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Impact of Soil and Water Conservation Measures on Farmers and Farming

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Abstract: *Rain fed farming system being the mainstay of the farming communities and rainfall is a basic water resource. Soil and Water conservation measures as an In-situ water conservation practice is transformative to the effect that it addresses the root of the debacle/distress/exploitation in agriculture by providing autonomy and control with a timely availability of water. Soil and Water conservation works such are Farm ponds, deepening of Check dam, check dams, micro irrigation, water ways, settling tanks have led to a positive impact on a) area under cotton cultivation b) Productivity c) Farm Net Income d) Water Use Efficiency (Kgs /acre/cum) e) Crop intensity f) Crop diversification/crop rotation g) School attendance /reduced dropouts h) Land improvement I) Migration and Employment j) Participation in Agriculture k) Soil nutrient enhancement l) Water levels in the wells m) Vulnerability & Adaptation responses and n) asset formation. Farm Pond as an In-situ water conservation tool without applying high-micron plastic paper to stop the seepage of stored water is found to be a good practice in the project.*

The Construction of water harvesting and soil conservation measures across all the sites in 3 blocks of Morbi, Dharangdhara and Dhoraji helped to being transformative changes in capitalising the benefit of structures such are Deepening of Check dam, check dams, water ways, Farm ponds, settling tanks etc. Transformative change is so impactful that it can lead to creation of a greater number of model farmers in the region. Distribution of farmers by different water conservation measures are such that of the 60 sample farmers 33 of the farmers were covered under WH structures like CD and CDD and FP followed by 10 under water ways, 9 under Settling Tanks and 8 under Drip. About 40% of the sample farmers opined that due to SWC works, the water table has in the wells increased by 4-5 ft and 31 % of the sample farmers could not answer the question as they did not have data to quantify. 16% of the sample farmers opined that the water table in the well increased by 2-3 ft and 13% of the sample farmers opined that water table in wells increased by 6-10 ft. As for as Crop diversification is concerned, 70% of the farmers informed with all confidence and happiness, that because of SWC works, they are able to take 2 crops , 21% of the sample farmers are able to take 3-4 crops and only 8% of the sample farmers could not go beyond 1 crop and it will be worth making special efforts to identify these farmers and improve their crop intensities. Due to SWC works, 100% of the sample farmers informed that seasonal migration in search of non-farm jobs reduced considerably and majority of the sample farmers 43 out of 60 were the beneficiaries of WH works and Water Ways.

Key words: *Soil and water conservation measures (SCM),System Analysis, Vulnerability Adaptive capacity, Impact, Buffer, passive element, active element, Critical elements, Drip Irrigation (DI) Dugout ponds (DP): Farm bunds FB): Farm pond (FP), Check Dam (CD), Check Dam Deepening (CDD), Settled Tanks (ST), Water ways (WW), micro irrigation, Crop Yield, Cost, Gross return: Net return, Net profit margin, Motor or lever and Best practices*

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I. Introduction

Soil and water are two important natural resources and the basic needs for agricultural production. During the last century it has been observed that the pressure of increasing population has led to degradation of these natural resources. In other words, increase in agricultural production to feed the increasing population is only possible if there is sufficient fertile land and water are available for farming. That's why soil and water should be given first priority from the conservation point of view and appropriate methods should be used to ensure their sustainability and future availability. It is a known fact that improved soil and water regime can improve crop production systems. Improved production and productivity of crop yield is the major target of livelihood security strategies. A study on "The contribution of soil and water conservation to sustainable livelihoods in semi-arid areas of sub-Saharan Africa, it is observed that in Uganda those farmers with limited access to land and work oxen are seen to be more likely to invest in SWC, perhaps reflecting a greater need to invest in soil fertility maintenance where a lack of draught power limits the options for opening new land[1]. Crop production practices and production, soil and water conservation objectives are highly harmonizing, since conservation of water, soil and vegetation leads to higher productivity of crops and livestock farming[2]. Likewise, there are many studies which reviewed the importance and impact of soil and water conservation measures. In a study on “Effect of Soil and Water Conservation Measures and Challenges for its Adoption”, farmer’s adoption rates, effects of SWC on soil loss, moisture retention, labour demand and crop yield have been reviewed. Literature shows that SWC measures have promising effects on reducing soil loss, trapping a significant quantity of sediment at early stages and improving soil moisture[3]. In a review of “Effects of soil and water conservation techniques on crop yield, runoff and soil loss in Sub-Saharan Africa: A review," - the authors analysed and synthesized the results of various studies that focused on the effects of CSB-SWC techniques on runoff, soil loss, soil properties, crop yield, and biomass in Sub-Saharan Africa (SSA). The effect of CSB-SWC techniques on crop yield varies with rainfall and slope, with most of the CSB-SWC techniques improving crop yields in low rainfall areas. In most cases, CSB-SWC techniques are economically feasible, due to improved crop yield and low labour opportunity costs and so on[4].

A case in point is the Better Cotton System supported by Better Cotton Initiatives with the financial assistance from IKEA has shown visible impacts in the domain of improved Cotton cultivation and stabilization of agro based livelihoods of the rural inhabitant consequent to improved soil and water conservation initiatives.

ACTION FOR PFOOD PRODUCTION (AFPRO) a national apex organisation established to alleviate poverty and provide income security to the most vulnerable population of India through natural resources management strategies, is implementing Best Cotton System Initiative (BCS) project in the states of Gujarat and Maharashtra since last eight years. The overall impacts of BCS project have been in the areas of natural resources regeneration and conservation, biodiversity, improved agricultural productivity, social impact in terms of bringing awareness among the laborers and landowners on the aspects of decent work and overall income levels of the community.

Though the Government of Gujarat and Maharashtra has carried out a meaningful work in the domain of rainwater harvesting through construction of series of small and medium dams on the rivers and major streams, but due to siltation and poor maintenance, the storage capacity of these dams have been reduced considerably. The Wankaner region of Rajkot district faces severe problem of water quality. High concentration of salt in the water is damaging soil health and as a result, the crop productivity is becoming low. In few villages, the natural topography of the area is causing waterlogged situation. Considering the above aspects, AFPRO with the help of IKEA, took initiatives in identifying the problems connected with the soil and water in the region and have tried to demonstrate simple, low cost and farmers friendly techniques for conservation and regeneration of these scare resources. AFPRO believes in process led development to register impacts of their interventions. Farming community responded to the process of planning and implementing field level interventions in a more positive manner. The process followed by AFPRO had a positive impact on motivating farmers to participate in water Soil and Water conservation measures. Detailed technical study was carried out in all the three regions to set priority interventions. Willingness of farmers to participate and contribute in the implementation of the project was given due consideration while selecting the sites and locations for various activities. The Soil and Water conservation activities have been carried out with the support from IKEA in Gujarat and Maharashtra projects. This was carried out on demonstration basis to educate and sensitize the farmers on the problems associated with Cotton Cultivation. Though these locations receive sufficient rain, but overexploitation of ground water and high density of tube and bore wells has made the area more vulnerable during the drought or low rainfall year.

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[1]The contribution of soil and water conservation to sustainable livelihoods in semi-arid areas of sub-Saharan Africa Edited by Charlotte Boyd and Cathryn Turton with N. Hatibu, H.F. Mahoo, E. Lazaro and F.B. Rwehumbiza,a P. Okubal and M. Makumbib/ ODI Network Paper 2000

[2]Kerr, J., 2002. Watershed development, environmental services and poverty alleviation in India. World Dev., 30: 1387-1400 & Muallem, T. and B. Yebo, 2015. Review on integrated soil fertility management for better crop production in Ethiopia. Sky J. Agric. Res., 4: 21-32.

[3]Kebede Wolka 2014. Effect of Soil and Water Conservation Measures and Challenges for its Adoption: Ethiopia in Focus. Journal of Environmental Science and Technology, 7: 185-199).

[4]Wolka, Kebede & Mulder, Jan & Biazin, Birhanu, 2018. "Effects of soil and water conservation techniques on crop yield, runoff and soil loss in Sub-Saharan Africa: A review," Agricultural Water Management, Elsevier, vol. 207(C), pages 67-79)

II. Methodology[5]

The selected methodology is based on principle and practice of Participatory Impact Assessment (PIA) using participatory tools and exercises[6]. The reason for the selection of the method was to ensure local voices and assessment of the development project, namely the processes of development taking place after the project was phased out. The main sources of information are the main beneficiaries, the local people themselves. The methodology proposes that Impact assessor's role (Consultant/Resource person) to be more of a facilitator that gives inputs to the discussions in order to cover the topics and areas that are within the scope of the study. Also, the facilitator ensures that the voices of different groups in the community, stakeholders, are to be heard. In order to carry out the IA within a certain time frame and within the intended groups, a plan for the process is needed. In addition, a process card approach was followed to a) Identification of problem in the project area b) Discussion with audience about the potential and scope for the problem solving measures of soil and water conservation measures c) Selection of the activities with long time sustainability with functional value d) Prepare a an action plan for the implementation and e) Discussion about contribution in terms of money manpower. As part of IA methodology, after a careful perusal of the data from the field survey, and to draw meaningful inferences, a System Analysis & (Non-Statistical) and Pivotal methods were employed.

In the context of soil and water conservation practices, changes in the context can be considered the result of social processes, i.e. interactions between individuals or groups, such as learning, adaptation, communication, decision, integration, etc as facilitated by the implementing agency i.e. AFPRO. The project "only" tries to trigger or strengthen these processes with its outputs. For example, any new technology driven Good or best practices as situation demands must be utilised and adapted or rejected by stakeholders if not found relevant, effective, and sustainable and communicate their experience and learn from it; when the biophysical environment or the economic situation changes, people adapt their perception and react to it. The moot question for IA at the project level is whether the project related interventions driven outputs have stimulated changes at the outcome level facilitating behavioural changes[7] to a) adapt and sustain best management and agro-ecological practices and social processes influencing impacts b)discover path ways for up scaling and help policy advocacy campaigns and c) how the lessons learnt from the project experience could lead to an enhanced capacities for better planning-designing and implementing projects and help resource generation.

Impact assessment under the present circumstance means

1. *Finding plausible relations between a project's activities and changes in the context (before and after the implementation of project) rather than scientific proof.*
2. *It also means to assess factors which are either passive or active to impact changes in agronomic practices, cost management options, cropping systems including soil and water management practices and*
3. *to demonstrate by providing empirical evidence to the fact that potential for area expansion and yield enhancement of cotton is high in dry land pockets which are treated better in terms of soil and water conservation measures to respond well to crop and water management practices*

The project activities proxied by interventions is expected to trigger changes towards setting the social process in action which means the proposed interventions prompts interactions between individuals or Learning groups, for learning, adaptation, communication, decision, integration, etc and the project objectives in general and interventions in particular make people/community/institutions either passive or active to the level and intensity of impacts.

System Analysis

To capture the impacts in the project area as part of System Analysis, the system of co-ordinates was divided into four Quadrants each quadrant implies certain character or function within the system-to mean the project environment. Note that in reality the "borders" between the four quadrants are gradual transitions and not sharp lines. As all numerical values reflect the experiences and knowledge of the participants (and not a

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[5]This paper is based on the Impact Assessment study conducted by AFPRO in select locations of in select locations of Surendranagar-Morbi and Rajkot districts of Gujarat state in India. Dr NR Jagannath: Impact assessment report on soil and water conservation measures in select locations of Surendranagar-Morbi and Rajkot districts of Gujarat state - Action for Food Production (AFPRO)-New Delhi March 2007

[6]IMPACT MONITORING & ASSESSMENT Instruments for Use in Rural Development Projects with a Focus on Sustainable Land Management Volume 1: Procedure Authors: Karl Herweg (CDE), Kurt Steiner (GTZ) & Instruments for Use in Rural Development Projects with a Focus on Sustainable Land Management Volume 2: Toolbox Authors: Karl Herweg (CDE), Kurt Steiner (GTZ)-2002

[7]Behaviouralchanges towards adapting soil and water management practices are critical for sustainable use of natural resources in general and water in particular as the gap between Demand and supply of water for multiple uses is widening and cost of providing water is becoming prohibitive especially in the context driven by climate change impacts.

mathematical algorithm), it is the relative (and not the absolute) position of each element in relation to others that is important

The process

For analysis purpose, in all 12 elements were identified for the project area located in Yavatmal district. These elements which were identified and hypothesized to impact the project outcomes were

1. Water availability (WA))
2. Soil & Water conservation measures (WCM)
3. Soil erosion (SE)
4. Net Return (NR)
5. Enhanced farm income (EI)
6. Crop productivity (CP)
7. Agronomic practices (AP)
8. Farmers participation (FP)
9. Crop diversification (CD)
10. Soil Nutrient quality (SNQ)
11. Climate change impacts (CCI)
12. Adaptation responses (AR)

These elements are either active or passive in nature as far as their influence on other elements is considered. A matrix was prepared by assigning ranks to each element depending on their power to influence the other element. Following ranks were assigned namely: 2.0 -Strong influences 1.0- Moderate influence; 0.5- Weak influence & finally 0.1-Very weak influence.

Activeness or Passiveness of each elements were calculated by adding up the ranking of all elements both horizontally and vertically calling them as **Active Sum-AS** (Horizontal sum) and **Passive sum- PS** (Vertical totals). As a next step, **an inter dependence** between the elements were considered by taking the product of every active and passive **sums (AS*PS).** Finally. **Active Ratio** was calculated by taking the ratio of Active Sum of every element and Passive Sum of every element of the matrix. The resultant matrix is given below

Sl.N0	Critical Elements	1 WA	2 WCM	3 SE	4 WQ	5 EI	6 CP	7 AP	8 SC	9 CD	10 CCI	11 AR	12 SP	Active Sum	ASXPS
1	Water availability (WA))		0.5	0.5	1	2	2	2	1	1	0.5	1	1	12.5	181.3
2	Water conservation measures (WCM)	**2**		2	2	2	2	2	1	2	2	1	0.5	18.5	222.0
3	Soil erosion (SE)	**1**	2		2	1	2	2	2	1	1	1	2	17.0	238.0
4	Water quality (WQ)	**0.5**	0.5	0.5		2	2	1	1	2	0.5	1	0.5	11.5	138.0
5	Enhanced farm income (EI)	**1**	2	0.5	0.5		1	2	2	2	0.5	1	0.5	13.0	234.0
6	Crop productivity (CP)	**1**	1	1	0.5	2		0.5	0.5	0.5	0.5	1	2	10.5	189.0
7	Agronomic practices (AP)	**2**	1	2	1	2	2		1	2	2	2	2	19.0	313.5
8	Soil conservation measures (SC)	**1**	1	2	1	2	2	1		1	1	1	2	15.0	202.5
9	Crop diversification (CD)	**1**	0.5	1	0.5	1	1	1	1		1	1	1	10.0	232.5
10	Climate change impacts (CCI)	**2**	2	2	1	2	2	1	1	1		2	2	18.0	189.0
11	Adaptation Response (AR)	**1**	0.5	0.5	0.5	1	1	2	1	2	1		0.5	11.0	143.0
12	Soil Profile (SP)	**2**	1	2	2	1	1	2	2	1	0.5	1		15.5	217.0
	Passive Sum (PS)	**14.5**	12.0	14.0	12.0	18.0	18.0	16.5	13.5	15.5	10.5	13.0	14.0		
	Active Ratio	**0.86**	**1.54**	**1.214**	**0.96**	**0.7**	**0.6**	**1.15**	**1.11**	**0.6**	**1.71**	**0.84**	**1.11**		

***Interpretation of Elements in the System Analysis**[8]*

Elements in the two sectors on the left (Symptom & Buffer) are rather passive, i.e. they are influenced by other elements more than they influence others. Elements in the two sectors on the right (Critical Element & Motor) are rather active, i.e. they influence other elements more than they are influenced. Elements in the two lower sectors (Buffer & Motor) are rather weakly interrelated. Elements in the two upper sectors (Symptom & Critical Element) are rather highly interrelated.

Quadrants	Particulars	System Analysis Results for Yavatmal
Q-1	**SYMPTOM POINTER**	Enhanced Farm income Crop diversification Water availability Water Quality Crop productivity Water conservation measures Soil erosion Agronomic practices Soil profile Soil conservation measures Climate change impacts Adaptation response
Q-2	**BUFFER**	
Q-3	**CRITICAL ELEMENTS**	
Q-4	**A MOTOR or LEVER**	

In a consultative manner, appropriate number of sample farmers were selected representing the agro-climatic zones in the project area of Gujarat project site, the project locations in Wankner, Dhrangdhara and Dhoraji blocks of Morbi, Surendranagar and Rajkot district was selected randomly to assess the impact of Soil and Water conservation. For attribution of impacts, same farmers who were covered under Soil and Water conservation works initiatives were considered as a reference group of farmers to respond to same set of questions prior to the construction of SWC works and thus care was taken to see that both respondents and their responses are not affected by variations in agro-ecological and social context. Samples size: In all 600 farmers were covered under SWC works of which only 10% samples were randomly selected for IA study. Sample farmers representing different villages in three blocks of Wankner, Dhrangdhara and Dhoraji blocks of Morbi, Surendranagar and Rajkot district were selected for the IA.

III. Results and Discussion[9]

System Analysis

For analysis purpose, in all 12 elements were identified in consultation with the farmers and project managers for the project area located in 3 blocks of Wankner, Surendranagar and Dhoarji. These elements which were identified and hypothesized to impact the project outcomes were

- *Water availability (WA))*
- *Water conservation measures (WCM)*
- *Soil erosion (SE)*
- *Water quality (WQ)*
- *Enhanced farm income (EI)*
- *Crop productivity (CP)*
- *Agronomic practices (AP)*
- *Soil conservation measures (SC)*
- *Crop diversification (CD)*
- *Climate change impacts (CCI)*
- *Adaptation Response (AR)*
- *Soil Profile (SP)*

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[8]Impact Monitoring & Assessment Instruments for Use in Rural Development Projects with a Focus on Sustainable Land Management Volume 1: Procedure Authors: Karl Herweg (CDE), Kurt Steiner (GTZ) & Instruments for Use in Rural Development Projects with a Focus on Sustainable Land Management Volume 2: Toolbox Authors: Karl Herweg (CDE), Kurt Steiner (GTZ)-2002

[9]Dr NR Jagannath: Impact assessment report on soil and water conservation measures in select locations of Surendranagar-Morbi and Rajkot districts of Gujarat state - Action for Food Production (AFPRO)-New Delhi March 2007

As can be seen from the table that there are SYMPTOMS or pointer observed in the project area namely Crop diversification and Enhanced Farm Income which are greatly influenced by other elements of the project area but relatively may not have much power to change the system (to mean the project area) and its surrounding environment itself- Symptoms though useful indicators of context changes, but development activities in this quadrant may only amount to a "treatment of the symptom, not the cause per se where the cause lies in other elements 2.

Likewise, there are BUFFER elements in the project area namely Water Availability, Water Quality and Crop productivity found which are characterised by low importance in the context. It is rather unremarkable because it neither influences other elements much nor is it influenced much by other elements of the system. Development interventions in this quadrant are expected to have little impact on the context.

CRITICAL ELEMENTS: In the project area, of the 12 elements identified and hypothesised to have an influencing power, it is observed 4 elements were observed to be very critical in nature which are Soil erosion, Water conservation measures, Agronomic practices and soil profile of the region and these elements are accelerator or catalyst in the project area. These elements change many things quickly but may also create many unexpected and undesired side effects if they are not properly addressed and assessed within the project. Development interventions for these elements can be highly uncertain, and impacts may be unpredictable if the process and strategies followed to implement these interventions are not Relevant-Effective and Efficient. Therefore, critical elements have to be a) understood properly and b) treated very carefully

These elements when addressed carefully could produce greater impacts especially at outcome level and have far reaching consequences on types of adaptation response to mitigate the impact of climate change. Further, addressing the critical element of the system i.e. Soil Erosion is important as managing soil for greater WUE is critical given the level of soil erosion problem in the project area. Through appropriate SWC measures. Water use efficiency (WUE) represents a given level of biomass or grain Crop Yieldper unit of water used by the crop. With increasing concern about the availability of water resources before and after construction of Soil and Water conservation works there has to be a renewed interest in trying to develop an understanding of how WUE can be improved and how farming systems can be modified to be more efficient in water use. As a short-term solution, the construction of Soil and Water conservation works served its purpose meet the critical water requirements. The other critical elements are Water conservation measures, Agronomic practices and soil profile which has bearing on the crop productivity, the nature of adaptation responses & type of soil conservation measures to be taken up in addition to creating impact on the farmers mindset to opt for crop diversification 5. Last but not least, for the project area the result is that Soil conservation measures, Climate change impacts and Adaptation responses were found to be a MOTOR or a LEVER signifying the fact that these elements are active with predictable impacts- This is the most interesting and are the elements leveraging the change process influencing development activities of the project area under consideration. As Soil conservation measures are critical since it maintain or enhance the productive capacity of the land including soil, water and vegetation in areas prone to degradation through a) prevention or reduction of soil erosion, compaction, salinity b) conservation or drainage of water and c) maintenance or improvement of soil fertility. When Soil conservation measures taken effectively could have far reaching consequences and impacts on SYMPTOM, BUFFER and CRITICAL elements of the system. When this element is addressed properly by taking into consideration the soil and location specific physical, biological and agronomic measures, it can have a far reaching impact on the rest of the elements namely, Crop productivity, potential for crop diversification, to enhance soil nutrient quality, water availability and help prepare for adaptation responses. This will help address the consequences of the CRITICAL element of the system namely Climate change impacts resulting in adverse effect on soil profile leading to soil erosion.

WATER CONSERVATION WORKS –CRITICAL ELEMENTS

The critical barrier related to water for livelihood security is its scarcity. Rain fed farming system being the mainstay of the farming communities' rainfall is a basic water resource. Growing population puts tremendous pressure both on the soil & water –the key productive resource base and begins an irreversible process of degradation of natural resources and on the path to desertification. The only means of providing water and increase soil moisture regimes to agriculture is through well designed and planned SWC works. Harvesting surplus runoff in Soil and Water conservation works and recycling the same for providing supplemental irrigation to Kharif crops or pre-sowing irrigation to rabi crops has proved to be the most successful technologies for adoption and this being done as an in-situ water conservation practice, the cost effectiveness makes the structure conducive for sustainable use.

Soil and Water conservation works as an In-situ water conservation practice is transformative to the effect that it addresses the root of the debacle/distress/exploitation in agriculture by providing autonomy and control with a timely availability of water. This provides social and economic space/opportunity to network for collective action by farming communities for the use of water resources. It will give fillip to diversify crop pattern and centre stage the power and role of women to maximize incomes based on individual factor endowments that suit their comparative advantage. Its shifts from despair to farmers led vision/aspiration to foster their farming knowledge and emotional attachment to their land. Its shifts from gambling with monsoon to a certainty of crops and opportunities for diversification of livelihoods like horticulture, livestock etc. Provides courage to invest in maximizing the productive capacity of land and water in a sustainable manner. Innovation helps reconnect and negotiate institutions and markets enhancing their domestic/social status and dignity. This will deliver upon their aspiration to educate children, consume healthy and regular

Soil and Water conservation works as an In-situ water conservation practice is transformative to the effect at it addresses the root of the debacle/distress/exploitation in agriculture by providing autonomy and control with a timely availability of water. The following table give an overview of SWC works in the 3 blocks of Wankner, Dhoraji and Dhrngdhara in the state of Gujarat in western part of India.

Sr. No.	Type of structure	Quantity		No. of farmers benefited	No of Villages covered
		Wankaner Project			
1	Water ways	43	5643.7m3	61	**07**
2	Water settling Tank	45		45	**20**
3	Farm bund	01		02	**01**
4	Drip Irrigation	20		20	**08**
Dhrangdhra Project					
1	Dug out pond	05	3893m3	52	**04**
2	Farm pond	06	5304m3	17	**06**
3	Water ways	10	4911m3	36	**04**
4	Farm bund	01	187 m3	01	**01**
5	Settling tank	03	03 No	03	**01**
6	Magnetic device	01	04 ha	01	**01**
7	Drip irrigation	05	07 ha	05	**01**
Dhoraji Project					
1	Deepening of Check Dam	14	13172m3	181	**14**
2	Farm Pond	01	612 m3	07	**01**
3	**Drip Irrigation**	**50**	**50 No**	**50**	**37**

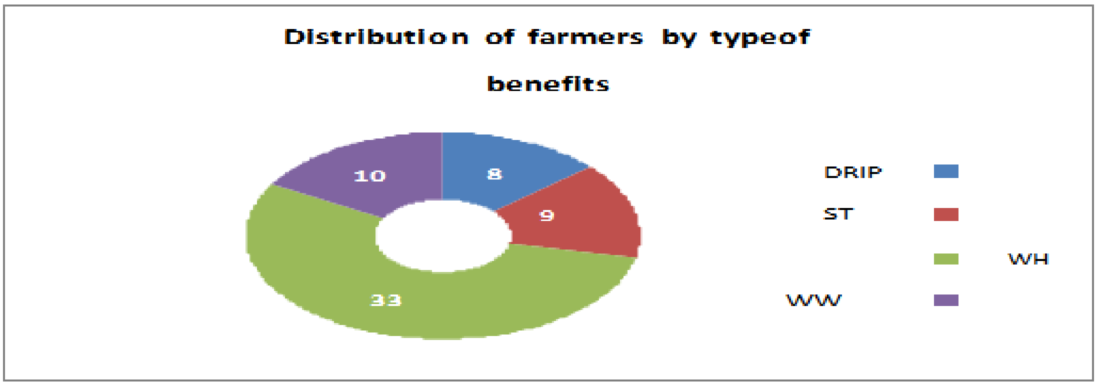
Source: Report on "Soil and Moisture Conservation under IKEA supported BCI projects in Gujarat & Maharashtra by AFPRO

The activities aimed at resolving issues around soil erosion, run-off, low water retention, low water table in the downstream wells. All these issues had its bearing on water availability, water quality, crop intensity, productivity. seasonal migration and net return to farm management. An impact assessment study was mandated to map the impacting elements and result of the impact of Soil and Water conservation works and examine as to how the construction of Soil and Water conservation works as an add-on activity could enhance productivity and Water Use efficiency of cotton in the project are

Analysis of the information collected from 60 odd farmers from three blocks namely Wankner, Dhoraji and Dhrangdhar showed that the construction of Soil and Water conservation works such are deepening of Check dam (CDD) check dams (CD), micro irrigation (MI) water ways (WW) settling tanks (ST) have led to a positive impact on a) area under cotton cultivation b) Productivity c) Farm Net Income d) Water Use Efficiency (Kgs /acre/cum) e) Crop intensity f) Crop diversification/crop rotation g) School attendance /reduced dropouts h) Land improvement) Migration and Employment j) Participation in Agriculture k) Soil nutrient enhancement l) Water levels in the wells m) Vulnerability & Adaptation responses and n) asset formation.

IMPACT RESULTS BY SWC TYPE OF WORKS

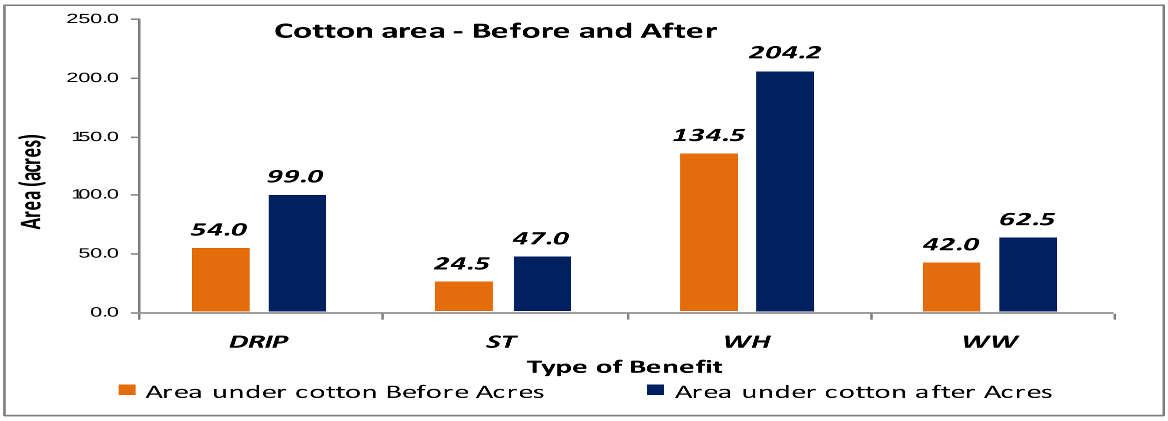
In all 60 farmers representing 10% of the 600 farmers covered under SWC works in three blocks of Wankener, Dhranghdhar and Morbi were interviewed belong to different social stratification who are both socially and economically vulnerable and represented different soil types. The following picture depict their distribution by number and area they owned and by type of SWC works However, when analysed the sample results by soil type, a pattern of difference could be observed across all soil types. 58% of the farmers covered 63% of the area under black cotton followed by 23% of the farmers reporting 13% of the area under medium black soil, 10% of the farmers under red laterite soil reported 19% of the area under red laterite soil. & minor proportion of farmers in the remaining soil types. The soil types too had its impact on parameters like; extended area under cotton, Crop Yield differentials, net return to farm management, gross return, cost of cultivation and water use efficiencies.



Distribution of farmers by different water conservation measures are such that of the 60 sample farmers. 33 of the farmers were covered under WH structures like CD and CDD and FP followed by 10 under water ways, 9 under Settling Tanks and 8 under Drip (see picture above)

IMPACT ON AREA IRRIGATED UNDER COTTON

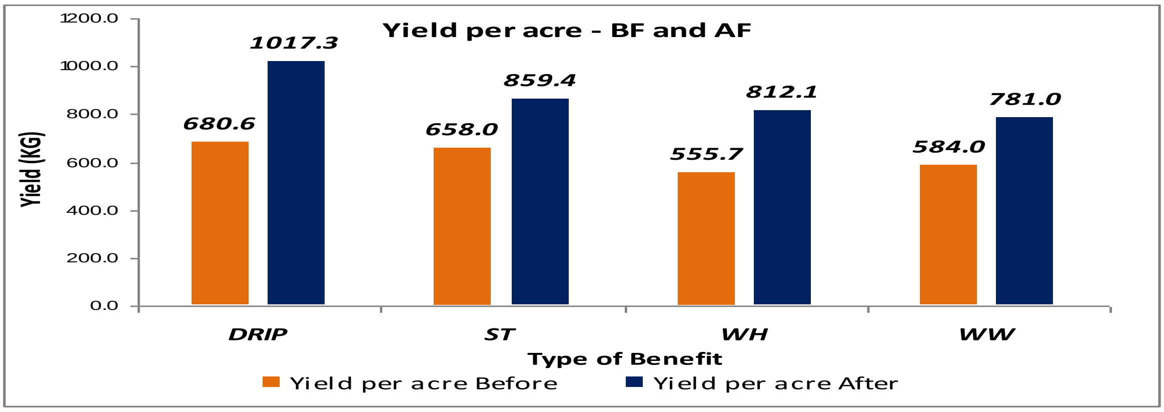
Construction of Soil and Water conservation works impacted the farmer's interest to increase area under irrigated cotton the intervention helped framers to increase cotton area under irrigation. The increase in area under cotton was observed to be relatively high under WH structure (70 acres) followed by drip irrigation (45 acres) Settling Tanks (22.5 acres) and finally Water Ways (20.5 acres)



Alongside the expansion of area under cultivation under cotton, because of supplementary irrigation to cotton fields during the critical stage of its growth period, productivity of cotton also increased by a huge margin.

IMPACT ON CROP YIELD

The Critical stages of moisture requirement for cotton include among others a) at the entry level of each stage. If the plant undergoes water stress during these stages, yields are significantly reduced. If water is available for one irrigation, it should be provided at the flowering stage If water is available for two irrigations, it should be provided at the flowering and boll formation stages If water is available for three irrigations, it should be provided at the seedling, flowering and boll formation stages.

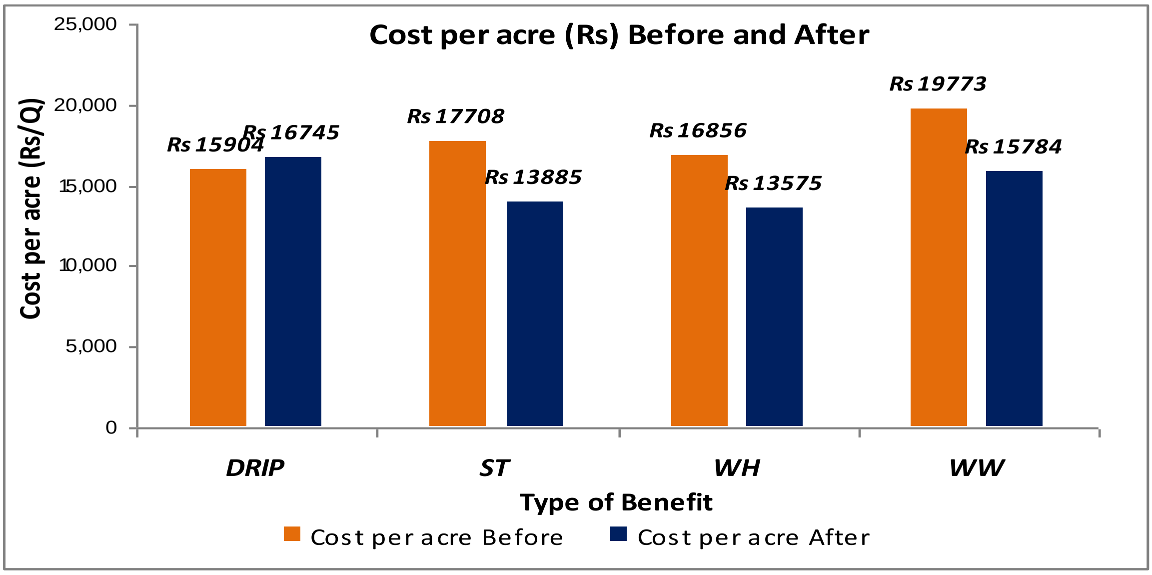


Since Farm pond construction has increased water availability, meeting moisture requirement was made easy at every stage of the crop growth in the project area. Execution of SWC works have impacted the Crop Yield potentials of cotton under BCSS project as it helped meeting the critical requirement of water during the crop growth period. Availability of water during the critical stages of crop growing period has helped farmers to register an increase in Crop Yield and it varied from a minimum of 5.84 Q/ac (BF-Under Water Ways) to a maximum of 10.17 Q/ac (AF Under Drip).

Parameters	Unit	DRIP	ST	WH	WW	Overall
Crop Yield per acre Before	Kg/acre	680.6	658.0	555.7	584.0	596.6
Crop Yield per acre After	Kg/acre	1017.3	859.4	812.1	781.0	862.0
	% Change	49	31	46	34	44

Across all the SWC type of works, an overall increase in Crop Yield was observed to be 44% (From 5.97 Q/acre to 8.62 Q/acre). Farmers who had the benefit of Drip irrigation, could increase the crop Crop Yield from 6.8 Q/ac to 10.18 Q/ac)-an increase in Crop Yield by 49%. Followed by farmers under WH structures (5.56 Q/acre to 8.12 Q/acre). However, the increase in Crop Yield was lower for farmers who were covered under settling tank. (Crop Yield increased from 6.58 to 8.59 Q/acre)

IMPACT ON COST OF CULTIVATION



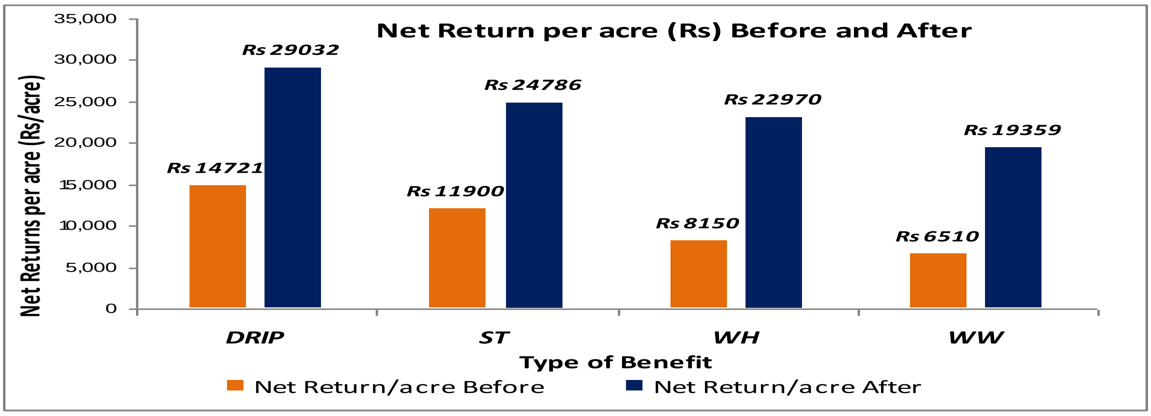
Parameter	Units	DRIP	ST	WH	WW	Overall
Cost per acre Before	Rs/acre	15,904	17,708	16,856	19,773	17,217
Cost per acre After	Rs/acre	16,745	13,885	13,575	15,784	14,705
	Difference	842	-3,823	-3,282	-3,989	-2,511
	%	5	-22	-19	-20	-15

Except for Drip Irrigation farmers, all other farmers responded to decrease in cost of cultivation after availing the benefit of water conservation measures. Under Drip Irrigation, the increase in cost of cultivation per acre is marginal + 5% which is in absolute term Rs 842 per acre)

Interestingly usage of different water harvesting structures did contribute to decrease in cost of cultivation per acre. The decrease in cots per acre ranged from a minimum of Rs 3282 (WH) to a maximum of Rs 3989per acre (Water Ways) and overall decrease in cost per acres was Rs 2511.

IMPACT ON RETURN TO FARM MANAGEMENT

Farming is risky. Farmers live with risk and make decisions every day that affect their farming operations. Many of the factors that affect the decisions that farmers make cannot be predicted



With 100 percent accuracy: weather conditions change; prices at the time of harvest could drop; hired labour may not be available at peak times; machinery and equipment could break down when most needed; and government policy can change overnight.

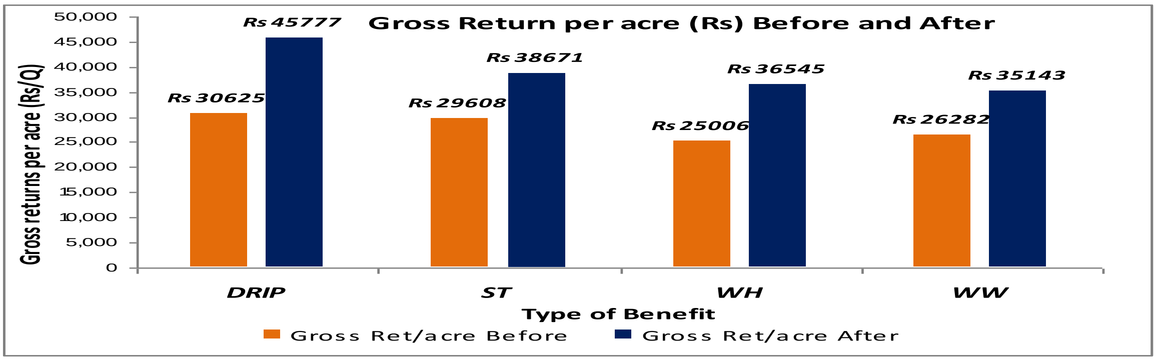
All of these changes are examples of the risks that farmers face in managing their farm as a business. All of these risks affect their farm profitability. However, a small intervention like Soil and Water conservation works–an insitu- water harvesting and conservation tool in the hands of farmers has the potential to minimize this risk and enhance scope for participation in cultivation practices.

Parameter	Unit	DRIP	ST	WH	WW	Overall
Net Return/acre Before	Rs/acre	14,721	11,900	8,150	6,510	9,632
Net Return/acre After	Rs/acre	29,032	24,786	22,970	19,359	24,084
	% Change	97	108	182	197	150

Soil and Water conservation works are able to minimize the risks and reap net return for the management. Increase in Crop Yield had its cumulative effect on Net Return per acre as well. Net Return per acre varied across the use of different structures from a minimum of Rs 6510 (BF- Water Ways) to a maximum of Rs 29032 (AF-Drip). Maximum Thus, without loss of generality, the Inference drawn from the farmer's feedback on net return consequent to the construction of Soil and Water conservation works is indicative of the fact that higher net returns with high productivity, rather than physical Crop Yield of cotton is a stronger motivating factor for farmer's sustained use of water storage structures. . Farmers across all types of SWC works seem to be convinced that for better yield, water retention, reduced run-offs and improved nutrient quality of the soil are critical issues which are greatly impacted by insitu-soil and water conservation & harvesting practices. Across all types of SWC works, the overall net return per increase was 150%. Farmers who were covered under WW structures could get the maximum increase in their net return to management (197%)

IMPACT ON GROSS RETURN

SWC works have greatly influenced the income level of farmers in dry pockets of wankner, Dhoraji and Dhranghdhra blocks of Morbi, Rajkot and Surendranagar districts in the state of Gujarat. Benefits received from Soil and Water conservation works answers, at least in the short run, the question: does it pay to be a farmer in places like wankner, Dhoraji and Dhrnghdahr blocks. Gross Return per acre increased due to the usage of Water conservation measures. It varied from a minimum of Rs 25006 (BF-WH)) to a maximum of Rs 45777(AF-Drip Farmers). However, the profit margin can only guide the farmer to decide on crop choice to sustain in agriculture.

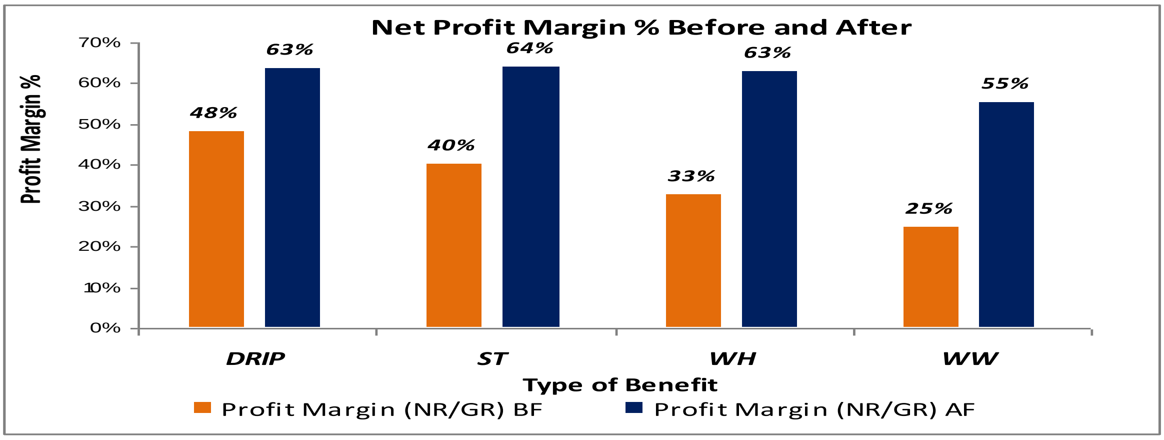


From the IA exercise, there are evidences to suggest that farmers especially growing cotton under "best management practice regime" with increased water availability to provide water at critical stages of crop growth are able to meet their basic livelihood needs to a great extent from income obtained from cotton fields.

Parameter	Unit	DRIP	ST	WH	WW	Overa
Gross Ret/acre Before	Rs/acre	30,625	29,608	25,006	26,282	26,848
Gross Ret/acre After	Rs/acre	45,777	38,671	36,545	35,143	38,790
	% Change	49	31	46	34	44

MPACT ON NET PROFIT MARGIN (NPM)

Improving the production capacity of agriculture outputs in general and cotton in particular to make the transition from field to fabric in a place like wankner, Dhoraji and Dhrnghdahr blocks through increases in Net Profit Margin is an important development goal of AFPRO where agriculture and cotton industry represents an important sector in the economy.



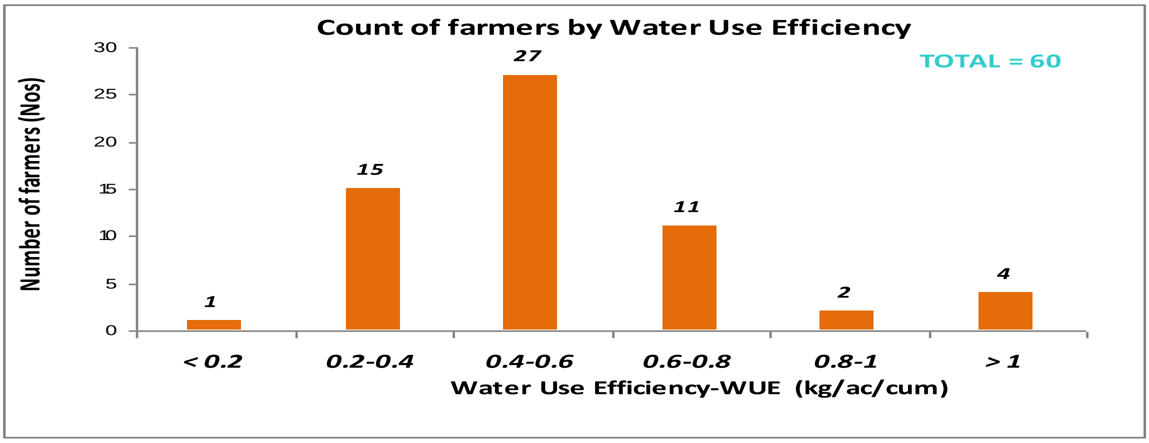
The agricultural sector provides livelihood directly and indirectly to a significant portion of the population of the dry pockets of Morbi, Surendranagar and Rajkot districts where poverty is more pronounced. Thus, a growing crop like cotton under best crop management regimes contributes to both increased farm business income and poverty alleviation

Parameter	Unit	Drip	ST	WH	WW	Overall
Profit Margin (NR/GR) –BF	%	48	40	33	25	36
Profit Margin (NR/GR) –AF	%	63	64	63	55	62
Increase in profit margin	%	15	24	30	30	26

Net Profit Margin ultimately guides the farmers to make an informed choice to continue or discontinue the cultivation of a crop like cotton. Here, the margins are measured as the ratio of agricultural profits (Net returns per acre) to agricultural revenues (Gross return per acre) and output is priced at the market value of final output. The Overall Net Profit Ratio across all types of SWC works has increased by 26% As it could be seen that margin is more for a situation wherein the benefit of SWC works exits, as compared to a situation wherein there were no SWC works undertaken.

IMPACT ON WATER USE EFFICIENCY (WUE)

The objective of rain-fed cropping systems in location like is to maximize the proportion of rainfall by way of harvesting through water conservation measures that crops use, and minimize water lost through runoff, drainage and evaporation from the soil surface and to weeds.



Due to the rapid growth in world population, the pressure on water resources is Increasing. In the future less water will be available for agricultural production due to competition with the industrial and domestic sectors and therefore it is inevitable that the production per unit water consumed, the water use efficiency (WUE) must be increased to meet this challenge. For farmers, WUE is the Crop Yield of harvested crop product achieved from the water available through rainfall, irrigation and soil water storage (Crop Yield Per Acre per Cum of water used- Kgs/acre/cum)-the simplest defining to work on field data without subjecting to the scientific rigor in computing WUE

Parameter	Unit	DRIP	ST	WH	WW	WAVG
Water Use Efficiency –WUE	kg/cum	0.48	0.45	0.58	0.50	0.53
Distribution of farmers	%	13	15	55	17	100

Though water availability in water storage structures critical, judicious use is important for realizing higher water use efficiency. Water Use Efficiency (WUE) was found to vary from a minimum of 0.45 kgs/acre/cum to a maximum of. 0.58 kgs/ac/cum of water.

The Water Use Efficiency is 0.53 kgs/acre/cum across all categories of structures. Interestingly farmers who were covered under WH structures like CD, CDD and Farm Ponds were able to achieve higher WUE levels as compared to those who were covered under Drip, Settling Tank, and Water Ways.

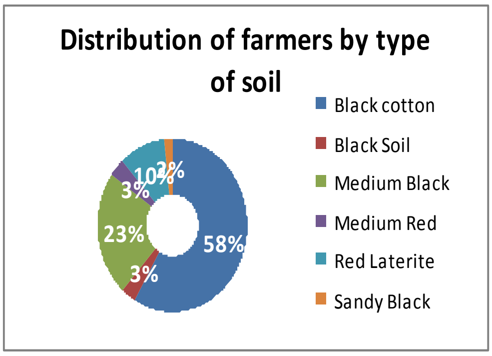
WUE Range	Count	%
< 0.2	1	2
0.2-0.4	15	25
0.4-0.6	27	45
0.6-0.8	11	18
0.8-1	2	3
> 1	4	7
Total	60	100

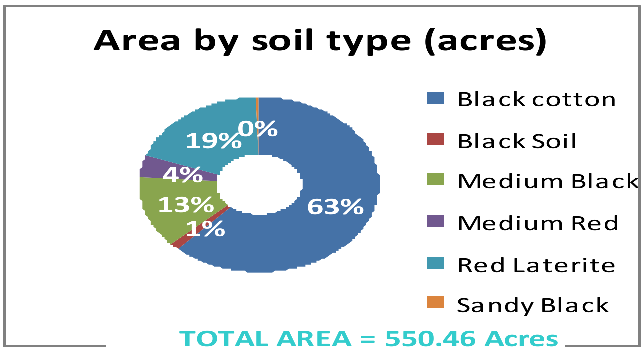
It could be inferred from the table that 63% of the sample farmers were at the WUE level of 0.4-0.8 kgs/ac/cum. For a comprehensive improvement of WUE, it is necessary to raise the following ratios to their maximum: stored soil water content/ water received through rainfall and irrigation, water consumption/ soil water storage, transpiration/ water consumption, biomass yield/ transpiration, and economic benefit/ biomass Crop Yield(*Vol. 10, pp. 1-15 (2010) Journal of Agricultural Physics ISSN 0973-032X)*

The need of the hour is also to increase more number of crops per drop of water- which is possible only when we promote in-situ water conservation and harvesting structures to store water for increasing crop intensity and provide farmers with the choice of crop diversification, crop rotation and other crop management practices.

It can be expected that large gains in water productivity can be made with rainwater harvesting or supplemental irrigation in dry areas with low seasonal precipitation. Investing in rainwater harvesting techniques and/or systems like Farm Ponds for supplemental irrigation, in combination with improved agronomic management and the use of fertilizers, may give a significant boost to the productive use of water resources. This is what AFPRO wanted to achieve through their converting rainfall to grain through conservation measures within BCSS project wherein, best cotton management practices are being followed by farmers.

SWC IMPACTS BY SOIL TYPES





However, when analysed the sample results by soil type, a pattern of difference could be observed across all soil types. 58% of the farmers covered 63% of the area under black cotton followed by 23% of the farmers reporting 13% of the area under medium black soil, 10% of the farmers under red laterite soil reported 19% of the area under red laterite soil. & minor proportion of farmers in the remaining soil types. The soil types too had its impact on parameters like; extended area under cotton, Crop Yield differentials, net return to farm management, gross return, and cost of cultivation and water use efficiencies.

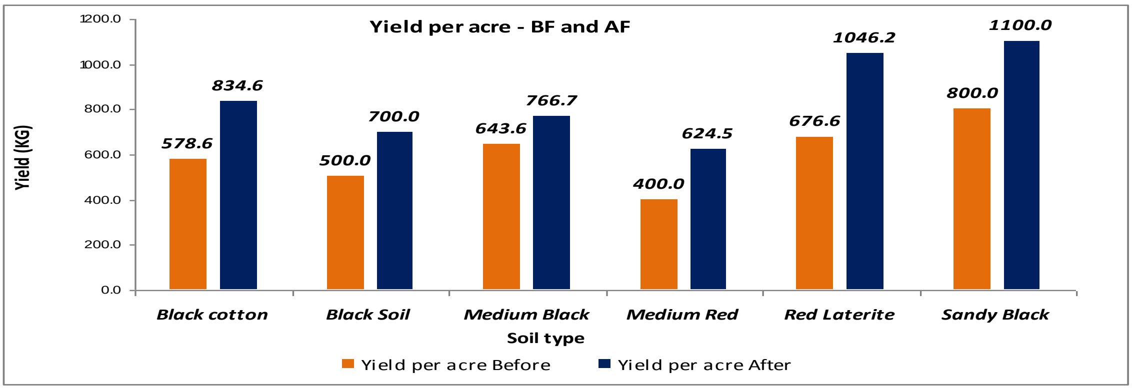
AREA IMPACT

Average area owned by farmers varied from a minimum of 2 acres (sandy black soil) to a maximum of 17.5 acres under red lateritic soil. SWC works and its benefits helped farmers to increase area under cotton in different soil types. Under black soil cotton registered an increase of 87 acres followed by red lateritic soil (40 acres) and 20 acres under medium black soil and other soil type's namely black, medium red and sandy black soils accounted for an increase of 10 acres under cotton.

Parameter	Unit	Black cotton	Black Soil	Medium Black	Medium Red	Red Laterite	Sandy Black	Overall
Area under cotton Before	Acres	148.5	4.0	33.5	15.0	53.0	1.0	255.0
Area under cotton after	Acres	236.2	8.0	53.5	20.0	93.0	2.0	412.7
Increase (Decrease) in area	Acres	87.7	4.0	20.0	5.0	40.0	1.0	157.7

IMPACT ON CROP YIELD

Medium red soil yielded 4 q/acre before execution of works and after execution of SWC works, the Crop Yield was maximum @ 11 q/ac under sandy black soil (could be due to small sample size and area).



Highest percentage of Crop Yield increase was for farmers under Medium Red soil from 4 Q/ac to 6.24 Q/ac). Followed by red farmers cultivating under Red Lateritic soil (6.76 Q/ac to 10.46 Q/ac),
Black cotton soil (from 5.78 Q/ac to 8.34 Q/ac) and increase in Crop Yield across all the soil types is 44%. If Crop Yield level is found to be lower than expected, it might be due to attack of

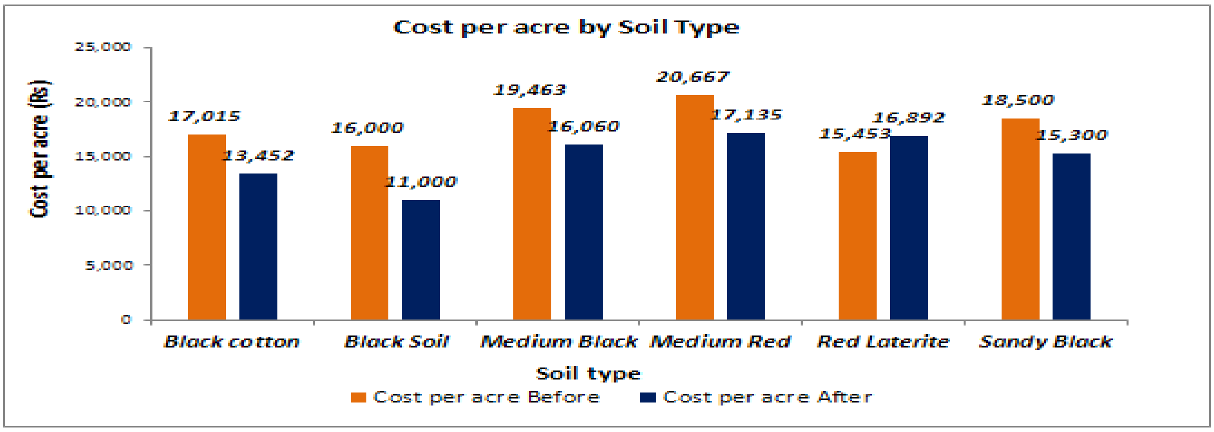
Pink Ball worm on Cotton Crop) which in effect reduce the Crop Yield level from 15 to 20 which in turn will

Parameter	Unit	Black cotton	Black Soil	Medium Black	Medium Red	Red Laterite	Sandy Black	Overall
Crop Yield per acre Before	Kg/acre	578.6	500.0	643.6	400.0	676.6	800.0	596.6
Crop Yield per acre After	Kg/acre	834.6	700.0	766.7	624.5	1046.2	1100.0	862.0
	% Change	44	40	19	56	55	38	*44*

have sequential effect on net income, gross income and net return per quintal

For most of the soil types, cost of cultivation per acres showed decrease in absolute values after execution of works except for red lateritic soil. The decrease in cost of cultivation was more under black soil (-31%) followed by black cotton soil (-21%), Medium black, medium red and sandy black @ -17%.

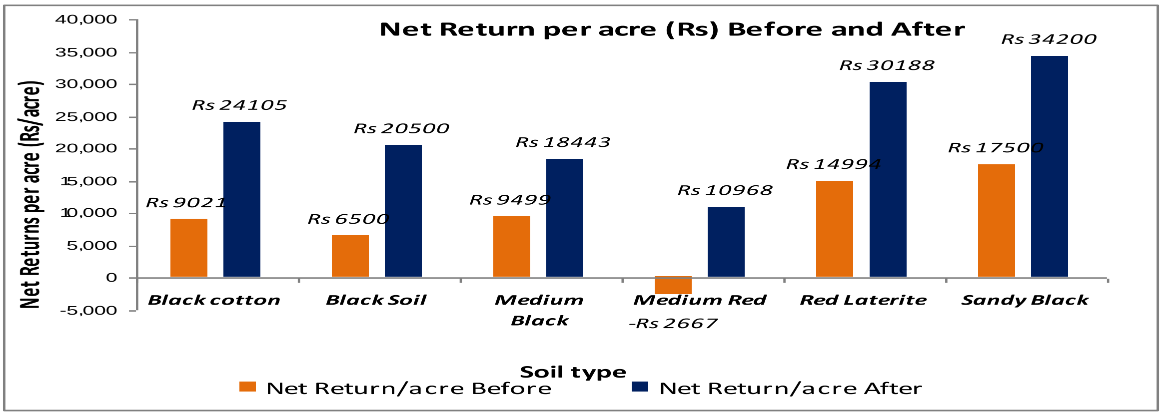
IMPACT ON COST OF CULTIVATION



Parameter	Unit	Black cotton	Black Soil	Medium Black	Medium Red	Red Laterite	Sandy Black	Overall
Cost per acre Before	Rs/acre	17,015	16,000	19,463	20,667	15,453	18,500	17,217
Cost per acre After	Rs/acre	13,452	11,000	16,060	17,135	16,892	15,300	14,705
	% Change	-21	-31	-17	-17	9	-17	*-15*

The reduction in cost of cultivation needs deeper analysis of cost components since most of the farmers uses open and Tube wells for feeding water into the newly created water storage structures and does involve energy cost and other cost being held constant (before and after execution of SWC works), the possible reasons for reduction in cost could be reduced number and hours of irrigation to crops but this needs more critical analysis to ascertain the reasons-however, reasons needs to be examined more closely.

IMPACT ON NET RETURN PER ACRE



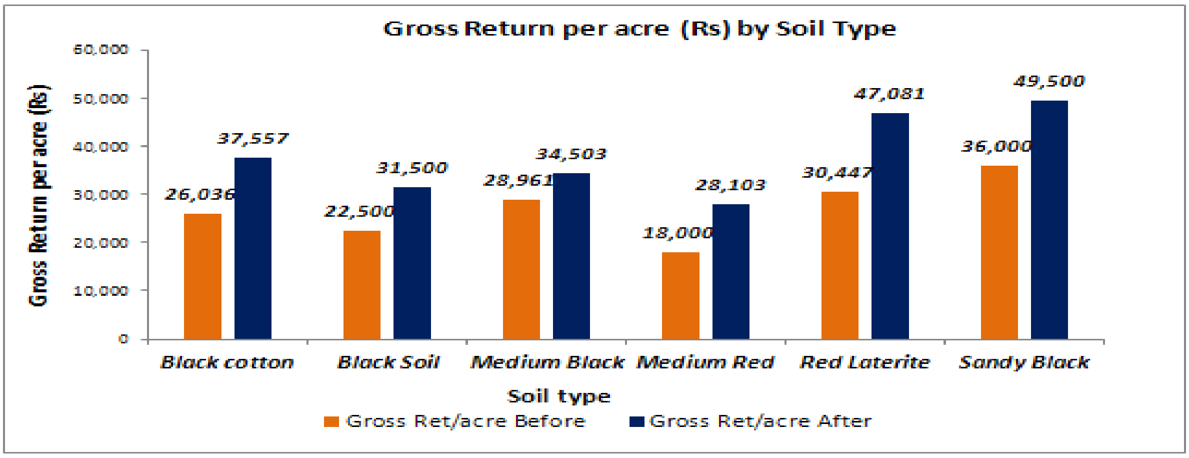
Net Return Per acre before execution of SWC works is found to be negative under medium soil (-667 Rs/acres) for those farmers whose main source of irrigation was open well and Tube wells and the reason for negative net return is due low Crop Yield rate (4 q/ac) and low gross return which is lower than the cost of cultivation. In a study on “The Impact of Soil and Water Conservation on Agricultural Economic Growth and Rural Poverty Reduction in China-Sustainability, it was found that soil and water conservation have a significant impact on the per capita income of rural households in China[10]

Parameters	Unit	Black cotton	Black Soil	Medium Black	Medium Red	Red Laterite	Sandy Black	Overall
Net Return/acre Before	Rs/acre	9,021	6,500	9,499	-2,667	14,994	17,500	9,632
Net Return/acre After	Rs/acre	24,105	20,500	18,443	10,968	30,188	34,200	24,084
	% Change	167	215	94	311	101	95	150

After execution of SWC works, the situation changed to positive gains mainly due to increase in Crop Yield per acre and also due to high gross return and cost being less than the return especially for farmers using tube wells and open wells. Before execution of SWC works, maximum Net Return per acre was under sandy black @ Rs 17500. After execution of SWC work, the maximum net return per acres went up to Rs 34200 an increase of 95%.

[10]The Impact of Soil and Water Conservation on Agricultural Economic Growth and Rural Poverty Reduction in China-Sustainability 2018, Abdul-Rahim, Chenglong Sun and A. W. Noraida.

IMPACT ON GROSS RETURN PER ACRE



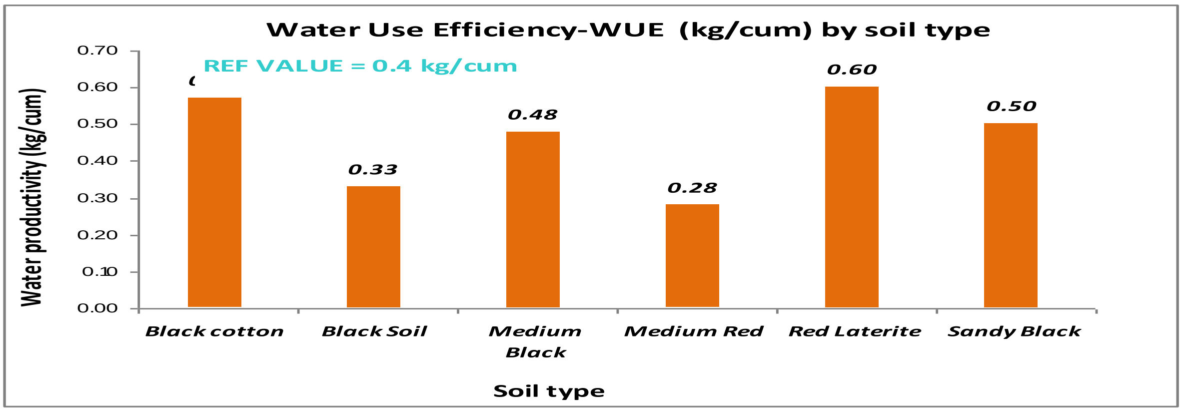
The gross return per acres was observed to be maximum under Sandy black soil after the execution of SWC works followed by Red lateritic soil and it is lowest for farmers cultivating under medium black soil. A scientific analysis of soil sample is necessary for correct attribution to the effect of SWC influence on soil types

Parameters	Unit	Black cotton	Black Soil	Medium Black	Medium Red	Red Laterite	Sandy Black	Overall
Gross Ret/acre Before	Rs/acre	26,036	22,500	28,961	18,000	30,447	36,000	26,848
Gross Ret/acre After	Rs/acre	37,557	31,500	34,503	28,103	47,081	49,500	38,790
	% Change	44	40	19	56	55	38	44

Percentage change of 56% in gross return per acres was for Medium Red soil-though in absolute terms maximum gross return was observed under Sandy black soil.

IMPACT ON WATER USE EFFICIENCY

The need of the hour is also to increase more number of crops per drop of water- which is possible only when we promote in-situ water conservation and harvesting structures to store water for increasing crop intensity and provide farmers with the choice of crop diversification, crop rotation and other crop management practices. Differentials across types of soils indicate that it has profound effect on yields and water requirement.About 63% of the sample farmers used water efficiently as indicated by WUE vale of 0.4-0.8 kgs per acre per cum. The following table is self-explanatory. The pattern of increase /decrease both in % terms and absolute terms did not follow the same order as that of Crop Yield per acres, area under cotton, net return, gross return and profit margin as far as **Water Use Efficiency** figures are concerned and those farmers who believed in the fact that higher water application/use does not necessarily imply higher Water Use Efficiency got the maximum benefit



Overall Water Use Efficiency across all soil types was found to be 0.53 kgs/acre/cum (weighted average across all soil types). WUE is lowest for farmers under medium red soil (0.28 kgs/acre/cum) and it is maximum @ 0.60 kgs/acre/cum under red lateritic soil. Only scientific analysis of soil samples under each soil type could throw more light on the factors contributing to the differentials in WUE values

Water Productivity	Unit	Black cotton	Black Soil	Medium Black	Medium Red	Red Laterite	Sandy Black	WAVG
Water Use Efficiency-WUE	kg/acre/cum	0.57	0.33	0.48	0.28	0.60	0.50	0.53
Distribution of farmers	%	58	3	23	3	10	2	100

WAVG: Weighted Average

WUE BY CATEGORY OF FARMERS

WUE values when analyzed by category of farmers, showed that small farmers could reach the WUE value of 0.32 kgs/acre/cum (lowest) as compared to 0.52 kgs/acre/cum (big farmers) and 0.48 kgs/acre/cum for medium farmers despite the fact that small farmers accounted for 77% of the sample household considered for IA. One needs to examine in detail the package of practices, soil profile, water use data, and Crop Yield and training inputs received by this category of farmers.

Water Use Efficiency by Farm size	Unit	BIG Farmer	MED Farmer	SMALL Farmer	Overall
Count	Nos	8	6	46.00	60.00
Total Area	Acres	226	51	273.46	550.46
Cotton area before	Acres	90	26	139.00	255.00
Cotton area after	Acres	156	41	215.66	412.66
Crop Yield After	Kg	169,700	41,000	145,01	355,710
Water use	cum	13,300	8,500	74,27	96,070
Water Use Efficiency (WUE)	Kgs/ac/cum	**0.66**	**0.80**	**0.48**	**0.53**

IMPACT ON VULNERABILITY& ADPATIVE CAPACITY

Effects of climate change that have implications for water resources include increased evaporation rates, a higher proportion of precipitation received as rain, earlier and shorter runoff season s, increased water temperatures and decreased water quality is a matter of serious concern for farmers of Wankner, Dhoraji and Dharngdhara blocks of Morbi, Rajkot and Surendranagar districts respectively. Climate change impacts have made the farmers ecologically-socially and economically vulnerable. In order to insulate farmers from these vulnerabilities, AFPRO has initiated Soil and Water Conservation Measures in select locations of Wankener, Dhoraji and Dharngdhara blocks of Morbi, Rajkot and Surendranagar districts. Impact Assessment made an effort to see how these measures reduced their ecological-social and economic vulnerabilities and their impact on adaptive capacities. Few examples are given to prove the point

Parameter Benefit Ranking (Low to High)	Soil & water Conservation Measures (SWC)						
	Unit	DRIP	ST	WH	WW	Grand Total	%
1	Nos					**0**	*0*
2	Nos	2		3	2	**7**	*12*
3	Nos	6	9	30	8	**53**	*88*
TOTAL		**8**	**9**	**33**	**10**	**60**	
WH includes farm ponds, Check dams and Check dam deepening							

Many of the sample farmers (88%) reported that SWC measures have benefitted them immensely and particularly they were happy about WH and Water Ways measures .

One measure like Water Ways is proved to be a good adaptive response to multiple vulnerabilities namely ecological-social and economical in ecologically fragile eco-system of Wankner, Dhoraji and Dharngdhara blocks. These water ways, as per farmer's feedback, helped a) prevention of gully formation b) increased ability of the soil to store water and nutrient c) reduced run-off rates d) conservation of water and nutrients e) protection of newly planted crops f) prevention of silt accumulation in low laying area g) reclamation of waste land h) improved productivity i) enhanced farm income j) Higher water use efficiency and

k) Reduced seasonal migration. The perception of indicators of farmers for ecological vulnerability is area prevented from gully formation, increased quality of soil. The indicator for social vulnerability is the reduced level of indebtedness cum high level of repayment and indicators of economic vulnerability is enhanced net return to farm management practices.

Other parameters which reflect the benefits of above SWC measures helping their vulnerabilities are given in the following table

Soil Quality	***Unit***	**DRIP**	**ST**	**WH**	**WW**	**Grand Total**	***%***
Increase in Quality	Nos	8	9	33	10	**60**	*100%*
Decrease in Quality	Nos	0	0	0	0	**0**	*0*
TOTAL		**8**	**9**	**33**	**10**	**60**	
Water depth							
0-3 ft	Nos			3		**3**	*16*
4-5ft	Nos			11		**11**	*40*
6 ft and above	Nos	2		2		**4**	*13*
TOTAL		**8**	**9**	**33**	**10**	**60**	
Crop Diversification							
1 Crops	Nos			3	2	**5**	*8*
2 Crops	Nos	6	5	23	8	**42**	*70*
3 Crops	Nos	2	4	5		**11**	*18*
4 Crops	Nos			2		**2**	*3*
TOTAL		**8**	**9**	**33**	**10**	**60**	
Migration							
Decrease in Migration	Nos	8	9	33	10	**60**	*100*
Increase in Migration	Nos	0	0	0	0	**0**	*0*
TOTAL		**8**	**9**	**33**	**10**	**60**	
New Asset Creation							
Yes - Created new asset	Nos	2	2	5	3	**12**	*20*
No - Did not create new asset	Nos	6	7	28	7	**48**	*80*
TOTAL		**8**	**9**	**33**	**10**	**60**	
School Enrollment							
Increased	Nos	8	9	33	10	**60**	*100*
Decreased	Nos	0	0	0	0	**0**	*0*
TOTAL	Nos	**8**	**9**	**33**	**10**	**60**	

Inference form the above are

1. Increase in soil quality as reported by 100% of the sample farmers indicative of the fact that ecological vulnerability of the soil is reduced
2. Water depth of more than 4ft as reported by 53% of the sample farmers suggest that water harvesting and storage structures are more of a recharging in nature than discharging in their functionality
3. SWC measures helped farmers to crop diversification as more than 88% of the sample farmers have taken more than 3 crops as against one single crop under rain-fed conditions which indicate that crop diversification as an adaptation response insulated farmers from hydrological and economic drought conditions
4. Due to high crop intensity (as measured by number of crops grown) has helped farmers to reduce /minimize their migration (as an adaptation strategy) as 100% of the sample farmers indicated that SWC measures have helped reduce their migration
5. Consequent to reduced out-migration, farmers are happy to inform that the school drop-out rates are reduced as can be seen from the table 100% of the sample farmers reported increase in school enrollment and this is noteworthy feature of SWC measures on social side relating to social vulnerability of school children

IV. Conclusion

Social process as followed in the project by AFPRO has contributed for farmers contribution and participation in SWC activities. Farmer's feedback though positive is a matter of concern for farmers collective action to initiate pro-active SWC measures especially when it comes to creating community assets like community Farm ponds. Most critical elements which have the high potential to impact the project area are soil profile, agronomic practices, SWC measures and soil erosion. Soil sample analysis is critical to adopt crop pattern to best respond to management practices so that soil profile is improved for adapting best agronomic practices

Conserving natural resources and creating an enabling environment by way of construction of In-situ water conservation and harvesting tool like Farm ponds (without the application of high-micron plastic paper to stop the seepage of stored water), settled tanks, deepening of Check dam. is critical and a pre-requisite to realize the effectiveness of package of agronomic packages and adaptation responses to climate change impacts and increase crop productivity. Given the way the water is recycled to Farm Ponds, the problem of ground water depletion and reduced flow into natural nalas and drains affects water availability in down steam wells for drinking purpose and it becomes impetrative to revisit their strategies towards natural resource conservation measures towards balancing multiple water needs. Water Use Efficiency (WUE) and Soil Nutrient management practices need to be balanced for better response to the package of practices. High water use need not necessarily result in high WUE and there is a need to calculate on a scientific basis the WUE. Building & capacity building of community-based interventions is a pre-requisite for sustainability. A scientific assessment of WUE for all crops and crop rotation is recommended for assessing the relative merit of individual crops and also crops grown in rotation. As it has brome evident that making water available in the water storage structures during pre and post monsoon period helped farmers to increase in area under cotton crop, enhance Crop Yield helped crop diversification and improved soil quality and enhanced farm business incomes

More social action is required for motivating the farmers to construct community-based farm ponds to meet the drinking water needs as it is as important as crop water needs-the logic of this can never be questioned. Making water available in the water storage structures during pre and post monsoon period helped farmers to increase in area under cotton crop, enhance Crop Yield helped crop diversification and improved soil quality and enhanced farm business incomes. SWC measures in general have contributed to an increase in both crop and water use efficiencies.

Net Profit margin was more for farmers who enjoyed the benefit of water storage structure. The logical connect among increase in area under cotton crop, high crop intensity, enhanced Crop Yield, crop diversification and improved soil quality, and enhanced farm business incomes has helped farmers to stop seasonal migration which in turn has helped reducing the level of school dropouts. Enhanced Farm income also helped farmers to create assets both farm and non-farm. SWC works and utilities have produced many spin-off effects including improved gender relations within the family.

Despite positive benefits and impact of SWC measures the sustainability potential of interventions is medium and with more intense social process, farmers could be motivated to be pro-active for collective community actions so that future interventions are people centric people controlled and people managed.

In addition, a measure like Water Ways proved to be a good adaptive response to multiple vulnerabilities namely ecological-social and economical in ecologically fragile eco-system of Wankner, Dhoraji and Dharngdhara blocks. These water ways, as per farmer's feedback, helped a) prevention of gully formation b) increased ability of the soil to store water and nutrient c) reduced run-off rates d) conservation of water and nutrients e) protection of newly planted crops f) prevention of silt accumulation in low laying area g) reclamation of waste land h) improved productivity i) enhanced farm income j) Higher water use efficiency and k) Reduced seasonal migration. The perception of indicators of farmers for ecological vulnerability is area prevented from gully formation, increased quality of soil. The indicator for social vulnerability is the reduced level of indebtedness cum high level of repayment and indicators of economic vulnerability is enhanced net return to farm management practices

The Very positive Results of Impact Assessment Study shows that SWC interventions to improve crop production, productivity, Return to Management and Water Use Efficiency at the field level have real potential for sustainable improvements in living standards. It is therefore recommended that a well-planned SWC measures be taken up in the potential area planned for up scaling initiative under BCSS.

AN EXAMPLE OF WATER WAYS AS A GOOD PRACTICE[11] TO CONSERVE SOIL & WATER & COPE WITH THE IMPACT OF CLIMATE CHANGE IMPACTS

Template on Good Practice in the Wankaner and Dhangadhra project	
Key parameters	Description
GOOD PRACTICE TITLE 	**CONSTRUCTION OF WATER WAYS** 
Brief Description of Good Practice	On the basis of runoff and impounding of water, a trench is dugout along/across the slope of the farmland. This is necessary where there is waterlogged condition during rains which doesn't support to crop growth. Through this small trench excess water is taken away from the main cropping land and optimum water is made available for the cotton crop for its better growth. This activity has been carried out in the Wankaner and Dhangadhra project. A total of 10555 Mt of waterways are constructed in 11 villages benefitting to 100 ha of land belonging to 97 farmers. It is cost effective as farmers through collective action could construct with their own contribution and participation
Why the Good practice was used: Briefdescription of the issue/improvement opportunity the Good practice was developed to address	1. Prevention of gully formation.... 2. Increased ability of the soil to store water and nutrient 3. Reduced run-off rates 4. Conservation of water and nutrients 5. Protection of newly planted crops 6. Prevention of silt accumulation in low laying area 7. Reclamation of waste land 8. Improved productivity 9. Enhanced farm income 10. Higher water use efficiency 11. Reduced seasonal migration

[11]Good practices at FAO: Experience capitalization for continuous learning: External concept note: September 2013

WHY DO YOU CALL IT A GOOD PRACTICE?- A RATIONALE

Criteria	Ranking (1-5) from Low to High				
Ranking	1	2	3	4	5
1. Effective and successful					5
2. Environmentally, economically and socially sustainable					5
3. Gender sensitive	1				
4. Technically feasible				4	
5. Inherently participatory					5
6. Replicable and adaptable					5
7. Reducing disaster/crisis					5

What are the benefits of the Good practice? Briefly describe the benefits derived from implementing the Good practice.	Prevention of gully formation Increased ability of the soil to store water and nutrient Reduced run-off rates Conservation of water and nutrients Protection of newly planted crops Prevention of silt accumulation in low laying area Reclamation of waste land Improved productivity Enhanced farm income Higher water use efficiency Reduced seasonal migration
What problems/issues were associated with the Good practice: Briefly Describe the problems/issues experienced with the initial deployment of the Good practice that, if avoided, would make the deployment of this Good practice easier the" next time".	According to System Analysis result, soil erosion is a critical element in the project area and soil erosion removes valuable top soil which is the most productive part of the soil profile for agricultural purposes. Siltation of watercourses and water storages was an issue needing priority action. The loss of this topsoil results in lower yields and higher production costs. When topsoil is gone, erosion can cause rills and gullies that make the cultivation of field crops impossible. The impacts of erosion on cropping lands include a) reduced ability of the soil to store water and nutrients b) exposure of subsoil, which often has poor physical and chemical properties c) higher rates of runoff, shedding water and nutrients otherwise used for crop growth and d) loss of newly planted crops and deposits of silt in low-lying areas. All these problems are addressed by way of constructing Water Ways
How the success of the Good Practice was measured: What data/operating experience is available to document how successful the Good practice has been?	Measured through New area brought under cultivation (Acres) Run-off rates (%) Nutrient quality of the protected lands Increase in Crop Yield(Quintal/ Acre) Increase in Net Return (Rs/acre) Net profit margin (%) Water Use Efficiency (Kgs/ac/cum)
Description of process experience using the Good Practice: Describe the operating experience with the Good practice with particular focus on the evolution of its development, end user experience, and the role the practice plays in soil and water conservation and management.	More than the technical process, it is the social process which posed challenge to reach an agreement on farmer's contribution and participation in the construction of water ways. The experience has been that farmers are not averse to contributing for interventions in their private lands as they could immediately perceive the benefits but when it comes to interventions in public land benefitting the common good, the hesitation was seen particularly when it comes to contribution. However, this problem was overcome through repeat visits and meetings. Once they experienced its benefits arising out of water ways, the demand for more in number increased and they also started questioning the technical design for the better.

An explanatory note

Terms	An explanatory note
Vulnerability	Is a function of the character, magnitude and rate of climate variation to which a system is exposed; its sensitivity; and adaptive capacity
Adaptive capacity	Is the capacity of a system to adapt if the environment where the system exists is changing? It is applied to e.g., ecological systems and human social systems
Impact	Measure of the tangible and intangible effects (consequences) of one intervention or entity's action or influence upon another.
Buffer, Critical elements	Is characterized by low importance in the context. It is rather unremarkable because it neither influences other elements much nor is it influenced much by others. Development activities in this quadrant are expected to have little impact on the context.
Critical element	Is an accelerator or catalyst in the system? It changes many things quickly but may also create many unexpected and undesired side effects. Development activities in this quadrant can be highly uncertain, and impacts may be unpredictable. Therefore, critical elements have to be treated very carefully.
Motor or lever	Is an active element with predictable impacts- This is the most critical impacting elements influencing development outcomes of the region under consideration
Drip Irrigation (DI)	A micro irrigation technology
Dugout ponds (DP)	Dugout or excavated ponds are constructed in areas of flat or gently sloping land not suited for ponds with dams in the current project; it also refers to deepening of check dams. As the name implies, dug ponds are created by removing soil and allowing water to fill in the dugout area. Most of the water supply comes from ground water seepage or natural springs. Soils are usually made up of materials that allow free movement of water through the pond bottom
Farm bunds FB)	A Farm bund is like an embankment, often built around the periphery of farmland to prevent water run-off. Bunds and trenches help reduce soil erosion and retain water during scanty rainfall. They also improve ground water levels by increasing filtration
Farm Pond	Farm ponds are small water bodies formed either by the construction of a small dam or embankment across a waterway or by excavating or dug out. The water is usually harvested from a small catchment area and then used for irrigation during prolonged period
Check Dam (CD)	A check dam is a small, sometimes temporary, **dam** constructed across a drainage ditch, or waterway to counteract erosion by reducing water flow velocity
Check Dam Deepening (CDD	Is a process of increasing the volume of water in check dams
Settled Tanks (ST)	Settling tanks are constructed from black clay soil or impervious soil or cement concrete. It is generally constructed to retain water which is lifted from bore wells/tube wells. This practice is generally followed in the areas where salts in water are too high and that the direct flooding is harmful for the soil health. By retaining water in the tank for certain period allows the salts to settle down and then the upper layer of water is drained for irrigation through gravity
Water ways (WW)	**Is** a trench dugout along/across the slope of the farmland in which run-offs are allowed to flow-in and impounded thereof

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