Chapter 6  Findings, Challenges, Suggestions and Conclusion
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In this chapter finding, challenges, suggestions and conclusion had discussed. The findings mainly derived from the primary and secondary data analysis.

In this research there were four types of respondents contributed i.e.1) Farmers, 2) Government officers, 3) Researcher, writer, scholar, thinker and leader, 4) NGOs professionals who had worked in Dangs. In this research main respondents were farmers 94%. Other respondents were government officers, NGOs professionals, scholars, writer, local leaders and researcher. For understanding subject both were equally important. Around 52% respondent were irrigated farmers which provide information about their own experiences of irrigated agriculture, income, status, irrigated agriculture economics, options they had used to irrigate their land etc. While 42% respondents were Rainfed farmers which provide information about their income from agriculture, migration other source of income, land ownership etc. Other respondents they had provide their role, their view of irrigation in the Dangs, suggestion for increase irrigation in the Dangs.

The data collected from irrigated farmers and rainfed farmers. There were 244 respondents of rainfed farmers from 66 villages and 300 respondents of irrigated farmers from 44 villages had taken as sample household. All 300 irrigated farmers had sources through which they irrigated their land.

During research work, researcher had observed and collected information on the modes of irrigation as available to the cultivators for irrigation of their land. The various modes adopted by irrigated farmers were from both the sources of irrigation, by (a) Surface water and (b) Ground water. The surface water sources were further classified by lift irrigation and flow irrigation. Ground water sources mainly two were in practice by the Dangs farmers, like open wells (shallow and deep), and tube wells. Surface water sources were available at rivulets, river, pond, storage of check dams, rivers, canals, diversion channels, channels etc. Any sources, where water was stored and lifted for irrigation through use of engine pump set or electric motor pumps set were taken as sources of lift irrigation. Flowing water from streams, canals, or other water channels whether flowing perennially or during rain whether stored or flowing and was used for irrigation without any use of motor pump were taken as mode of flow irrigation.

Researcher had analysed of the different data both for Irrigated farmers and rainfed farmers. These had summarized for findings and suggestions to increase irrigation in the Dangs district. It was summarized in three sections.

A. Impact of irrigation on Irrigated farmers
B. Challenges faced by irrigated famers
C. Suggestions for increase irrigation in the Dangs district.
A. Impact of irrigation on Irrigated farmers
Research analysis arranged in sequence input, output, outcomes and impact. Following flow chart explains each in details and gives conceptual clarity of impact of irrigation.

Chart No.6.1 Schematic diagram: Impact of irrigation on irrigated farmers

- **Input**
  - Land: Irrigated and Unirrigated
  - Source of knowledge/ supplier
  - Options of Irrigation: Flow/ Lift. Surface water / Ground water
  - Performance: Water availability Surface water / Ground Water (Shallow aquifer/ deep aquifer)
  - Seasons (One, two, three seasons)

- **Irrigated Farmers**
  - Ownership of Cattle
  - Family size
  - Sharing Benefit and cost: Individual or Group

- **Output**
  - Total Income
    - Increase cropping intensity
    - Income: Agriculture and Productivity
    - Income from Milk
    - Income from Migration

- **Outcomes**
  - Improve land
  - Increase wage rate and labour demand
  - Expenditure for better livelihood

- **Impact**
  - Education
  - Migration
  - House
  - Status in society
Following the flow chart findings had discussed steps by step in following sequence.

- **Input**: These had seven components: land, options of irrigation, water availability, finance, ownership of cattle, family size, source of knowledge and projects/scheme
- **Output**: These had four components. They were agriculture productivity, cropping intensity, income from farm, income from milk (dairy) and income from migration.
- **Outcomes**: These had four components. They were improvement in land, increase wage rate and labour demand, increase expenditure for family to had better life.
- **Impact**: Due to irrigated agriculture there were four positive impacts observed in this research work i.e. education, migration reduction, house condition, status of farmers. (Comparison of irrigated farmers with rainfed farmer)

**Input: These had seven components: land, options of irrigation, water availability, finance, ownership of cattle, family size, source of knowledge and projects/scheme.**

1) **Source of knowledge/ scheme or project/ inspiration:**
Before we go to analyze the irrigation, let’s know how farmers come to know and inspired to do adopt irrigated agriculture or who had helped them to do irrigation.

Around 57% farmers either learned or inspired from other farmers either from own village or nearby village. Almost 21% people had come to know from Government scheme or various government departments other than agriculture. There were 7% farmers had interaction with Agriculture department or agriculture universities. There were 12% farmers they had known by self or education, 3% had got to know from BAIF.

In 1968 some of the progressive farmers had started irrigation in villages of Subir taluka. Increase area under irrigation was from 1990 onwards. Average experience to do irrigation of Irrigated farmers was seven years. Some of the farmers had 26 years of experience and some of them had just started year back.

2) **Options of irrigation**
In the Dangs district, irrigation by well 35%, Mobile Pump Set 36%, tube well irrigation23%, irrigation by group well 1% and 1% by flow irrigation. Irrigation tools used differently by different cast. Lift irrigation by Bhil (92%) and Kokani (8%), while Well irrigation by Bhil (31%) and Kokani (65%), Group Well irrigation by Kokani (50%) and Varli (50%), Tube irrigation by Bhil (12%), Kokani (85%) and Varli (3%). Flow irrigation by Kokani (100%).

3) **Water Availability**
   **Ground Water:**
   Open Wells: Ground water availability had measured by measuring performance of well irrigation. In the Dangs district, 6% wells had water for monsoon only, 50% wells had water for two seasons (Monsoon and winter (Kharif & Rabi)), although 44% wells had water for all three seasons. On other hand 56% wells had no water to irrigate summer crops. This measurement gives us condition of shallow aquifer. Performance of shallow aquifer was 44% considering irrigation for all three seasons.
   Tube Wells: Deep ground water availability had measured by measuring performance of tube well irrigation. In the Dangs district 40% tube wells had two seasons water and 60% had three seasons water for irrigation. Ownership of tube well was Bhil (12%), Kokani (85%) and Varli (3%). Performance of deep aquifer was 60% considering irrigation for all three seasons. In terms of exploring irrigating Kokani had taken lead in the Dangs District.
Surface Water:
Surface water availability had been measured by feedback of mobile pump users at various locations of rivers and rivulets at different villages in the Dangs District. According to mobile pump users, water available during monsoon season only (100%), Monsoon and winter (44%) and all three seasons (52%) at different locations of various rivulets across the Dangs District. Where 4% respondents had not surety about their surface water, it was depends upon monsoon. Mobile pump users were Bhil (30%), Kokani (62%) and Varli (8%). Surface water availability was 52% with respect to small size of mobile pump users. Small size mobile pump set (2 to 8hp) had maximum irrigation capacity was 2 to 4 acres only.

4) Finance for promoting Irrigation:
These finance had arrange by themselves either from bank or from their own sources. This was over and above government subsidy. This did not include their family labour work to promote irrigation.

Average finance invested was Rs. 18382 at the Dangs District. Bhil (22%) had average irrigated finance of Rs. 16056, while Kokani (72%) had Rs. 19604. Kokani had greater investment than Bhil. On other hand the regional variance was Ahwa taluka had Rs.11572, Waghai had Rs.19221, while Subir Taluka had Rs.27200 irrigation finance by farmers. Almost 51% farmers invested up to Rs.10000, 34% had invested between (Rs.10001 to Rs.30,000) , 15% famers invested than Rs. 30000.

5) Land Ownership: (Comparisons between Irrigated farmers and Rainfed farmers)
Comparisons between Irrigated farmers and Rainfed farmers brought out some key differences had discussed here.
There were five categories of farmers decided based on size of the land they owned. Basic differences in land ownership between rainfed farmers and irrigated farmers were in category of marginal farmers (Land up to 1hectare) there were 48% rainfed farmers and 29% irrigated farmers. In category of small farmers (1.1 to 2.0 hectares) there were 29% rainfed farmers and 35% irrigated farmers while comparing for Small- Medium farmers category (2.1 to 4 hectare) both rainfed farmers and irrigated farmers had 18%. In category of Medium farmers (4.1 to 10 hectares) only 5% rainfed farmers and 16% irrigated farmers. Differences in land ownership between rainfed farmers and irrigated farmers were there in the Dangs District.

Average land holding of irrigated farmers was 6.21 acres and they had average irrigated land 1.84 acres and average unirrigated land 4.85 acres. Average land holding of rainfed farmers was 4.15 acres. Basic difference in landholding between irrigated farmers and rainfed farmers was 2.06 acres. Landholding of irrigated farmers had average 2.06 acres more than rainfed farmers.

6) Livestock
Ownership of cattle addressed dung economy and economic gain due to milk and their use in agriculture. Ownership of cattle (cow or buffalo) had directly income from their milk (dairy) and their dung used as fertilizer for irrigated agriculture. Out of 300 respondent, 218 (73%) had cattle, and 175 (58%) had income from milk (dairy). So out of 218 cattle owner 175(80%) had income from milk (Dairy). Ownership of bullock/ buffalo (pada) had directly link with agriculture. Both animals had useful for farming. Their dung used as fertilizer for irrigated agriculture.
Out of 300 respondents, 231 (77%) had their own bullocks/ buffalo (Pada) which support both farming and provide fertilizer for irrigated agriculture. Average animal they had 2.3 (either two or three).

7) Family size
Average size of the family of the irrigated farmers was 5.8 say 6. These distributions had helped to analysis data further. Bhil had average family size 6.0 and Kokani had 5.8 per household. There was not much difference between these two casts. These provide human resource to irrigated farmers family.
Institutional aspect had discussed in the challenges part because 80% irrigation managed by individual only 20% by group of farmers. Group irrigation had several advantages over individual irrigation in the Dangs contest.

Output: These had four components. They were agriculture productivity, cropping intensity, income from farm, income from milk (dairy) and income from migration.

1) Agriculture and cropping intensity:
Access to irrigation infrastructure had increase crop yield, agricultural production and farm income within a region. The total beneficial impacts of irrigation development, both direct and indirect, had summarized under the following categories.
1. Increased crop production (yield improvement) and increased farm income.
2. Increased cropping intensity
3. Increased employment- increase wage and increase labour requirement
4. Increased farm consumption and increased assets

Impact on agriculture is primary effect due to irrigation. To understand agriculture impact need to know crops economics. Let’s see the crop economics of irrigated farmers.

The Dangs district farmers grow five main crops i.e. Rice, Finger Millet (Nagali), Small millet (Varai), Vegetables (Ladyfinger, chilly, bringal, tomato, coriander), Black gram (Udad). In addition to this they had grown groundnut, pigeon pea (tuvar), sorghum, etc. It was useful to reviewed economics of different crops.

Almost 99% irrigated farmers grow rice. Rice is staple food of the tribal people. Irrigated farmers used seeds from 7kg to 13kg and average seed rate was 11kg practice in the Dangs. Average production of rice was 2089kg, while they had received Rs.13 per kg market price. Their average income from rice production was Rs.26132 and their expenditure to grow Rice comes to Rs.6284 (where their own labour was not included). Average net value they received from rice was Rs.19849.

Bhil had average net value of production of rice was Rs.18332, Kokani received Rs.20880 while Varli received Rs.15303. There were respondent from various Cast i.e. Bhil 28%, Kokani 66% and Varli 6%. There were 34% respondent from Ahwa, 28% from Subir, 37% from Waghai taluka.

According to focus group discussion with the famers, average 3.3kg per acre seeds used by farmers. It also depends on type of land, if land is flat it reduce seeds rate and if land is sloppy it increase. Average production comes to 627kg per acre or 1567 kg per hectare. District average was 1228kg/ ha. as per agriculture department (Directorate of Agriculture, Government of Gujarat, 2013)

Almost 40% irrigated farmers had grown finger millet (Nagali). Most of the farmers grow for their own consumption at small patch of land. In this calculation where they grow on sizable land and sufficient quantity considered. Average seed rate varies from 2kg to 4kg per acre; it depends on type of land, size of land and number of showing etc. Average rate they had got Rs. 18 per kg. Average production was 341kg per farmer. Average net income per farmer was Rs.3135.

Following the focus group discussion with famers, they had average seeds rate 2kg per acre. It also depends on type of land, if land is flat it reduce seeds rate and if land is sloppy it increased. Average production comes to 297kg per acre or 741 kg per hectare.

District average was 884kg/ ha. as per agriculture department (Directorate of Agriculture, Government of Gujarat, 2013).
On an average 30% irrigated farmers grow Black gram in considerable area. Other farmers were growing Black gram on boarder of the farms for their home consumptions only, they were excluded due to small quantity. Average seeds rate 5kg, production 110kg and net value of production Rs.3464. The Dangs District farmers grow black gram for home consumption as they had staple food rice and dal, if they had surplus they sell.

Following with focus group discussion with famers, they had average seeds rate 11.4kg per acre. Average production comes to 250 kg per acre or 625 kg per hectare. District average was 702 kg/ ha. as per agriculture department (Directorate of Agriculture, Government of Gujarat, 2013)

Around 25% irrigated farmers grow small millet (Varai) on considerable scale. Other farmers do it on sloppy land or on small patch of land for their home consumptions which did not include in this calculation, which was very small in quantity. Farmers used 1.1kg of seeds and had average production of 186kg and average net value they got Rs. 3425. Day by day area under this crop reduces in the Dangs district. It required lots of labour during year, Chidani and Adar are integral part for growing small millet (Varai/ or Vari)

During Focus Group discussion with famers, average seeds rate farmers used 2kg per acre. Average production comes to 335 kg per acre or 838 kg per hectare. District average was 900 kg/ ha. as per agriculture department (Directorate of Agriculture, Government of Gujarat, 2013)

In the Dangs District 60% irrigated farmers grow vegetables (mix vegetables: More portion of Lady finger, bringal, tomato, chilly, coriander etc.). Famer used average 2kg of seeds and has production 873kg and average net value of production comes to Rs.9111. In vegetable farming more depend up on market because several times the price goes up and down and the profit margin depends on market price. Second agro climate situation it had direct relation with crop production so if condition is favorable famers get bumper production. Third the production in the area, number of famers and number of hectare it had grown. If production is more and demand is less, price will go down and vice-a-versa.

Around 38% irrigated famers grow groundnut. In the Dangs people do groundnut only on smaller area and purpose was both to produce groundnut and produce grass. Average seeds they had used 26kg production was 335kg. They had average net production value Rs. 5451. During Focus Group discussion with the famers, average seeds rate per acre farmers used 50kg kg per acre. Generally farmers used flat or less sloppy land for groundnut crop. Average production comes to 644 kg per acre or 1611 kg per hectare. District average was 1344 kg/ ha. as per agriculture department (Directorate of Agriculture, Government of Gujarat, 2013)

Improve farmland had facilitate to grow more crops on available land. Irrigation leads area under different crops during different time of years, may have two crops in same lands as per water availability. Average cropping intensity increase up to 1.29, Ahwa (1.4), Subir (1.28) and Waghai (1.22), while Bhil (1.21) and Kokani (1.32). Average land under farming before irrigation was 5.2 acres and after irrigation reached up to 6.7 acres. On and average it was increased by 1.5 acre.

2) Income from Milk

Around 58% of irrigated farmers had income from Dairy (milk animal). Irrigated farming and Dairy both had support from each other. Average net income from Dairy was Rs.34170. Over and above it gives milk for home consumption which was not calculated in this calculation. Other was dung value that famers had used in his own farm and additional dungs they sold in village that was not included in this calculation of income.
In South Gujarat Tribal area Dairy had good network and they had forward and backward linkage. They provide services to their members. Provide cattle feeds, veterinary services and procure milk from their villages. Milk procurement system was computerized system in Gujarati language, where producers get price as per their milk quality and quantity. They had got regular payment and update records. Dairy had transparent operating system.

There were two chilling centers at Subir and Waghai working at the Dangs District. There average milk procurement per day was 18657 liters from 188 milk cooperatives had 4480 member (milk producers). Milk producers were member of milk cooperative and they had backward and forward linkages to promote animal husbandry to increase milk production. Milk cooperative provides facility to their members such as cattle feed, veterinary doctor, grains, purchasing milk, on time payment (twice in month), cattle insurance, veterinary services etc. Milk producers had got average Rs.20 to Rs.24 per liter of milk based on quality. Milk cooperative had computerized system to calculate milk price according to quality and that was on spot. This had encouraged milk producer to improve their quality of milk. Average income due to milk selling comes to Rs.5lakh per day, Rs.150 lakh per month and Rs.1800 lakh annual.

3) Total Income: These had three parts, income from agriculture, income from milk (dairy) and income from migration. The comparison of income between irrigated farmers and rainfed farmers which quantified gain that irrigated farmers had due to irrigation. There were almost 86% rainfed farmers and 12% Irrigated farmers had income up to Rs.20,000. In income group of Rs.20,001 to Rs.50,000 there were 13% rainfed farmers and 35% irrigated farmers. There were 53% irrigated farmers and only 1% rainfed farmers had income more than Rs.50,000.

Out of 300 household only 44 (15%) household people had migrated. Average income of migration was Rs.9057 of irrigated farmers.

Average total income of irrigated farmers was Rs.58613 while average income of rainfed farmers was Rs.16732. Average farm income of Irrigated farmers was Rs.34330 and rainfed farmers were Rs.12485. Income per hectare of irrigated farmers was Rs.24221and rainfed farmers Rs. 11031. Irrigated farmers income per hectare was 2.2 times of rainfed farmers.

Outcomes: These had four components. They were improvement in land, increase labour demand leads increase wage rate and, increase expenditure for family to had better life.

1) Improve farm land leads increase Farming (In Acre)
Almost all 100% irrigated farmers had agreed that their farm land improved due to irrigation. Almost 87% had stated that they had cleaned their farm. They had stayed over their farm after irrigation started; spare time had helped them to clean their farm. After irrigation 81% had done farm bunding where 88 % invested in land levelling. However 27% had converted their wasteland (unused) in to agriculture land. There were only 22% stated that they had done watershed work. The Dangs area need specific focus on watershed treatment and it need special design to adopt because of undulating terrain, high rainfall and very high runoff.

2) Increase employment: Increase labour demand in various sectors leads increase wage rate and due to irrigation:
There were more employment opportunities for farming families as well as for hired labourers in the locality. There were seven areas where wage rate increase due to irrigation. The main reason was increase labour demand leads better opportunity to decide where to work and how much need to pay. At the same time farmers also earn more so they had paying capacity. Due to irrigation there were other development
take place in rural area and that leads more labour in sector i.e. agriculture, animal husbandry, construction, small business, main big business, local labour work etc.

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Research had found 82% indicate that it increase wage in agriculture, 55% stated it increase wage in animal husbandry (milk animal link with dairy) work, 43% stated that increase local labour wage. Irrigation had impacted first on agriculture and its need more labour for different time during year. There were no industries in the Dangs district. As discussed in focus group discussion with farmers and NGOs professionals there was increase in labour wage rate from Rs. 30 to 40 in 2010 to Rs. 80 to Rs.100 in 2015.

3) Increased expenditure for farming, home consumptions and Assets:
Priority of expenditure of irrigation farmers was Home Consumption (76%), Health (78%), Home appliances (54%), Education (72%), Seeds, Fertilizer and Pesticides (58%). Second priority was for entertainment (33%), Social festival and gatherings (29%), Food (34%), and 3% saved money.
Other assets of irrigation farmers were TV (64%), Tape/Radio (22%) Motor Cycle/ Scooter (46%), Tractor (9%) and Car/Jeep/ Truck (5%), Mobile (95%).

Assets of rainfed farmer’s house:
- Kachcha House (Bamboo walls cover with cow dung and soil, country tiles/ handmade soil tiles/thatch roof, floor with cow dung and soil ): 90 to 95%
- Do not have anything except few utensils for cooking: 20 to 25%
- Mobile: 60 %
- TV with disc: 30%
- Two wheelers: 30%

Most common assets of Tribal house at the Dangs District (Rainfed and Irrigated farmers):
- Hand flour mill (hath thi anaj dalvani ganti): 80% people had
- “Ukalhu and Musal” : For clean grain and pulses : 100%
- “Muski” bamboo vessel to store grain: 100%
- Wooden Swing: 80 to 90%
- Wooden bench: 20%
- “Wooden Khatla” (traditional wooden frame and string knit bed): 80%

Impact: Due to irrigated agriculture there were four positive impacts observed in this research work i.e. education, migration reduction, house condition, status of irrigated farmers.

1) Migration:
Reduction in distress migration seems to be positive sign of development. There was 29% migration from rainfed farmers while 15% migration from irrigated farmers. Difference between them was 14% less migration of irrigated farmers. Migration of irrigated farmers had reduced by 48%. Reduction of migration was due to work availability at home, village or region. Generally tribal people prefer to work at their own village rather going outside for earning money. In case of irrigated farmers they had work at their farm and also engaged with activity like animal husbandry.
2) Impact of irrigation on Housing
In the Dangs District, each tribal family had one house. House had mixed types of rooms, Pakka rooms, Kachcha rooms, Pakka and Kachha rooms. In this research, analysis had done for total rooms, Pakka rooms and Kachcha rooms.

Pakka rooms: Pakka rooms define as their walls constructed by bricks, roof may be with country tiles or concrete slab or asbestos cement plate or galvanize iron plate and floor with cement concrete or mosaic tiles. Irrigated farmers average 2 to 3 pakka Rooms (Average 2.3), ownership distributed among Bhil (16%), Kokani (81%) and Varli (3%).

Kachcha rooms: Kachcha rooms define as their walls constructed by bamboo and plastered with mixture of cow dung and soil, roof may be with country tiles or handmade tiles and floor cover with mixture of soil and cow dung. On an average 2.87 (2 to3Nos) that each farmers had Kachcha rooms. Among that Bhil had 30%, Kokani had 64% and Varli had 6%.
On an average irrigated farmers had total 3 rooms, someone had Pakka rooms, someone had Kachcha rooms and someone had mixed one or two Pakka rooms and one or two Kachcha rooms.

3) Education
Income of famers and stability provide environment for education to children. Migration reduces due to irrigation. Irrigation leads increased income. For research, three children education was considered for the analysis.
First Child: Around 88% irrigated farmers their first child had educated. However 62% had their first child passed 9th standard and studied at higher level.
Second Child: Around 74% irrigated farmers their second child educated. However 46% respondents had their second child passed 9th standard and studied at higher level.
Third Child: Around 47% irrigated farmers their third child educated. However 43% respondents had their third child passed 9th standard and studied at higher level.

4) Status of irrigated famers:
Status of farmers includes physical assets, social importance and financial well to do, leadership and helping others, family wellness, their importance in society etc. Here respondents had responded their status and it was analyzed.

Out of 300 respondents, 292 respondents had responded. There were not a single respondent responded their condition was poor, 42% had responded good, where Bhil contributed 10%, Kokani 32%. However 58% reported as medium status, where Varli contributed 5%, Bhil 19% and Kokani 34%.

Due to irrigation there were impact observed in irrigated farmers’ family. This impact had categories in five areas: Economic, Education, Social, Health and Political. Impact purely visualized by respondent, they had selected only one and other selected more than one.

The impact analysis shows that 87% irrigated farmers had impact on economic development due to irrigation. However 67% had stated social development due to irrigation, which was higher than earlier findings that of 58% had good social status due to irrigation. At the same time 57% stated impact on education which had further quantified while discussing education analysis of their children, and 62% stated it impact on health due to irrigation. Only 3% had said political development due to irrigation.
B. Challenges faced by irrigated farmers

Almost 85% of the population is dependent on agriculture for their livelihood, which makes this part of the population even more dependent on water. Almost 59% is forestland and only a limited amount of land is available for agriculture to support a growing population. Another limiting factor is the fact that 68% of the land is situated on a slope. Dangs topography is highly undulating and variation in high is 105mt to 1317 meter. Due to increasing population in the Dangs district availability of land per household reduced and pressure on land increase.

Challenges faced by irrigated farmers had describe through flow chart which will give conceptual clarity

Chart No. 6.2 Challenges faced by irrigated farmers for irrigated agriculture.
1) Problems and challenges face by Dangs district people in terms of irrigation

Problems had divided in to two areas, one was the concern raised by irrigated farmers about what kind of problems they faced to promote irrigated agriculture. Second was to increase expenditure on various domains to promote irrigated agriculture.

a) Problems faced to promote irrigation:

Apart from limited agriculture land, the Dangs farmer faced various kinds of problems. The main problems were insufficient water, need to have water lifting devises, pipeline to reduce losses and provide water to undulating land, Convert undulating land by doing land levelling.

Around 51% irrigated farmers had pointed out the water was the biggest problem. Electric connect was there but they don’t had sufficient voltage or number of hours assured power supply, so 45% had stated problem of quality power supply. Farmers had pointed out there were two years waiting list to get three phase power connection. Followed by 49% had stated they don’t had proper lifting devise i.e. diesel engine and electric motor required to address their key problem of not having or damaged one. However 19% had raised problem of undulating land need land levelling.

Problems face by farmers to promote irrigation at different region (taluka). Waghai (63%) and Ahwa (55%) had more focused on problem of water while Subir (51%) had stated problem of power supply. Ahwa (65%) and Subir (53%) had mentions the problem of water lifting devises i.e. electric motor and diesel engine. Undulling land and lack of Pipe line was common problems of all three regions to increase efficiency of water and effectiveness of irrigation. Subir and Waghai stated more problem of storage of water however Ahwa people more concerned about quality of power supply. Both Ahwa and Subir had equally focused on have good quality of lifting devises.

b) Irrigated agriculture also increases expenditure that concerns raised by farmers.

Irrigated agriculture needs pesticides, fertilizer, seeds, weeding, farming, fuel for pumping machinery, electricity/power charges, pipe line and machinery repairing etc. Kokani (66%), Bhil (41%) and Varli (76%) had pointed out that they had problem of pipe line and machinery repairing. Bhil (30%), Kokani (55%) and Varli (65%) had stated that improve variety of seeds for irrigated crop. They had faced problems of quality of seeds and cost of seeds. Bhil (21%), Kokani (51%) and Varli (53%) specified the problem of timely availability of quality of pesticides and fertilizer. They did not have information about their soil and they don’t have knowledge of use of fertilizer and pesticides. Several times they had misguided by local shopkeeper. Traditionally they don’t use chemical pesticides and fertilizer in their traditional rainfed crops. Concern for quality power supply and cost of fuel both play key role to promote irrigation, Bhil (28%), Kokani (48%) and Varli (59%) had shown their problem of cost of fuel/energy charge.

2) Institutional arrangement for irrigation intervention at the Dangs district.

Institution had two types of institutions: 1) Membership based Water Users Association, 2) Common source/ resource/ assets users group

1) Membership based Water Users Associations: These are the formal institutions registered under irrigation cooperative act by cooperative department. Numbers was limited to 12.

2) Common source/ resource/ assets users groups: It is informally people do irrigation collectively. There were various ways they act with a group with different type of operating system:

- Individual own the resources (well/ tube well/ pumping machinery) and two to five farmers use it pay irrigation fees to owner of the resources.
- Individual own the resources (well/ tube well/ pumping machinery) and jointly do farming sharing expenditure and benefit equally for crop growing and production.
- Group of people (Two to Five) own well and they put their own machinery and do irrigation.
Group (two to five) own the resources (well/ tube well/ pumping machinery) and they used for irrigation, sharing expenditure (cost of fuel/ electric charge/ repairing).

Analysis of Irrigation project based on Management and operation: Individually or in group
Overall irrigation had operationalized 20% by group of farmers and 80% by individual farmers, However Bhil (5%), Varli (2%) and Kokani (13%) had performed their irrigation in group. Even though there are possibilities to form small group (three to eight) farmers and promote mini lift irrigations in the Dangs District. Source of Mini Lift Irrigation may be well, tube well or river.
There were advantage and disadvantage of group irrigation scheme. Advantage of that the Dangs tribal had very less land holding where capital investment will be costly for individual farmer. On other hand if group of farmers do irrigation they may get government funding under different scheme. On other hand operational cost reduced if more farmers use it, cost per acre watering reduced by 25 to 30%. This will ultimately benefit to farmers. Maintenance costs also reduce due to regular use of pumping machinery.
There were some of the problems that farmers had raised during focus group discussion that was dispute in sharing benefit when water was limited, problems of sharing responsibilities, sharing expenditure and payment on time, long run some of strong individual become owner of the project.

Always doing irrigation in limited land by individual farmer was costly due to capital cost and operational cost per farmer.

Researcher had studied in depth of the various parameters of development and had prepared SWOT analysis of the Dangs district defined as under.

Strength: Almost 59% forest area and very good tree cover both in forest area and farm land area and had rich in biodiversity. Good rainfall, larger number of community based institution (SHGs), good literacy rate, commitment for development from government (Vanbandhu Kalyan Yojana (VKY)), and good natural resource available for small scale industries. Dairy network is now established may be strengthened more will be useful.

Opportunity: Organic farming, organic horticulture and natural availability of food may be future of the Dangs district. Farmers of the Dangs district using less chemical fertilizer and pesticides that may be helpful. Bamboo availability can be used for small scale industries. Skill of Varli (painting) and Kotwalia (bamboo craft) may be enhance and facilitate will be one of the rare new market opportunity.

Weakness: Less area under irrigation, very high undulating land, poor power supply quality and less duration, water problem in summer, migration, very less recharge due to geological condition and high runoff due to undulation, far away from state capital, and some of the villages are in very remote area.

Threat: Youngster does not have interest in agriculture alone. Still people had tendency of have subsidy (free). The Dangs needs special commitment from other stakeholders i.e. government and non-government organisation. The Dangs district had very limited infrastructure facilities available.
Verifying Hypotheses

1. Agriculture is governing factor for livelihood of Dangs people.
   True, Agriculture is governing factor and it had directly impact on many sector i.e. food, primary income source, opportunity for labour employment, wages of labour, dairy sector, supporting other businesses etc. This hypothesis had verified and agreed.

2. Dangs tribal has not awareness of irrigated agriculture.
   Partly true, because there were less than 20% area under irrigation and there were different options were used by the Dangs tribal. On other hand they had awareness but had limitation of their land size, sloppy land, and good rainfall in monsoon. At the same time free grazing and problems of power supply restrict them to do irrigation. Partly true and partly falls, they had awareness around 40%.

3. There are gaps in irrigation promotion from different agency at Dangs.
   True, it was stated while discussed in group and with individuals. There were discussions on current role and future role also. All stakeholders were agreed that there is possibility to increase irrigation in the Dangs district. Almost 80% yes, comparing with past there were improvement in irrigation sector but yet it can improve further.

4. Irrigation is increase agriculture production, change cropping patter and enhances food security.
   True, Result produced from this research had proved this. Due to irrigation there were increase in production and also increase surplus in addition to that 58% farmers had gone for dairy (milk animal) and had additional income.

5. Various irrigation options are available at Dangs district.
   True, various irrigation options that comes out from this research. There were two types of irrigation, surface irrigation (Flow irrigation) and second lift irrigation (from surface water or ground water). In flow irrigation limited place and limited for few farmers, it was functioning. Coming back to lift irrigation there were good progress in last ten years but there is need to check it efficiently and effectiveness. Several farmers had raised questions about irregularity of power supply and quality of power supply. There was concern raised by farmers that due to undulating land and high in elevation there was high cost per acre watering if they used diesel or kerosene. Most of farmers used kerosene instead of diesel. There was not a single farmer used solar power for irrigation. Various irrigation options are available agreed but there is still scope to explore more.

6. There is scope to scaling up of different water resources options to increase irrigated agriculture in the Dangs.
   True, at end of this research it was proved that all stakeholders had common view that scaling up will be possible to increase irrigated agriculture in the Dangs district. There were sufficient rainfall, four rivers and land available. Irrigated farmers had suggested model for scaling up irrigated agriculture.

7. Dangs people do migration for employment.
   True, it was proved that both irrigated and rainfed farmers do migration for employment. There were different period of migration. Irrigated farmers had less migration than rainfed farmers.
C. Suggestions for Appropriate Water Resource Development models to promote irrigation in the Dangs district.

During research work researcher had come to contact with various people and had qualitative discussion on this topic with stakeholders. Suggestion to increase irrigation in the Dangs district had received by various Stakeholders i.e. Dangs farmers, Government officers, Researcher, writer, thinker and local leaders and NGOs professionals.

**Suggestion by irrigated farmers to increase irrigation in the Dangs district:**
There were qualitative responses received from irrigated farmers for suggestion to increase irrigation in the Dangs district. It had divided in to six sections which was analyses as under.

Out of 300 respondents 193 respondents had responded, the responses of farmers had divided in to six groups. Out of total respondent, there were 28% Bhil, 65% Kokani and 7% Varli.

**G1.** Training, Awareness, Information, Learning new technics, exposure, advice, scientific farming, (Capacity building of farmer, IEC (Information-Education-Communication), On field demonstration of scientific farming), Government scheme information, incentive for irrigation: 11% respondent had suggested.

Advise to farmer, awareness irrigation, awareness, guidance, awareness irrigation, exposure of farmers, awareness, exposure to farmer, incentive and awareness in farmer for irrigation, information of irrigation scheme, exposure to farmer, scientific farming, scientific agriculture, government scheme information, incentive to farmer for irrigation, government scheme to reach farmer

**G2.** Various scheme from government (well, well deepening, pipe line, technology, group lift irrigation, drip irrigation, ), Improved variety of seeds, fencing: 19% respondents had stated.

Well from government, technology, ten people do irrigation on government well, government scheme, improve variety of seeds, accept irrigation by other farmer, group irrigation with protection fencing, group well, incentive to farmer for irrigation, government scheme to reach farmer, need help, promotion of irrigation, irrigation scheme to farmer, drip irrigation, pipe line, pipe line from river, pipe line, tank and lift irrigation, pipe network, drip irrigation, well deepening

**G3.** Electricity on economic rate for 10 hour with full voltage subsidy and priority to give connection to tribal farmers:  3% had stated this.

Power economic rate continue for 10 hour, three phase for irrigation, electricity advise to farmer, incentive to farmer for irrigation, government scheme to reach farmer, priority

**G4.** Increase Water Storage: 26% respondents specified this priority.

Water storage, tank, boribandh, boribandh in summer, well from government, Checkdam, Checkdam deepening, Checkdam desilting, farm pond, earthen dam, earthen/stone check structure on stream, priority

**G5.** Farm treatment: Soil and Water conservation work, (farm bunding, land levelling, land development and land improvement) :  37% respondents specified this priority.

Farm bunding, land development, land levelling, land improvement

**G6.** Vision of farmers (Impact) : (Green revolution, stop free grazing, stop migration) :  4% respondents stated

Leads Green revolution, stop free grazing in summer, stop migration

Model had been finalized based on above details while FGD with farmers.

**Suggestion from the Government officers to increase irrigation in the Dangs District:**

- **Source (Maintenance and Creation):** Priority should be desilting of existing checkdams and tanks and repairing and renovation of old checkdams and tanks. Most important will be there is need to have around ten to twelve big size reservoirs needs to create in the Dangs. There are good sites available, but required permission form forest department.
• Promotion of irrigation: Focus needs to have small size irrigation project preferably with electric connection. Government should subsidies electricity for five- eight years. Promotional policy for group/ cooperative irrigation.
• Drip Irrigation: Promotion of drip irrigation will be very much required in the Dangs District, to save water and irrigate more area.
• Forest: Needs to have total area treatment as per need of the Dangs District. Needs to have special design for this area to have protection of soil and water in the forest area.
• Land Treatment: The Dangs needs special design to have watershed treatment.

Suggestion by researcher, thinker, professionals, writer, local leaders, scholars to increase irrigation in the Dangs District

Due to small patch of land in front or back side of Dangi people house, there is need to have water for that. One of the professionals had specially emphasis that there is water for drinking and cooking, domestic use (cleaning utensils, washing cloths etc), toilet, bathing, animal, “Wada” kitchen garden. Six different requirement of water if we provide that can change life of the Dangi. Homestead (wada) land irrigation will ensure increase income by Rs.10000 to Rs.20000. This will also give fresh vegetables and fruit to family.

There is need to take care while working in the Dangs and doing forestry work, no continuous bund, staggered trenches, contour trench, “Go with what people are doing”. Experiment of Napier grass in agriculture resulted in protecting crop from worm. Earlier there was shifting cultivation practice by tribal now almost they stable in village and stop shifting cultivation.

It was derived from discussion that, there is need to kick out “Project approach” if we want to do sustainable development in the Dangs. There is a need to have integrated area development approach for the Dangs Development.

If we calculate the amount spent by government from 1961 onwards on different scheme/ projects till today it will comes to Rs.21 lacks per family (statement by senior researcher).

In the Dangs district, irrigation by channel was practice since 1989, to store water on top and channel it from top to bottom and irrigate the filed on the way. Irrigation focused in 1995 onwards to promote irrigation thru well and built check dam by 2001 onwards.

There were so many different views of different persons as per their perspective of the Dangs development some of them had compiled as follows:
• In the Dangs district irrigation can be viewed as total planning approach rather than project based approach. This needs to focus special section of the community with integrated development approach.
• There are potential for various options of irrigation that can scale up.
• Area needs to plan in such a way that that it includes area treatment which needs special technical criteria that needs to follow due to heavy rain, undulating terrain and high runoff.
• Irrigated agriculture needs to combined with animal husbandry and advantage of forest needs to cultivate by adopting “natural farming” or “organic farming” or specially focus on locally grown crops and market with value addition. This will not only address problem of surplus but also get lucrative price of agriculture produces. Consumers will have genuine quality product and farmers will get their price. This will motivate farmers to continue grow traditional variety without chemical fertilizer and pesticides. On other hand this will reduce cost of production.
• People had lacking the trust in collective action; this can be developed by proper community organizing.
• Gram Panchayats and Gram Sabha needs to strengthen by involving in the development work. There are needs to do capacity building programme for their leaders and functionaries.
• The differences between Bhil and Kokani needs to understand. Project and development action can be design and implement accordingly.
• Needs to have dedicated power supply (electric power) for the irrigation project on subsidies rate for five years to promote irrigation in the Dangs.
• Needs to focus on training for irrigated agriculture with field days and field demonstration to build trust and skill in the tribal people of the Dangs.
• Individual operated small project had greater success like well irrigation, mobile pump set irrigation and small group of farmers (2 to 4) have collectively do irrigation. This is more feasible due to small holding of farmers, land in different places and undulating terrain.

Problem of free grazing needs to short out by villagers either they stop free grazing and start stallfeeding or irrigated farmers had to do fencing in group. If group of people join and do fencing will be cheaper than individual farmers do for their own farms.

Needs to do forward linkage with dairy (animal husbandry), this will sustain irrigated agriculture and have continuous income during year. Dairy with irrigated agriculture supplement each other.

Malki: The practice of Malki is another livelihood source connected to agricultural land of the tribal households in the Dangs. Under this practice, occupancy rights were given only to those lands which were actually leased to Dangi and are in their natural position since 1st January 1970. The reserved trees on these lands continue to vest with Forest Department but the cultivators are entitled to lop them for the purpose of cultivation. Prior to 1997, 50% of the revenue from the logged trees was given to the land holder but now it has become 100%. For every tree being cut at least 3 tree saplings should be planted. The surroundings of the house provides with vegetables, fruits, herbs and other vegetation products grown for home use. The total amount disbursed was Rs. 1981691749 to 13548 household. (North and south Dangs Division) average Rs. 1.46 lacs per household. (Forest Department, Government of Gujarat, Up to July, 2013). From 1997 onwards 100% money which was raised by selling trees given to farmers.

“Malki” had positive impact on the tribal of the Dangs, they had purchased equipment for agriculture and irrigation, renovate their houses, paid dues, purchase animal (cow/ buffalo / bullocks / Pada), motorcycle, paid dues, invest in education of their children etc. It provides opportunity to come out from the orbit of poverty. On other hand, several people had misused money in wasteful expenditure.
Perspective of Water in the Dangs context: Views of researcher and senior scientists

There are small quantity of water required for different purposes that create environment for development and address Health, Economy, Drudgery and helping to protect environment. Source water protection and enhance availability of water to tribal is challenging task in undulating terrain. This needs to thinking on area based approach to address problem of street (faliya) and village.

Chart No.6.3 Five different use of water and it impact on tribal livelihood
Conceptualise above discussion to promote irrigation in the Dangs district:

Chart No. 5.22 Conceptual frame work for promotion of irrigated Agriculture

Enhance livelihood of the Dangs tribal they had proposed integrated model explain in the flow chart.

Chart No.6.4 Conceptual frame work for promotion of irrigated agriculture in the Dangs

Suggestion to increase irrigation in the Dangs District by NGOs professionals:

- Community Awareness programme (irrigation and agriculture) : Exposure, training, field days, Video show, analysis of agriculture, soil testing, scientific farming, methods of irrigations
- Resources creation: Wells, water storage in Checkdams, water storage in Rivulet and River, mobile engine and electric motor for lifting water.
- Power: Electricity 24 hours, promote group irrigation (three to six farmers- mini lift irrigation)
- Agriculture: Improve agriculture practices, organic farming, organic horticulture, demonstration, on field training,
- Marketing: Marketing of agriculture produces, value addition, organic produces marketing,
• Development of other sector: Animal husbandry (increase Milk production), produce good quality fodder, wormy-compost, compost pit for dung, saving and credit thru small groups, organic farming. Small scale agro business, support for small businesses i.e. grosser shop, cycle repairing, automobiles, barber shop, tailor shop, vehicle on rent etc.

Planning commission (2004) has ranked the Dangs as number one among 447 districts of India as the most backward district. They have used index with three parameters: 1) density of people belonging to Scheduled Castes and Scheduled Tribes, 2) agricultural wages and 3) output per agricultural worker. Government of Gujarat had also ranked it’s blocks under backwardness to focus development effort; in 1966 out of most backward 25 blocks of Gujarat Dangs ranked 8th, by Dr. I.G.Patel committee in 1984 Dangs ranked 8th from 184 blocks of Gujarat, by Cowlagi committee in 2005, Dangs ranked 9th from 225 blocks of Gujarat. This background was enough to had priority of this district for development.

Understanding situation and incorporating suggestions from various stakeholders researcher had proposed integrated plan for enhance irrigation in the Dangs district. It has specified in to nine areas.

1. **Area treatment:** River Basin Planning, Integrated Watershed Management Programme, Drainage line treatment. (Three needs to combine all three and had specially designed for the Dangs district). Forest treatment will be one of the focus areas.
2. **Water Resource Development**
3. **Infrastructure development for irrigation**
4. **IEC:** Information, Education and Communication, Awareness, motivation and creating enabling environment
5. **Agriculture:** Demonstration, sharing, learning and scaling up (Rainfed and irrigated agriculture)
6. **Allied activities that will support to promote irrigation in the Dangs district.**
7. **Community organizing for understanding Group dynamic and group formation, community based users group.**
8. **Governance at all level.**
9. **Enabling environment to promote irrigation at the Dangs District.**

1. **Area Treatment:**
   a. River Basin Planning
   b. Integrated Watershed Management Programme: Watershed based planning ( Status of existing watershed, gap filling if work already done in past, include repairing if required )
   c. Drainage treatment (Status of existing drainage and gap filling, repairing of existing structure)
   d. Forest treatment (Includes soil and moisture conservation, water harvesting, forest protection, gap filling and new plantation). Farm forestry link with “Malki” play major role in maintain and increase tree cover in the Dangs district. Forest had their guideline to do work. Forest planning should be included in above all three planning.

Almost 95 percentage people are tribal and out of this 85 percentage people are depends upon agriculture for their livelihood. Almost 59% area is under forest and 34% area is used for agriculture. Area under irrigation was 4% of total geographical area and 13% of cultivable land.

In the Dangs district average landholding per household is 1.31 hectare (Census, 2011). It was 1.58 hectare (Census, 2001). The landholdings are small and hardly sufficient to support a livelihood of household. Researcher had identified that water can play major role to enhance the livelihood of poor tribal people in Dangs district

Area had two portion almost 59% area under forest and it had manage, control and protect by forest department. Forest department had to do treatment based on watershed and also as forest guidelines. Mostly forest land located in upper catchment of rivers and watershed. Upper catchment needs to treat
perfectly. There is a need to work on drainage (1st, 2nd and 3rd order) that passes thru the forest. Gabions, Nala Plug, check walls and continuous contour trench as well as staggered trenches needs to be constructed properly. Forest department had plan but mostly they had priority to plant trees as gap filling. There was lack of planning and designing to treat undulating land as river basin approach. Department needs to acquire that competence and use latest technology. If it is perfectly done than most of the Dangs villages had positive impact on its water availability.

There are four major rivers in the Dangs namely Ambika, Gira, Khapri and Purna. All four rivers originate from the north-eastern part of the Dangs and flow towards the south-west. The drainage of the rivers mostly follows the south west direction. The Gira ultimately meet Purna and the Khapri ultimately meet Ambika. The Ambika and Purna meet the Arabian Sea. The Gira and Khapri are major tributaries of Purna and Ambika respectively.

The Dangs receives an average annual rainfall 2414 mm (Annual rainfall from 1991 to 2014), highest 4613 mm and lowest 1431mm. The rainfall is spread over a period of about 120 days, from 15 June to 15 October. Last six years (2009-2014) the rainfall was below the average rainfall that leads water shortage during summer season (April-May-June). Earlier six years (1993-1999) the rainfall was above average in the Dangs district. This may be effect of climate change. In spite of high rainfall and many rivulets there is crisis of water during summer both for irrigation and drinking water due to an undulating terrain. The lack of adequate water storage, ground water recharges and water management are the main reasons for this lack of water. The importance of water act as catalyst for the development of the Dangs. The lack of assertive planning, implementation and management of watershed work for harvest, conserve and recharge water ultimately Dangs suffer from water scarcity during summer. Water can play important role in livelihood of Dangs people. There is need to have river basin planning, four river passes thru the Dangs District. I say it’s for Ganga for Dangs. (Common letter are “ang”).

Forest department had to take leads because it is a single largest department had total hood on this. Almost forest department had 59% area under their control. Tree cover and grasses along with proper treatment of forest land played vital role to improve water resource situation for the Dangs District.

Four river basin planning: After having forest land planning, the second department will be irrigation department. Irrigation department had mastering over drainage treatment and watershed treatment. Each river basin had several watersheds. Each watershed needs to do treatment as per watershed guidelines.

For treatment of watershed WOTR can be concern to prepare plan and do demonstration in the Dangs. WOTR had experience to work in similar area. In certain hilly area terracing needs to be done just like Himachal. Expert from north can be called for planning and initial implementation. Secondly the learning from Ralegaon and Hivre bazar needs to include in this planning.

Lastly drainage treatment needs to plan properly, that includes storage structure of different size at different location. To plan watershed or drainage treatment there is need to have close collaboration with forest department. For drainage treatment needs to consider the experiences of Khopala, Ajab and Rajsamdiyala. This will enhance learning to construct series of checkdams at appropriate site and technically feasible. People had planned, implemented and now maintain checkdams in all these villages. In the Dangs condition there is need to do proper treatment of upstream area, where smaller size stream needs to do treatment with Nala plug, check walls and gabions.
For the Dangs District, area treatment planning had three sections and three levels of planning, River Basin Planning, Watershed planning and Drainage Treatment. In these planning there is need to involve local people at different stages to make planning more people inclusive. Local people knowledge will be very helpful to plan and fulfill peoples need.

“Malki” now tribal farmers from the Dangs get 100% return from trees in their farm land. Every tree in their farm will be “earning member of the family” After 15 to 20 years farmers get good amount of money. It’s like “amount in PPF”. Farmers of the Dangs district needs to give special attention to this. There is long term benefit in this work.

2. **Water Resource Development**
   a. Storage in rivulets and rivers by Checkdams
   b. Storage in different order stream by tanks/ ponds.
   c. Storage in rivers and rivulets by big dams
   d. Storage in rivulets by temporary structure i.e. boribandh
   e. Recharge old unused wells and tube wells
   f. Recharge exiting under used wells and tube wells.
   g. Find out recharge zone and recharge rainwater (aquifer, fault, fold, dyke etc.). Geohydrology exploration for recharge water to increase ground water storage.

Local people can play importance role in planning for water resource development. They had local level knowledge that lacking in expert of the subject.

While doing research, researcher had observed and collected information on the modes of irrigation as available to the cultivators for irrigation of their land. The various modes adopted for eliciting response of
The household were from both the sources of irrigation, by (i) Ground water sources and (ii) by Surface water sources.

The surface water sources were further classified by lift irrigation and flow irrigation. Ground water sources included sources like open wells, dug wells, shallow wells, deep dug wells, tube wells, etc. In short all sorts of wells were taken as the mode of ground water source for irrigation. Surface water sources included rivers, rivulets, pond, reservoirs of check dams, diversion channels, channels etc.

There were numbers of checkdams and tanks are in place. First priority should be repairing of checkdams and tanks needs to be taken. This will cost less and had immediate effect. For fixing priority, detailed survey required to carry out, which will be helpful to categories repairing work and prepare budget and plan. Secondly, desilt existing checkdams and tanks. Silt is one of the important raw materials which can be used to do land treatment of the poorest farmer. Good quality of silt needs to be used. Silt will be helpful to do land levelling and terracing.

Chart No. 6.6 Water and Land base activities

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<td>Soil &amp; Water Conservation</td>
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<td>✓ Farm Bunding</td>
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<td>Watershed Development</td>
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Any sources, where water was stored and lifted for irrigation through use of motor pumps were taken as sources for lift irrigation. And where flowing water from streams, canals, or other water channels whether flowing perennially or during rain whether stored or un stored gravitation, and was used for irrigation without any use of motor pump were taken as the modes of flow irrigation.

Increase area under irrigation:
1. Surface water use:
   a. Pump set on river and rivulet
   b. Mobile pump set
   c. Diversion channel from top to down
2. Ground Water use:
   a. Well and tube well irrigation:
   b. Micro irrigation (Drip and sprinkler)
3. Infrastructure development for irrigation
   a. Flow irrigation: 15 villages
   b. Lift from river and rivulet: 80 villages
   c. Lift from wells and tube wells: Almost 200 villages, where water shortage is there may go for drip irrigation.
   d. Old working project needs to review and include in gap filling plan.
   e. Old defunct project if possible revive.
   f. Different scheme for repairing, revive and for new project.
   g. Promotional scheme to have electricity (quality and duration) for irrigation.

Infrastructure development for irrigation:
   a. Flow irrigation: 15 to 20 villages (detailed survey required)

During several field visits of the Dangs district and series of discussion with farmers there are observations that brought out as under:

Irrigation during kharif (monsoon) season: During monsoon season the Dangs farmers manage water from divert it from top to bottom. Hilly undulating terrain and rainfall of 100 days (From 15 June to 15 October) create opportunity to bring water from upland to down side of land. Their paddy (rice) crop need more water compare to nagali and varai (traditional) crop. They divert water on counter line from top of the hill to paddy filed when they required water during rain. As soon as the paddy field got enough water they again diverted this water to local rivulet.

Irrigation during Rabi (winter) season: There are villages where water naturally flows from top of the hill to running down by gravity flow in the rivulet during Rabi (winter) season. In number of location, it was observed that group of farmers put earthen bund or check dam there on hill side and store water. From this storage water they divert this water to their field on contour line. Thus they do two to five watering to late kharif crop and Rabi crops.

b. Lift from river and rivulet: 80 villages
c. Lift from open well and tube well: 150 villages

Five ways to increase area under irrigation in the Dangs district:
• Mobile pump set (Individual or group of farmers):
• Open well (Individual or group of farmers):
• Tube well (Individual or group of farmers):
• Small lift irrigation (up to 10 acres irrigation) (from rivulet/river):
• Medium size Lift irrigation (11 to 25 acres irrigation):

Different Energy used to pump water for irrigation
• Using kerosene.
• Starting with petrol and then kerosene:
• Using electric power:
• Using solar energy for pumping water (yet to explore for the Dangs District)

Different ways that the Dangs farmers do irrigated agriculture/ horticulture:
• Using water that comes out from bath: In this region the people used to have papaya tree, banana, tapioca leaves (in Gujarat we used tapioca leaves where in south they use roots) or vegetable that grown by using bath water in the backyard/ front yard of their house.
• Bori bagicha: The Dangs farmers now a day grow vegetables in plastic bags that had filled up by good soil and organic manure. They used top of the bags and sides (three to six holes) for growing different types of creeper vegetables.
• Diverting water from the rivulet: In several places where water has been stored and then it carry thru earthen field channel up to the downstream field. Thus they do flow irrigation in small patches of land during Kharif, Rabi and summer.
• Using hand pump bore well: In number of places the farmers installed submersible pump set in the bore well or jet pump and irrigate nearby land.
• Due to undulating and hilly terrain, there was number of places the check dams had stored water in rivulet/ river during summer season. There are places where water is available for 12 months and some of the places where water available for 10 to 11 months. Farmers do riverbed cultivation mainly watermelon, cucumber with the residue soil moisture in riverbed and if required they do one or two watering to their crop. They also put their mobile engine/ electric motor and pump water to nearby land and also do irrigated farming and cultivate vegetable.

4. IEC: Information, Education and Communication, Awareness, motivation and creating enabling environment
   a. People play very important role in planning, implementation and management that needs to understand and internalize by all government department and NGOs.
   b. To create environment there needs to have awareness programme for all stakeholders.
   c. Planning needs share with all citizens and they had to consult before implementation.
   d. Videos and pamphlet should be prepared for increasing awareness in common people.
   e. Television, mobile needs to use as communication tools to reaching out different stakeholders.
   f. Exposure visits to several places needs to conduct for better planning and create ownership. Ralegaon, Hiware bazar, Kopala, Rajsamadhiyala, Ajab needs to add in list of places where farmers, government officers and NGOs professional can do exposure visit.
   g. Success stories of the irrigated farmers of the Dangs needs to highlight and share it with different stakeholders in different forum time to time.

5. Agriculture: Demonstration, sharing, learning and scaling up (Rainfed and irrigated agriculture)
   • Agriculture programme needs to revisit and redesign.
   • Farmers needs to involve from day first they know their crop, soil and topography and agro climatic situation.
   • Soil analysis, crop economics needs to study properly, village to village and place to place.
   • Krishi Vigyan Kendra can play important role only they needs to understand this district and act accordingly. General rules will not work in this district.
   • More sharing and learning and have field days on farmers’ field.
   • More and more demonstration at farmers’ field.
   • Use of technology for improvement of farm level management.
   • Exposure and user’s friendly training for farmers to explore their knowledge in agriculture field.
   • Had video and films to educate farmers in their local language.

6. Allied activities that will support to promote irrigation in the Dangs district.
Due to irrigation there were several other activities had demand and raised scope for other small business. Businesses had directly or indirectly link with agriculture.
• Animal Husbandry (Dairy)
• Grocery Shop
• Automobiles (Motor cycle, cycle and four wheel) repairing, servicing etc.
• Tailoring
• Carpentry
• Fabrication
• Plumbing
• Civil Construction – Mason training, scaffolding, bar bending etc. These had beneficial to both customer and owner. Customer had services at their door step and owner can earn their livelihood.

7. **Community organizing for understanding Group dynamic and group formation, community based users group**
   - Individual contact
   - Field level interaction with farmers
   - Group formation (This is one of the most difficult task for the Dangs District) or used existing group or revive defunct existing group
   - Mass awareness by foot march and rally, workshop at seminars, village level meetings (Gram Sabha),
   - Mass awareness by using technology (television and mobile).
   - Those who are going to have “Maliki” needs to have guidance to use that money properly to enhance their livelihood.

8. **Governance at all level**
   - Have different committee working at different level and people representative should be at all level.
   - Gram Sabha needs to be strengthen
   - One window system needs to apply for villages
   - Now the Dangs had three talukas that will help to had decentralize implementation
   - Transparency needs to provide. Display planning, progress and expenditure on walls. Also give information to all as open for all.
   - To have complaints solve cell separately. (grievances redress cell)

9. **Enabling environment to be built at the Dangs District for development work**
   - Awards for farmers for best irrigation practice/ more crop productivity/ more profit from unit area/ more crop per drop/ innovation in irrigation /
   - Awards for government officers
   - Awards for NGOs workers
   - Awards for local leaders
   - Promotional policy
   - Declare special zone and incentives to attract good, committed, brilliant, hardworking people to work in Government.
   - Provide budget and flexibility
   - Improve rural infrastructure i.e. road, transport, communication, staying facility, hotels etc.
Based on research work and discussion with various stakeholders following model had proposed for water resource development to increase area under irrigation at the Dangs district.

Chart No. 6.7 Proposed model for water resource development to increase area under irrigation in the Dangs district.

**Capacity building of farmers and provide enabling environment for promotion of irrigation:** Training, Awareness, Information, Learning new techincs, exposure, advice, (Capacity building of farmer, IEC (Information-Education-Communication), Government scheme information,

**Scientific Farming**
Improved variety of seeds, fencing, on field demonstration of scientific farming, incentive for irrigation

**Water Resource Development: Increase Water Storage**
Checkdam, Checkdam deepening, Checkdam desilting, tank, boribandh, boribandh in summer, well from government, farm pond, earthen dam, earthen/stone check structure on stream, priority of the state and district.

**Water Resource Management:**
Promotion of Irrigation by various irrigation schemes:
Scheme from government (well, well deepening, pipe line, technology, group lift irrigation, drip irrigation)

**Electricity on economic rate for 10 hour with full voltage and priority to give connection to tribal farmers:**
Power economic rate continue for 10 hour, three phase electricity for irrigation, advice to farmer, incentive to farmer for irrigation, government scheme to reach farmer, priority for poor

**Farm treatment: Soil and Water conservation work,**
Farm bunding, land levelling, land development and land improvement, gabion, Nall plug, farm protection wall, check wall

**Allied activities:** Animal Husbandry (Dairy), Grocery Shop, Automobiles (Motor cycle, cycle and four wheel) repairing, servicing, Tailoring, Carpentering, Fabrication, Plumbing, Civil Construction - Masons

**Vision of farmers (Impact)**
Leads Green revolution, stop free grazing, stop migration
This proposed model is conceptual model based on that there is needs to develop operationalize model to align with the administration and prevailing government structure.

**Conceptualise Models to operationalize action model to increase irrigation in the Dangs district.**

There will be conceptualise planning at river basin level and project (activity) planning unit will be village. In case of the Dangs district, one village may have more than one micro watershed. Micro watershed may have smaller in size due to high undulating nature of topography. Planning will follow the stream order (1\textsuperscript{st}, 2\textsuperscript{nd}, 3\textsuperscript{rd}...Order stream) this will leads from small stream, rivulet and up to river.

Chart No. 6.8 Conceptualise Models proposed for Water Resource Development and Management for the Dangs District.

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**Conceptualise Water Resource Development and Management Planning, Implement and Monitoring for the Dangs District**

- **River Basin Planning**
  - Planning and Implement and Monitoring

- **Sub-River Basin Planning** *(Rivulet level Planning)*
  - Rivulet level planning and Implement and Monitoring

- **Forest Department Work**
  - Forest Plantation, Farm forestry, soil and moisture conservation, water harvesting, Protection, Forest management, Malik, MFP,

- **Village level**
  - Sector based, community based, rivulet wise, river based, Micro-watershed,

- **Regional (Taluka) level Planning**
  - Sector wise, community wise, Rivulet and River wise, (watershed, micro-watershed wise)

- **District Level Planning**
  - Sector based
  - Community based
  - River basin Planning, Implementation, Monitoring,
  - Taluka wise Planning, Implementation, Monitoring,
Future role of key stakeholders to increase irrigation in the Dangs district:

Key stakeholders were farmers, government offices and NGOs professionals.

Future Role of farmers to promote irrigation in the Dangs:

- Maintenance of Assets: Farmers can take interest to maintain assets of water resources which are beneficial to them i.e. checkdams, tanks etc. To demand if they do not have it. Promote water harvesting by doing boribandh, desilting checkdams and provide silt to their own farm, contribute their own labour to maintain and upgrade their farm level structures i.e. farm bunds, Nalla plugs etc.
- Training and Exposure: Farmers should take interest and learn from the training conducted by government or NGOs. After training try to test the things on smaller areas and if see benefit then do it on sufficient scale and sharing the learning with other farmers.
- Group Formation: There were possibility to have lift irrigation either from well, river or pond. They need to form small group from 5 to 20 farmers based on size of lift irrigation project. If they do jointly it will reduce capital cost and management cost. If sufficient numbers of group are in place they join their strength and demand to address their common problem to the Government.
- Protection of their crop: Dangs people had their culture to keep the animal free to graze just after Holi. This practice not only spoil the crop that standing in the field but other to stop raising their crop after Holi. This problem that farmers can jointly resolved. Open grazing is one of the biggest threats that farmers are facing to do irrigated agriculture. Second option to do protection by providing fencing to their farm land. This is again if they united and do it in group of farmers will be cheaper than doing individually.
- Liaison with Government and NGOs: For liaison with Government and NGOs need good leadership and collective action. The group formation and united on common agenda will serve the purpose. On other hand recognizing some of the genuine effort and result either by Government or NGOs should be acknowledge publically.
- Leadership: There are couples of good leaders in the Dangs District. They should provide leadership for common agenda and unite people to enhance irrigation in the Dangs. There are regional common issues if it resolved by collective action, it can produce excellent result in short time.
- “Chidani and Adar”: Needs to understand and find out proper answer for this. This will not only protect environment but if they find out alternative will enhance sustainability of trees and had fuelwood and compost fertilizer too.
- Value addition to their agriculture and horticulture product: The Dangs district famers used very less chemical fertilizer and pesticides. Their crops can be grown and then their produces can be sold as organic produces. Need little effort and caution while do farming process.
- Raising awareness of scientific agriculture (both rainfed and irrigated farming) in the Dangs district farmers will be key concern.

Future role of Government officers:

(It was difficult to convey the about the future role so this was asked differently and try to get answer which was close to their future role)

- Source (Maintenance and Creation): First priority should be desilting of existing checkdams and tanks. Second should be repairing and renovation of old checkdams and tanks. Third should be construction new checkdams and tanks at possible sites. Most important will be there is need to have around ten to twelve big size reservoirs needs to create in the Dangs. There are good sites available, but required permission form forest department.
- Promotion of irrigation: Big scheme had less success. Focus needs to have small size irrigation project. Electricity supply is must be provided to promotion of irrigation. Irrigation by kerosene/ diesel is costly. Promotional policy for group/ cooperative irrigation.
• Drip Irrigation: Promotion of drip irrigation will be very much required in the Dangs District, to save water and irrigate more area.

• Government Procedure and budget allocation: Government should allocate budget on time and needs to simplify procedure or rectify procedure which can produce result not paper.

• People Awareness: There is need to raise awareness in people for improved agriculture practices and have profitable agriculture.

• Forest: Needs to have total area treatment as per need of the Dangs District. Needs to have special design for this area to have protection of soil and water in the forest area.

• Land Treatment: Needs to focus on terracing as northern India (Himachal Pradesh) had it. The Dangs needs special design to have watershed treatment.

• Linkage with other sectors: Dairy will be one of the sector need to strengthen along with irrigated agriculture. Another will be marketing agriculture produces with value addition like organic product. Third will be horticulture (fruits: Mangos and cashew) produces can have value addition and market to have better price. Forth will be vegetables. On other hand consumers have proper product with reasonable price.

Future role of NGOs to promote irrigation in the Dangs

• Awareness: River basin and watershed approach needs to understand and internalize so that mass awareness can be done. NGOs do more work on creating awareness in people and also provide grassroots level information to concern government officers about project and programme. Unit people on both river basin level and watershed level. Acquire competence to do mass awareness programme. Community Awareness programme (irrigation and agriculture): Exposure, training, field days, Video show,

• Demonstration: NGOs do the work on small scale and demonstrate to success the intervention to promote irrigation. By implementing few project on ground and focus to produce result. After successful implemented pilot project try to increase number of projects so that it can accepted by community and government both. NGOs had fund from Government and private donor (CSR).

• Development of other sector: Animal husbandry (increase Milk production), produce good quality fodder, wormy-compost, compost pit for dung, saving and credit thru small groups, organic farming. Small scale agro business, support for small businesses i.e. grocery shop, cycle repairing, automobiles, barber shop, tailor shop, vehicle on rent etc.

• Promotion: Sharing successful experience and learning from failure of project and programme. Provide platform for interaction between people and government officer.

• Policy influencing: Sharing of successful project had several time discussions with government top officers and lead to discussion to have pro people policy to promote such interventions. To suggest some changes in existing policy so that it support the action at grassroots level and operationalize to scaling up project and programme.

• Agriculture: Improve agriculture practices, organic farming, organic horticulture, demonstration, on field training, analysis of agriculture, soil testing, scientific farming, methods of irrigations.

• Marketing: Marketing of agriculture produces, value addition, organic product promotion and marketing.
Conclusion

The objective of this research is to study economic impacts of water resources development for irrigation in the Dangs district. To achieve objective researcher had attempt to know economic status, crop productivity, cropping pattern, problems and challenges in terms of irrigated agriculture, strengths and weakness of the different irrigation methods and options of irrigation to increase area under irrigation in the Dangs district, roles of stakeholders, institution arrangement etc. Based on that suggested appropriate Water Resource Development models for promote irrigation in the Dangs. It was assumed that irrigation can increase agriculture production and various irrigation options that are available and that can act as catalyst agent to enhance livelihood of the Dangs tribal. Government and donor policy is favorable to develop water resources in Dangs district and had prime focus of development due to poorest district. Dangs have distress migration due to lake of livelihood opportunity after monsoon.

The limitations of this research are mainly respondent were less educated so the response it limited to their knowledge of the subject. Study area had majority tribal community (96%), so research will be more applicable to such community. Study focus irrigated agriculture. The Dangs topography is very undulating. Basalt rock formation and high runoff limiting the ground water recharge. Finding are applicable to region had these similarities.

In India almost 8.6 percent is schedule tribe population, while in Gujarat it is 14.8 percent and in the Dangs district it is 94.65 percent of its population as Scheduled Tribe, although its’ share is small 2.3 percent of the total ST population in the state. Almost 85 % of the population is dependent on agriculture for their livelihood, which makes this part of the population even more dependent on water. Tribal development and Water Resource Development both compliments each other. During last two decades both the subjects got importance at local, national and international level. Researcher had identified that water can play major role to enhance the livelihood of poor tribal people in Dangs district. The Dangs district topography is undulating has an average rainfall 2414 mm and had four rivers.

Researcher had analysed different data both from Irrigated farmers and rainfed farmers. Research findings, challenges and suggestion for increased irrigation in the Dangs district had summarized in three parts.

- Impact of irrigation on Irrigated farmers
- Challenges faced by irrigated famers
- Suggestions for increase irrigation in the Dangs district.

Farmers had come to know about irrigated agriculture from farmers, from various government departments and NGOs. They had experienced that the Electricity will be chipper options if power supply quality and time assured. Bore well will not be feasible for all area so it depends upon ground water condition. Lifting from rivulet will be practical options needs to strengthen by water harvesting and doing in group if possible. Open well technically good options only capital cost is higher, need government supply, they had suggested that they should have scheme like “Jeevandhara”. Mini lift irrigation had more successful than medium and major lift irrigation project in the Dangs district. Mini lift irrigation had command area up to 10 acres and having three to seven farmers irrigated their field.

There were two options for water availability either Ground water or surface water at the Dangs district. As far as Ground water is concern there were two practices prevailing to use ground water one is open well and second tube well. Performance of shallow aquifer was 44% considering irrigation for all three seasons. Performance of deep aquifer was 60% considering irrigation for all three seasons. Surface water availability was 52% for all three seasons.
Average investment by farmers for irrigation was Rs. 18382 at the Dangs District. Bhil (22%) had average investment of Rs.16056, while Kokani (72%) had Rs. 19604. Kokani had greater investment than Bhil.

Almost all 100% irrigated farmers had agreed that their farm land improved due to irrigation. Almost 87% had stated that they had cleaned their farm. They had stayed over their farm after irrigation started; spare time had helped them to clean their farm. After irrigation 81% had done farm bunding where 88 % invested in land levelling. However 27% had converted their wasteland (unused) in to agriculture land.

Average cropping intensity increase from 1 to 1.29. Average land under farming before irrigation was 5.2 acres and after irrigation reached up to 6.7 acres. On and average it was increased by 1.5 acres.

Assets that owned by irrigated farmers were TV (64%), Tape/Radio (22%), Motor Cycle/ Scooter (46%), Tractor (9%) and Car/Jeep/ Truck (5%), and Mobile (95%).

On and average irrigated farmers had total 3 rooms, someone had Pakka rooms, someone had Kachcha rooms and someone had mixed one or two Pakka rooms and one or two Kachcha rooms. Irrigated farmers had average 2 to 3 Pakka Rooms (Average 2.3). On an average 2.87 (2 to3Nos) that each farmers had Kachcha rooms. Assets of rainfed farmers had Kachcha House 90 to 95% (Bamboo walls cover with cow dung and soil, country tiles/ handmade soil tiles/ thatch roof, floor with cow dung and soil ). They had mostly 2 rooms and very few had 3 rooms.

Almost 87% irrigated farmers had impact on economic development due to irrigation. However 67% had stated social development due to irrigation. In this research, three children of irrigated farmers’ education were analyzed. Around 88% irrigated farmers their first child had educated, 74% had their second child educated while 47% had third child educated

Comparisons between Irrigated farmers and Rainfed farmers brought out some key differences which discussed here in three domains i.e. land ownership, income and migration.

Average land holding of irrigated farmers was 6.21 acres and they had average irrigated land 1.84 acres and average unirrigated land 4.85 acres. Average land holding of rainfed farmers was 4.15 acres. Basic difference in landholding between irrigated farmers and rainfed farmers was 2.06 acres. Landholding of irrigated farmers had average 0.6 acres more than rainfed farmers. Crop intensity of irrigated farmers of the Dangs district was increased up to 1.29. Rainfed farmers had crop intensity was one or less than one in case if they don’t grow crop during monsoon.

There were almost 86% rainfed farmers and 12% Irrigated farmers had income up to Rs.20,000. In income group of Rs.20,001 to Rs.50,000 there were 13% rainfed farmers and 35% irrigated farmers. There were 53% irrigated farmers and only 1% rainfed farmers had income more than Rs.50,000. Average total income of irrigated farmers was Rs.58613 while average income of rainfed farmers was Rs.16732.

Migration of irrigated farmers had reduced by 48%. Irrigated farmers status analysis reflected that the 42% have good status, however 58% reported as medium status.

Improvement of tribal life through irrigated agriculture shortly concluded by refereeing to ladder of prosperity and correlate with this research finding as under.
In Dangs District, 59% area is under forest and 34% area is used for agriculture. Area under irrigation was 4% of total geographical area and 13% of cultivable land. Irrigation potential created was 20% of cultivable land. The quality of land is poor and 66% of the agricultural land is situated on slopes, which makes irrigation difficult. In the Dangs district average landholding per household is 1.31 hectare (Census, 2011), it was 1.58 hectare (Census 2001).

Irrigated farmers had pointed out the source of water was the biggest problem. Electric connect was there but they don’t had sufficient voltage or number of hours assured power supply. Farmers had pointed out there were two years waiting list to get three phase power connection. They had raised problem of not having proper lifting devised i.e. diesel engine and electric motor. They had problem of undulating land need land levelling.

Area development planning had suggested along with the river basin planning which had integrated watershed development programme and drainage line treatment that should be specially design for the Dangs district. Forest treatment will be one of the focus areas for integrated planning. Various water harvesting structures needs to construct and existing damaged structure needs to repair. There were great emphases that required creating awareness about scientific farming and create enabling environment to promote irrigation at the Dangs District. Need to support and enhance animal husbandry (dairy) that will support to promote irrigation in the Dangs district.

The research has been conducted in-depth to understand the irrigation scenario and different methods adopted for irrigation by farmers in the Dangs district. The benefits of irrigated agriculture and challenges were discussed in detailed. All these interactions clearly emphasis that the farmers are getting real benefits through irrigation but they had limited land for irrigated agriculture. Still farmers and other stakeholders had pointed out the vast scope for the development of irrigated agriculture. But proper care to be taken to choose the right methods of irrigation which is manageable by tribal community.

Conclude by quoting “Rahim”

Rahiman Paani Rakhiye, Bin Paani Sab soon.
Paani Gaye naa oobre, Motti, Manas, Choon . –Rahim