formalized between the individual producers and the seed institutions to give buy back assurance to producers and to devise a mechanism for collection of the produce and its further processing and marketing in an institutionalized way.

We have calculated the benefit of Seed production in 3 stages: a) to the producers, b) to the seed producer's group and c) to the buyers.

Benefit to high yielding Seed Producers:

The 175 acres under high yielding Seed production have an output of 19 quintals/acre as

Table7: Benefits from Wadi programme in Banswara

Area	Quantity Qtl	Productivity (Quintals/acre)	Total Production (quintals)	Total Income (Rs)	Income Crores Rs
Vegetables	2500	110	275000	1,10,00,000	1.10
Orchard (Surviving) – Mango	2662.5	32	85200	51,12,000	0.51
Orchard (Surviving) - Lemon	2662.5	27	71887.5	43,13,250	0.43
Orchard areas with Vegetables	1087.5	110	119625	47,85,000	0.48
			Total		**2.52**

compared with 10 quintals/acre for other Maize variety produce. Out of this 19 quintals, 13 quintals Seed production is obtained @ Rs 25 / quintal and the remainder of 6 quintals @ Rs 12/quintal. Overall, there is a net benefit of Rs 0.57 crores to the seed producing farmers in these 175 acres under Seed production.

Benefit to Seed producer's group:

The Seed producers group buys Seed from seed growing farmers at Rs 25/quintal and sells it at Rs 45/quintal in the market. There is a processing charge of Rs 10/quintal and the remainder is profit, giving a net benefit of Rs 0.22 crores to the seed producer's group.

Benefits to Buyers:

The buyers who would otherwise have a much lower production per acre (10 quintals, as opposed to 19 quintals with high yielding seeds), use these seeds on an estimated 28,400 acres of land (at 8 kgs Seeds/acre input), giving a net benefit of Rs 23.88 crores to the buyers.

The total benefit therefore from the Seed programme is estimated annually at Rs 24.68 crores.

Benefits of advance agricultural practices

Wadi – a fruit trees, vegetables, spices, trellis vegetables and vermicompost program – intervention of advance agricultural practices (AAP) – a total mix

In the Wadi program Sadguru included 4 interventions eg, wadi (fruit plants), vegetables varieties and spices and with trellis vegetables (*machan*) and vermicompost also – we can

call a comprehensive or advance agricultural package or practices (AAP), though started initially with 'wadi' program. Therefore, its impact should be seen by taking as 'one' intervention of advance agricultural practices. However, all four of them were not started in the same time (in a year). Wadi started in 2008-09; vegetable and machan in 2012-13, spices in 2008-09 and vermicompost in 2007-08. Especially fruit orchard eg Mango and Lemon, we have analyzed in a separate section after AAP.

The word ***"Wadi"*** is used in Gujarati and Hindi – meaning 'small orchard' which is a tree-based

Summing up the Impacts

Here, we sum up the cumulative impacts of all the interventions among beneficiaries in Banswara district for Sadguru foundation. This includes the impact of advanced agricultural practices, seed production, wadi, and also the additional benefit of water from LI cooperatives. As we see in the above table, the total contribution from grains, seeds and others comes to around Rs 26.92 crores annually. The estimated contribution from Wadi programme is around Rs 2.52 crores; and the benefit from the water supply is around Rs 1.76 crores. The Seeds programme contributes to an impact of Rs 24.68 crores. As a whole, these amount to Rs 55.89 crores annual contribution from the impacts of the interventions in Banswara and Jhalawar. If we look at the local economy and consider a multiplier effect of 3, we can have an estimated impact on the local economy as around Rs 167.69 crores annually [Table 8]. This, as a whole, for Sadguru's efforts in Banswara would be a tremendous contribution to the local economy, especially considering that most of the places such as Kushalgarh have tribal populations. As comparable to the Dahod work of Sadguru, this is also emerging as something highly significant and of a scale of effort.

Table 8: Summing up overall Benefits of Interventions

Sr No.	Intervention	Annual Impact (Rs Crore)
1	Cereal and Pulses crops	26.92
2	Water Benefit from Lift Irrigation	1.76
3	Wadi and related interventions	2.52
4	Seeds intervention	24.68
	Total	**55.89**
	Impact on Economy (Multiplier effect of 3)	**167.69**

Conclusions:
A Case for Decentralized Water Management

The larger level planning of Water Resources in India pays attention mainly to large River basins such as the Ganga and Narmada and the management of reservoirs along the main course of these rivers. Such planning is definitely important for a large part of India. What is however missed in such planning, is that there is also another whole part of the country which cannot access the benefits of these large scale Water Resource planning, simple because they live either in the catchments of these larger river basins, or in the entire stretches of otherwise, smaller river basins, for which such planning is not made.

An entirely different model of Water Resource development and management has therefore got to be adopted for these neglected parts of the country, which then have to depend on localized water sources such as ponds, aquifers and nearby streams, for their water requirements.

It is also a matter of extreme importance that these other areas are also those which are highly impoverished and where agriculture is relatively less vibrant. Many of these are also the tribal parts of the country.

The work of N M Sadguru Water and Development Foundation and other organizations over the past 40 years has shown that small scale Water harvesting work need not be limited to one-off examples, but that they can be scaled up to these small river basins and achieve an impact that makes a big difference to the local economy.

Here we cite some examples from INREM's work in the past 8 years that strengthen this argument further.

a) **N M Sadguru Ater and Development Foundation's work in Dahod,Banswara and Jhalawar**

The intensive work of Sadguru Foundation in Dahod district of Gujarat starting from Lift Irrigation (LI) cooperatives, and then extending to agricultural improvement practices,

Agroforestry, Floriculture, Vegetable cultivation and others, have together led to around an estimate 5.6% contribution to the District's agricultural economy of Rs 1568 crores. This is all possible because of the 125 LI cooperative systems functioning in a decentralized manner with community based institutions, and linked to that the allied activities that the organization has built upon with Government partnership. Secondly, this current study in Banswara and Jhalawar districts of Rajasthan shows the wide ranging impacts of 107 check dams in Banswara and 37 check dams in Jhalawar. The beneficiaries in Banswara received a total annual production of Rs 55.89 crores and Rs 167.69 crores as contribution to the regional economy. This is accumulated from a wide mix of interventions of *Wadi*, Seed production, and improved agricultural practices. These examples of Sadguru Foundation show us a very strong example of scaled up, decentralized development model based on small scale Water harvesting and allied activities.

b) Sajjata Sangh Network's contribution to Gujarat agriculture growth

INREM's research with the Sajjata Sangh, a network of Watershed and Agriculture organizations in Gujarat focused on the cumulative impact of the work of all these organizations across Gujarat. This entire work of organizations spanning 5411 villages in 108 blocks covers around 0.85 million Ha of area. Together, they contribute around Rs 1600 crores cumulatively to the agricultural economy of Gujarat, which is as much as 40% of the annual agricultural growth of the state. This research showed that when put together, all the small scale Water harvesting, watershed and related activities have an enormous impact on the nation's growth.

All these examples remind us that we need a different thinking for the country's hinterlands that continue to suffer from neglect and mis-match in planning. In the context of the current Prime Minister's Krishi Sinchayee Yojana (PMKSY), places which cannot be served by the larger Water resource planning, need to pay attention to this alternate model presented by Sadguru Foundation and allied organizations. The work of Sadguru Foundation has shown that Lift Irrigation (LI) with cooperatives is a way ahead for the interior tribal areas that have small rivers flowing by, but cannot access that water. Alongside such community based LI development, we also need parallel improvement in agricultural practices, better seeds and connection with the market. When these come together, we get such significant impact as we have seen in Dahod, Banswara and Jhalawar. Such examples need to spread and replicated across India and should be accepted as a model of regional small decentralized water resource development as N M Sadguru Water and Development Foundation showed the way for the poor small tribal farmers.

INREM Foundation

INREM Foundation is a research institution probing societal issues concerning water, public health, agriculture and the environment. The institution develops innovative inter-disciplinary solutions and brings them into the wider domain of practice by participating with communities and government. INREM works in the middle space between grass-root community based work, research on natural resource issues and policy formulation to bring about innovations to larger discussion.

The organization has contributed towards understanding water conservation and agriculture innovations in the field and their impact at large scales. The main contribution in recent times has been in the area of Water quality mitigation along with its linkages with different areas including that of public health. The organization is especially known for its pioneering contribution in the area of Fluoride water quality issues bringing about new ideas to the problem of mitigating the disease Fluorosis arising out of high Fluoride in water.

Sadguru Foundation

Established in 1974, Navinchandra Mafatlal Sadguru Water Development Foundation is a non-governmental organization which is non-political, non-profit making, secular organization registered under the Public Charitable Trust Act, the Societies Registration Act (1860) and the Foreign Contribution (Regulation) Act. It is recognized by the Department of Rural Development of the government of 3 states of Rajasthan, Gujarat and Madhya Pradesh. The organization is receiving funds from the state and central government, national and international funding agencies for its rural/tribal poverty alleviation NRM programs.

Its main objectives are to improve the living condition of rural and tribal people by developing environmentally sound land and water resources programmes; improve the environment; arrest the distress migration; improve the socio-economic status of rural people and strive for their overall development. This is prompted by facilitating the growth of local institutions that support and sustain the NRM Programmes.

The project area is classified as a drought prone semi-arid region of the country and is pre dominated by tribal and rural poor who are poorest of the poor struggling for their very existence. The project area is spread across 3 states in16 districts of Rajasthan, Gujarat and Madhya Pradesh, covering about 5,39,151 households and about 32,36,290 people in more than 1557 villages under NRM activities.

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