Implementing Climate Proofing Practices in Rawatpura Watershed

Project Technical Report
(January 2013 to August 2015)
Implementing Climate Proofing Practices in Rawatpura Watershed

Project Technical Report (January 2013 to August 2015)
Project Technical Report Submitted by:

Prayatna Samiti
26/27, Mahavir Colony, Bedla Road, Badgaon, Udaipur 313 011, Rajasthan, India
Tel.: +91-294-2450281
E-mail Id: info@prayatnasamiti.org, prayatnaudr@gmail.com

to

GIZ
Natural Resources Management Programme
A-2/18, 2nd Floor, Safdarjung Enclave
New Delhi 110 029, India
<table>
<thead>
<tr>
<th>S. No.</th>
<th>Chapter</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Project Background</td>
<td>5</td>
</tr>
<tr>
<td>2.</td>
<td>Executive Summary</td>
<td>6</td>
</tr>
<tr>
<td>3.</td>
<td>Explaining Climate Proofing</td>
<td>7</td>
</tr>
<tr>
<td>4.</td>
<td>Project Objectives</td>
<td>8</td>
</tr>
<tr>
<td>5.</td>
<td>Rawatpura Watershed Description in Relation to Problem Identification</td>
<td>9</td>
</tr>
<tr>
<td>6.</td>
<td>Explaining Climate Proofing Methodology in Rawatpura</td>
<td>12</td>
</tr>
<tr>
<td>7.</td>
<td>Project Activities</td>
<td>16</td>
</tr>
<tr>
<td>7.1</td>
<td>Installation of Agro Advisory Laboratory (Agromet Lab)</td>
<td>17</td>
</tr>
<tr>
<td>7.2</td>
<td>Construction of Gully Plugs with Recharge Pit in the Water Streams</td>
<td>19</td>
</tr>
<tr>
<td>7.3</td>
<td>Bamboo and <em>Aloe vera</em> Plantation in the Pasture Land</td>
<td>20</td>
</tr>
<tr>
<td>7.4</td>
<td>Plantation of fodder tree <em>Boswellia serrata</em> (Salar)</td>
<td>21</td>
</tr>
<tr>
<td>7.5</td>
<td>Demonstration of Hybrid Napier (CO-2) demonstration</td>
<td>22</td>
</tr>
<tr>
<td>7.6</td>
<td>Plantation of Horticultural Species</td>
<td>24</td>
</tr>
<tr>
<td>7.7</td>
<td>Construction of Diversion Drain</td>
<td>25</td>
</tr>
<tr>
<td>7.8</td>
<td>Testing Improved Cookstove</td>
<td>26</td>
</tr>
<tr>
<td>7.9</td>
<td>Waste Wier Innovation</td>
<td>27</td>
</tr>
<tr>
<td>7.10</td>
<td>Continuous Contour Trench</td>
<td>28</td>
</tr>
<tr>
<td>7.11</td>
<td>Water Absorption Trench</td>
<td>29</td>
</tr>
<tr>
<td>7.12</td>
<td>Stone Pitched Thawla</td>
<td>30</td>
</tr>
<tr>
<td>7.13</td>
<td>Demonstrating Gradonies</td>
<td>31</td>
</tr>
<tr>
<td>7.14</td>
<td>Biogas Units</td>
<td>32</td>
</tr>
<tr>
<td>7.15</td>
<td>Fodder Grass Seed Sowing</td>
<td>33</td>
</tr>
<tr>
<td>7.16</td>
<td>Silviculture</td>
<td>35</td>
</tr>
<tr>
<td>7.17</td>
<td>Creation of Pasture Group and Fodder Bank</td>
<td>36</td>
</tr>
<tr>
<td>7.18</td>
<td>Farmers Field Schools</td>
<td>37</td>
</tr>
<tr>
<td>7.19</td>
<td>Formation of Compost Pits</td>
<td>39</td>
</tr>
<tr>
<td>7.20</td>
<td>Awareness Camps</td>
<td>40</td>
</tr>
</tbody>
</table>
1. Project Background

Due to the gradual shift in climate patterns a regular change in ecosystem is evident all over the world. The effect has its implications on the vegetation, fauna and abiotic components. When observed at the micro level the most affected are the ecosystems which were already vulnerable to the existing weather conditions.

Weather extremes occurring over the years have affected the habits of communities which they adapted in response to the climatic variations, which are often unsustainable and could not resist the adverse weather very long. At this stage it becomes necessary to develop the preparations and plans which must strengthen the climate change adaptation practices as their inherent part to be followed. These must be further implemented to build the climate resilient structures to increase the capacity of the communities to face climate risks.
2. Executive Summary

The project titled “Implementing Climate Proofing Practices in Rawatpura Watershed”, was implemented in Rawatpura watershed by Prayatna Samiti, Udaipur with the support of GIZ and Indo German Watershed Development Programme (Rajasthan) and National Agriculture Bank for Rural Development (NABARD) from January 2013 to August 2015. The project represents the initiatives taken by the local people to strengthen the climate change adaptation practices in Rawatpura watershed located in Udaipur district of Rajasthan. The watershed has 5 mini watersheds of Rawatpura, Malo ka Guda, Rathodon ka Guda, Karmal, and Sinhar. The area experiences the intermittent rainfalls in the 4 months of monsoon period with the average rainfall of 618.43 mm recorded in past 2 decades. The average maximum temperature in summer is 39.28 degrees Celsius, 31.63 in monsoon, and 25.81 in winter. The average minimum temperature in summer is 21.94 degree Celsius, 22.32 in monsoon and 10.1 in winter. The project started in the year 2013 with the aim to infuse climate proofing policy at the local level. The PRA was conducted at the initial stage to plan the location and strength of physical and biophysical structures where a hazard map was prepared to locate the weather extremes. The physical and biophysical structures were set up according to their need in the watershed. The structures were prepared along with setting up a Weather Station at Malo ka Guda so that forecast can be done to plan the adaptive practices related to agriculture and animal husbandry.

The activities included sowing of fodder grass seeds on farm bunds; bund planting; bamboo and Aloe vera plantation; waste wier innovations; constructing diversion drain in crop cultivated area; continuous contour trenches on private pasture land; water absorption trench; stone wall fencing; constructing gully plugs with recharge pits; stone pitched thawla on common and private pasture; demonstrating gradonies; sowing grass seeds in pasture; fodder trees plantation; creation of pasture groups and fodder bank; demonstration of hybrid napier; improving local cow management practices; demonstration of improved cook stove; biogas units; rain water harvesting structures with backyard horticulture; formation of farmers field school and installation of Agromet Lab.

The above activities proved to be climate resilient which reduced the risks taken during climatic variations.
3. Explaining Climate Proofing

Climate proofing means identifying risks to a development project, or any other specified natural or human asset, as a consequence of both current and future climate variability and extremes, and ensuring that those risks are reduced to acceptable levels through long-lasting and environmentally sound, economically viable, and socially acceptable changes implemented at one or more of the following stages in the project cycle: planning, design, construction, operation, and decommissioning. (Climate Proofing: A Risk-based Approach to Adaptation, Asian Development Bank, 2005).
4. Project Objectives

- Develop climate proofing measures by building physical and biophysical measures in the watershed area.
- Customizing climate change adaptation practices in watershed through preparation, planning and approval of the developmental tasks.
- Making local communities adapt climate resilient models for their livelihood and ecological security.
- Enable communities to analyse and forecast weather and adapt the climate resilient practices according to the forecast.
5. Rawatpura Watershed Description in Relation to Problem Identification

Rawatpura watershed is a macro watershed covering 1,100 Hectare of area. The watershed is located at 74°02’ E and 74°05’30” E and 24°25’ N and 24°27’15” N geographical coordinates with around 25 kilometres South East of Udaipur district of Rajasthan. The watershed has 5 mini watersheds of Rawatpura, Malo ka Guda, Rathodon ka Guda, Karmal, and Sinhar. The highest elevation point of the watershed above Mean Sea Level (MSL) is 458 meter and the lowest elevated point MSL is 340 meter. The watershed stretches up to 6,450 meter from NW to SE.

The drainage lines are of 1, 2, 3 and 4 orders with end drainage in Makrari River. The area consists of small to medium sized gullies sloping between 8 to 15 per cent. The average soil depth is 0.77 meter existing with silt loam textured composition. 60 per cent of the area exhibits undulating terrain with soil erodibility found at the slopes. The same area is used for agriculture which is rain fed and for grassland management. The agriculture is mainly rain fed with single crop cultivation. The land characteristics shows slopes varying between 2 to 16 percent moderately or highly eroded, with soil conditions fair to good.

The average maximum temperature in summer is 39.28 degrees Celsius, 31.63 in monsoon, and 25.81 in winter. The average minimum temperature in summer is 21.94 degree Celsius, 22.32 in monsoon and 10.1 in winter.

The average rainfall of the area is recorded to be 618.43 mm. The highest intensity per hour rainfall in last 30 years is 45 mm. The highest rainfall in 24 hours in the last 30 years (mm) is 170 mm.
Daily Rainfall description with respect to climate risk identification:

Daily normal rainfall of the district is shows that rainfall is insignificant during the period from January to end of May and middle of October to end of the year. The highest daily normal value of the order of 10 mm is observed around 190th to 215th day of the year. The rainfall increases from middle of June and attains its peak value around 190th to 215th day and then starts decreasing up to end of September. A drastic decrease in rainfall takes place after the 300th day and there are occasional spells of rain during rest days of the year.

About 74% cases the daily rainfall occurs less than 5 mm; in 13% cases it ranges between 5 to 10 mm and in 6% cases it ranges between 15 to 20 mm. The daily rainfall exceeding 50 mm is rare. However, there are cases when it was observed in the range of 50 to 150 mm also.

Seasonal and annual rainfall description:

Total annual normal rainfall of Udaipur district is 586 mm with 31% coefficient of variation (CV).

Total rainfall during Winter season is lowest (12 mm) among all seasons. The rainfall is rather more in Summer (11 mm) and Post Monsoon (16 mm) seasons than winter. A drastic increase in rainfall is observed from summer (11 mm) to monsoon season (554 mm). The highest (CV 155%) rainfall variability is observed in Post Monsoon season, while the lowest (CV 34%) in Monsoon season. About 94% of the annual rainfall is realised during the monsoon season. The contribution of winter, Summer and post monsoon seasons rainfall are 1%, 2% and 3% respectively.
It can be concluded that chances of dry weather during different weeks of winter, first half of summer and post monsoon seasons are more than 80%. Probability of two successive wet weeks is less than 20% during these seasons. Chances of rainy weeks gradually increase from 20% (22nd week) to more than 90% (30th week). The probability of wet week during July and August months lies between 90 to 100%. The chances of two successive wet weeks is about 60 to 80% during these two months. The probability of wet week when its preceding week is dry, is also very high (more than 90%) during these two months. All these probabilities gradually decreases after 33rd week onward and become even less than 20% during 40th week. (Rainfall Profile of Udaipur, Meteorological Monograph: Hydrology N0.15/2013, O.P. Singh, S. S. Singh & Surender Kumar Meteorological Centre, Jaipur India Meteorological Department, New Delhi).

The present sources of income are agriculture and animal husbandry with 37 per cent of people practicing agriculture and 27 per cent rear livestock. 9 per cent people migrate outside in search of jobs.
6. Explaining Climate Proofing Methodology in Rawatpura

The project was initiated with a Participatory Rural Appraisal (PRA) at Rawatpura village. This was the first step of preparation of the Climate Proofing plan. The PRA focused on preparation of Historical events and action taken against them; Seasonal event calendar; Seasonal calendar for livelihood activities; and Hazard risk map (Risk map).

It was observed that since 1966 weather extremes taken place at irregular interval of time and efforts were done to minimize their effects. In 1966 severe famine caused crop failure, and cattle were lost. The efforts were done by the government, red sorghum was distributed through PDS and Rawatpura pond was developed with community contribution. High rainfall occurred in 1973 which caused crop collapsed, and dam breaching occurred. As a result people took up wheat and jayad crops. In 1990 dragon fly infestation occurred which destroyed all the grains. To avoid the situation people beat trays and torched fire, government supplied red wheat and people fell ill. In 1992 and 1995 severe drought took place which destroyed crops and livestock. This resulted people to migrate and take loans. In 1999 and 20014 drought again strike back which resulted in cutting of forest trees and land degradation occurred at large scale. In 2005 and 2008 hail storms took place which destroyed crops and diseases spread out. During heavy rains in 2010 wheat and grass got affected which resulted in purchase of grass at Rs 10,000 by each household.

The seasonal calendar was prepared to ascertain the relationship among months, seasons, livestock diseases and crop plantation:
A Hazard Map was a critical exercise to plot the weather extremes in the watershed map so that planning can be done around the vulnerable areas with respect to climate risk mitigation. Table mentioned below presents the picture of weather extremes in the watershed:

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Weather extremes/situations</th>
<th>Corresponding land condition</th>
<th>Area/Villages</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Places facing high degree of land degradations, soil erosion, streams carrying heavy soil loads, etc.</td>
<td>Slopes.</td>
<td>Karmal, Malo ka Guda and Rawatpura.</td>
</tr>
<tr>
<td>3.</td>
<td>Locations with good soil cover and have potential for good grass growth.</td>
<td>Plains.</td>
<td>Rawatpura, Karmal and Rathadon ka Guda.</td>
</tr>
<tr>
<td>5.</td>
<td>Places with extremely higher and lower temperatures.</td>
<td>Top elevations.</td>
<td>Karmal, Rawatpura, Malo ka Guda and Sinhar</td>
</tr>
</tbody>
</table>
In order to address the above weather extremes occurring in the climate of the watershed region the emphasis was put on strengthening the land treatment exercises on government and private land practices with the involvement of community members in decision making. Following activities were carried out: Sowing of fodder grass seeds on farm bunds; bund planting; bamboo and Aloe vera plantation; waste wier innovations; constructing diversion drain in crop cultivated area; continuous contour trenches on private pasture land; water absorption trench; stone wall fencing; constructing gully plugs with recharge pits; stone pitched thawla on common and private pasture; demonstrating gradonies; sowing grass seeds in pasture; fodder trees plantation; creation of pasture groups and fodder bank; demonstration of hybrid napier; improving local cow management practices; demonstration of improved cook stove; biogas units; rain water harvesting structures with backyard horticulture; formation of farmers field school and installation of Agromet Lab.
Climate Proofing Approach in Rawatpura

Weather Extremes
Intermitent Rainfalls during Monsoons

Climate Proofing
A risk mitigation approach

Preparation Planning Approval

Domestic Farming
Boundary Plantation
Skill Building
Saving Fuel Wood
Organic Farming

Pastures
Silviculture
Land Treatment
Drainage Line Treatment
Grassland Management
7. Project Activities
7.1 Installation of Agro Advisory Laboratory (Agromet Lab)

It was an important step towards strengthening climate change adaptation practices. The Agromet lab is a local weather station installed at Malo ka Guda village which helps in forecasting and record present and historical data of the watershed and adjoining villages lying within the radius of 10 kilometre. Established in the year 2012 the Agromet lab is been successful in forecasting and recording the weather conditions. A local person, weatherman, was trained to record and decipher the data so that people can prepare themselves for weather based agricultural practices. The Agromet lab consists of the following weather measuring equipment: dry and wet bulb thermometer for measuring humidity; Max-Min thermometer for measuring maximum and minimum temperatures; Wind wane for observing wind direction; Anemometer for measuring wind velocity; and Rain gauge for measuring rainfall.

Over the time the Agromet lab has been able to forecast and decipher the important weather extremes and the recommendations to plan the agriculture:
✓ Rain forecast: Wind velocity less than 5 kilometre/hour; humidity more than 60 per cent; Minimum temperature not more than 20 degree Celsius; Maximum temperature less than 30 degree Celsius.
✓ When maximum temperature is 30-32 degree and minimum temperature is 14-15 degree then one must be prepared for wheat sowing.
✓ During winter when temperature recorded is less than 3 degrees for more than 3 days; there is stagnant wind and clear sky this indicates fog attack.
✓ Mustard is to be sown when there are no clouds in the sky.
✓ During rains the sowing of crops is to be done when there is 25 mm of rainfall during 2-3 days.
✓ If the rain has occurred up to 50 mm then let the field dry before sowing.
✓ Ploughing is to be done after 20-25 days of sowing and the rainfall is recorded to be 10-12 mm. Manure is to be applied to the field after 20-25 days of sowing and there is 12-15 mm of rainfall.
✓ When the temperature is recorded to be 35-40 degrees; wind velocity is 1-7 kilometre/hour; wind direction is from south to north; and humidity is 70-80 per cent then kharif crop is to be sown.
✓ When the temperature is 30-35 degree; wind velocity is 5 kilometre/hour then one can spray the pesticides. This is to be noted that the pesticide must be sprayed after 2-3 hours of rainfall stops.

The weatherman collects the data two times a day – one in the morning and second in the noon so that weather variations can be observed minutely. The data is disseminated through writing Maximum Minimum temperatures, Humidity, Rainfall, Wind velocity and Wind direction on the boards fixed in front of Agromet Lab and grocer's shop in Malo ka Guda village. A record sheet of the data collected since March 2012 is also been maintained by the weatherman. The recorded data has also been tallied with city weather stations and the website www.krishi.rajasthan.gov.in and www.farmers.gov.in which showed that they were measured correctly. The data written on the board is successful in attracting the people as they have found it useful in planning their agricultural fields. The weatherman also delivers the importance of data to community members in village gatherings and group meetings. The data collection will also help in analysing the historical weather trends occurred in the climate of the place.
7.2 Construction of Gully Plugs with Recharge Pit in the Water Streams

The Gully Plugging comprised of the construction of the series of check dams constructed from stones, which is the locally available material, across the gully bed to control soil erosion, runoff velocities and induce siltation in the upstream. A single gully plug was effective and efficient in checking soil erosion, retarding runoff, and absorption of water when constructed with recharge pit at upstream along with its length. The recharge pit absorbed water allowing it to collect and then percolate gradually in the ground.

131 cum volume of gully plugs were constructed across the drainage line of order 1 and 2 crossing the private pasture lands of the area of 5 Hectare of Rawatpura, Sinhar and Malo ka Guda 10 Farmers.

Most of the recharge pits were constructed along the gully plugs and around them. 667 rmt (running meter) of recharge pits were constructed in 19 Hectare pasture land area of Karmal and Rawatpura villages.

The structures have benefited the farmers by absorbing the water down the ground which has increased the vegetation cover in 0.5 Acer of its catchment lying upstream. Although the rainfall of the area was recorded to be 475 mm in the year 2015 with high intensity in the month of July the absorption of water took place.
Bamboo plants were planted as to implement one of the biophysical measures to grip the loosely packed topsoil to check soil erosion. The saplings were planted around the recharge pits and on the gully plugs structures. Besides restricting soil erosion the species also provides economic benefits with the wood being used in crafting wooden equipment. Aloe vera was planted along the drainage line and on the gully plugs. The plant species is a xerophyte which checks soil erosion and is known for economic value utilized in manufacturing gels for skin and digestive tracts.

858 bamboo plants were planted around the recharge pits and upon the gully plugs; 1,000 *Aloe vera* saplings were planted along the drainage line and upon the gully plugs lying in the pasture lands of 16 farmers from Malo ka Guda and Rathodon ka Guda villages.

As the area recorded only 475 mm of rainfall in 2015 only 25 per cent of the saplings could survived. The survived plants grown well on the gully plugs due to water absorption by the soil around.
7.4 Plantation of fodder tree *Boswellia serrata* (Salar)

Salar trees were planted as to develop Forage Forestry Model in the pasture land and upstream catchment of the gully plugs. Salar is economically important tree which provide fodder as well has medicinal importance in curing both animal and human diseases. Leaves are fed as fodder which also supplements deworming agent. For human beings the bark is used to treat skin lesions, stomach ulcers and anti-ageing.

810 Salar pants were planted in the 9 Hectare of private pasture lands of 2 farmers of Rawatpura and Malo ka Guda villages.

With the recoded survival rate of 80 per cent the trees are growing well in the region. The leaves are used to feed buffaloes and goats of the farmers. The reason behind the loss of the 20 per cent of the trees was found as the low rainfall in the area this year.
The Hybrid Napier was grown as a perennial grass species (monocot) known for its high protein content. The grass grows well in temperate and sub temperate climatic zones. The roots of the grass binds the top soil fragments and foliage provides important nutrients to the livestock. The grass regrow at fast speed and attain 8 feet height to provide ample amount of fodder.

The grass is a hybrid of *Pennisetum typhoides X P. purpureum* (Elephant grass X Bajra). It has larger leaves, softer and less persistent hairs of leaf blades and sheaths and less sharp leaf edges. The stems are also less fibrous. The tillers are more numerous and grow faster. Hybrid Napier can grow on a variety of soils. Light loams and sandy soil are preferred to heavy soils. It tolerates a soil pH range from 5 to 8.

25 demonstration units of the grass were done in Rathodon ka Guda, Malo ka Guda and Karmal villages.
The grass was propagated by the farmers through the root strands. The demonstrations had replaced the need of fodder collected from the grassland thereby reducing the grass regeneration pressure on the pastures and farm fields. The practices of open grazing was also replaced with stall feeding as the grass was readily available at the house. According to the beneficiaries 15 kilogram of the fodder grass is harvested at the interval of 7 days which has replaced the dry fodder requirement. Milk production of buffaloes has also been increased by 0.5 litres since the grass has been fed.
7.6 Plantation of Horticultural Species

The fruit trees were introduced as a set of Boundary Plantation practice. The fruit trees comprised of the indigenous species of castor, guava, mango, custard apple and papaya. The fruit trees are the important sources of the income in the watershed as the fruits are sold at good price in the local market.

5 types of trees consisting of castor, guava, mango, custard apple and papaya were provided to 25 farmers of Rawatpura, Malo ka Guda and Karmal villages.

The trees of guava, mango, custard apple and papaya have grown with the survival rate of 90 per cent with 2 plants provided to each of the beneficiary. Beneficiary farmers also sold Castor seeds at the rate of Rs 40 per kilogram. Other fruit trees are still to bear the fruits.
The Diversion Drains were built as the water diversion structures at the sloping edge of the farm fields. The structure absorbed the excess of water during the high intensity rains thereby preventing water logging in the fields. The diversion drain outlets into the water stream.

A total volume of 367 cum of Diversion Drains were constructed along 5 Hectare of cultivated land in Malo Ka Guda village.

The fields were prevented from water logging during high intensity rainfall in the month of July 2015 as runoff water was absorbed in the diversion drain.
The improved cookstoves were introduced to reduce the pressure on forests for their fuel wood supply. They also brought down the headload of women as they required almost 50 per cent of the fuel wood to the wood required for traditional stoves. The stove can use any type of solid biomass fuel including wood, cow dung and agricultural waste. The technology produces 70% less smoke and uses 50% less fuel than traditional mud cookstoves. It adds convenience to lives by reducing the time and/or money they must spend collecting or buying fuel and allowing for a more comfortable cooking experience. The Smart Stove model is tested and certified by the Ministry of New & Renewable Energy (MNRE), Government of India.

5 Cookstoves were tested in 5 households with 1 in Rathodon ka Guda, 1 in Malo ka Guda and 3 in Rawatpura villages.

The cookstoves are getting popularity with beneficiaries tested the model with the daily preparation of the meals. Recorded data of 30 months shows that the wood consumption is reduced by 50 per cent where 4 kilograms of the wood used daily was reduced to 2 kilogram. More people from the villages are also coming with demand on the cookstoves.
7.9 Waste Wier Innovation

The waste wier or water outlets were introduced as water drainage lines to drain excess of waters from crop cultivated area. These are the PVC pipelines of 4 inch diameter and 1.5 meter length connecting up lying field to the down lying field. Thus, waste wiers prevents water logging in the cultivated farm lands.

143 waste wiers pipelines were provided in Mala ka Guda, Rathodon ka Guda and Sinhar villages to cover 10 Hectare of farm lands.

The waste wiers were been able to take out the excess of water from the field areas in 2015. Due to the outlets provided the fields were able to withstand maize production with the yield of 2.5 quintal from 0.25 Hectares. With the same amount of rainfall in 2014 the crop was damaged due to water logging giving only 0.5 quintals of yield.
The CCTs constructed on the ridges of up to 30 degree slopes of private pastures served the purpose of water absorption. The trenches also provided appropriate environment to grow fodder grasses in the grooves. The grass seeds were also spread on the bunds (excavated soil) of the CCTs.

835 cum volume of CCTs were excavated in Rawatpura and Mala Ka Guda private pastures covering 10 Hectares of land area belonging to 15 farmers.

The trenches were able to absorb the water flowing down the slopes. 10 wells lying in the valley area showed a considerable rise of 25 feet of water level as recorded in October 2015. The water was utilized in irrigating the wheat and maize crops. Due to the water level rise the farmers have also produced vegetables farming by irrigating a small patch of land in their farms. Production of wheat was also been raised by 0.5 quintal. Silt deposition of around 0.2 meters in the trenches shows that the run off is reduced over the span of time. Due to the absorption of water the vegetation cover of local grasses has increased on the ridges. The recoded data shows that the production of fodder in 1 Hectare of land raised from 3,750 kilograms to 5,000 kilograms.
WATs were introduced as exclusive structures to absorb the water flowing down the slopes ranging between 25 to 35 degrees. The WATs are effective in absorbing water coming with high velocity by harvesting it and then percolating slowly in the ground.

109 cum volume of WATs were taken up in 2 Hectares of catchment of 5 beneficiaries in Sinhar and Mala ka Guda village.

The soil moisture capacity was been increased in the trenches to build the environment to grow fodder grasses and vegetables. A 4 kilogram of fodder per WAT was collected in October 2015. The water level in the down lying 10 wells was also increased by 30 feet.
7.12 Stone Pitched Thawla

Thawalas were introduced to uphold the moisture around the root stock of the plants growing on the slopes. Thawla is a 1 feet high mound of mud constructed on the slopes around the plants. The mound surrounds the plant from lower side which is pitched with stones. Thawlas are effective in holding the moisture around the plant roots.

8,974 stone pitched thawalas were constructed in 15 Hectare of Government Pasture land in Rawatpura and Karmal villages. 21,530 thawla were constructed in 20 Hectare of Private Pasture land in Rawatpura, Karmal, Sinhar, Mala ka Guda, and Rathoron ka Guda villages.

A the thawlas were constructed around 2 to 3 feet long plants of Palas, neem and custard apple trees and small bushes the soil moisture content was recorded to be preserved to sustain the plant growth in 2015. More farmers from the villages around has observed the activity as beneficial and demanding it to be done in their pasture lands.
7.13 Demonstrating Gradonies

Gradonies were constructed as steeping inward sloppy narrow bench terraces constructed in contours. Usually, gradonies are suitable for afforestation in uniformly steep sloping land. Based on steepness of the slope width of the gradonies is decided. Gradonies help in increasing the vegetative cover by increasing the sloppy surface area.

9 Hectare of the area was covered by the gradonies for 15 beneficiaries in Mala ka Guda and Karmal.

The gradonies were effective in capturing the interest of farmers in vegetable cultivation. Farmers trained in training programmes planted the vegetables on the gradonies to get additional benefits from the pastures and farm field. Vegetables grown were tomato and brinjal. 10 kilogram of vegetables harvested by each of the beneficiaries were also sold in the local market.
7.14 Biogas Units

The biogas units were constructed to produce cooking fuel from the animal excreta thereby reducing the consumption of fuel wood and head load. The biogas also stopped smoke thereby production thereby contributing to the climate change mitigation. The main feature of the biogas plant is the fixed underground digester chamber, constructed with a layer of bricks and an additional layer of cement mortar forming the roof above. Connected to the underground chamber is an inlet tank, through which manure is fed into the plant. The manure then ferments separating the slurry from the methane gas which rises and collects at the top of the digester tank, and is released through the gas outlet pipe. The slurry passes into the outlet tank where it is ejected from the plant and can be used as fertilizer on the field (from Deenbandhu model description).

5 units of biogas were demonstrated with 2 at Mala ka Guda, 2 at Rawatpura and 1 at Rathodon ka Guda. The models were built outside the houses of the beneficiaries.

The models are been able to provide clean source of energy. The practice has introduced a change in habit of the family members with switching over to the gas stove from traditional mud chullha. The beneficiaries cook the 3 times meal from the biogas. The households which are practicing the biogas technology have completely replaced the fuel wood with the biogas. The slurry byproduct is being utilized as organic manure in farming.
Grass seeds were spread to support grassland management practices. Grasses grown helped in fodder regeneration and cutting off the speed of rain drops hitting the ground. They were introduced as best cultivars of the region to provide nutrition to the animals. The grasses grown were Kali Laap (*Heteropogon contortous*), Motha Dhaman (*Cenchrus setigerus*), Rohida and Heran.

Kali Laap is a green fodder with production of 25–30 t/ha, dry matter yield is (8–10 t/ha) and crude protein yield (0.6–0.8 t/ha). The variety is highly suitable for rangeland and community grazing land in drought prone areas of semi-arid, tropical and sub-tropical areas during Kharif season as a perennial crop. It is resistant to lodging, disease and pests and highly responsive to agronomic practices.

Dhaman is adapted to arid and semi-arid climates (annual rainfall as low as 200 mm) with a long dry season. It is also drought tolerant. Responds well even to light rain when temperature is adequate for growth. Optimum growth occurs at 30–35°C. It is extremely tolerant of heat and drought but also survives frost (Indian Grass Land and Forest Institute, Jhansi).
Heran and Rohida are leafy grasses with high protein content and responds well in semiarid climate.

Grass seeds were spread in 96 Hectare of private pasture land in Rawatpura, Mala ka Guda, Sinhar and Rathodon ka Guda.

The seeds were sown on the CCT bunds and ridges of the pastures after their treatment with vermiwash. The vermiwash treatment provided nitrogen content to the seeds during their germination. The vegetation density per square meter also increased. The fodder generation from 1 hectare of the land increased from 3,750 kilograms to 5,000 kilograms. With quantitative and qualitative fodder grasses being fed to the livestock the milk production of buffalos in 2015 increased by 0.5 litre per animal per day.
7.16 Silviculture

The fodder trees Neem, Karanj, Custard Apple and Palas were planted as one of the agroforestry management practices. The trees are used as fodder as well as sources of timber.

200 trees were grown in 44 Hectare area of private pasture.

The trees planted in the year 2012 have attained the height of 3 feet with 70 per cent survival rate.
A 15 member pasture group was formed to take decisions on fodder management. The pasture group collected 8,143 kilogram of grass from their pastures and purchased from other people. The fodder will be sold on the profit of Rs 2 per kilogram during the glut period (May to June) to the people who require it. The pasture group also manages the grassland by improving vegetation in their pastures.
The Farmer Field School (FFS) was introduced as the part of extension education to inculcate improved farming practices amongst the farmers. A group of 10 farmers were engaged in the Farmer Field School to initiate the group-based learning process. The tested results were well disseminated amongst the farmers.

Farmers Field School is a non-formal education model of farmers wherein a situation for field oriented, discovery based learning is created.

There were 10 farmers from the watershed villages who participated in testing the field demonstrations of vermiwash, experimenting with 4083 wheat variety and mixed crop operations. Trainings were also imparted to the farmers to utilize their farm field in vegetable cultivation.

The practice of applying vermiwash on the crops was promoted widely amongst the farmers. By spraying organic manure the farmers got 2 quintal of extra wheat from the same area of land. The sprayer was shared amongst them so that the input cost of agriculture can be minimized. 4083 wheat
demonstrations were carried out with 20 farmers. The wheat variety is climate resilient which also produced taller plants than the indigenous one. The seeds were further distributed to 20 other farmers of the region to replicate the results. 20 farmers have also started practicing vegetable farming with the plan to sell the vegetables. The practices are the improved agriculture practices in which the plants were planted in the linear fashion on the ridges of the ridge and furrow model of field preparation.

So far 12 meetings have been organised along with 5 demonstrations of farming methods.
25 compost pits were prepared in Malo ka Guda and Rawatpura villages to utilize Farm Yard Manure (FYM) and livestock excreta for the preparation of compost. The compost will be utilized as one of the Nitrogenous manure for the plants to help them grow. The activity will enhance the farm yield of farmers.
6 awareness camps were done with 2 in Malo ka Guda, 1 in Sinhar, 1 in Rawatpura, 1 in Rathodon ka Guda and 1 in Karmal. Around 935 participants participated in the awareness camps. Communities and school children participated in the cultural events and rallies to organise to sensitize masses on change in weather trends and what measures to be taken to adapt them. The awareness generation focused on using less water demanding crop seeds, protection of grass lands, use of organic manure, integrated agriculture, mixed cropping, agroforestry, micro irrigation and good water governance. The practices are resilient to any climatic variations.