

## **LOW COST WATER SAVING TECHNOLOGIES IN CENTRAL ZONE (M.P. AND CHHATISGARH)**

Study conducted by: --- NAVADEEP voluntary organization, INDORE (M.P.)

### **Executive summary**

Action Plan of India Water Partnership(IWP) for 2009 envisaged a countrywide study on“Low cost water technologies combined with sustainable practices “. Nava deep voluntary organization Indore, prominent member of IWP since its inception and organizer / coordinator of Central India Zonal Water Partnership under GWP/IWP system was entrusted in June 2009 to conduct this study in central zone i.e. states of Madhya Pradesh and Chhattisgarh.

A **framework** for study, on the basis of general guidelines and background papers from IWP, was formulated by the expert group of Nava deep. It included study on: ---

- (A) Indigenous and traditional methods of conservation and supply of water.
- (B) Innovative and sustainable farm practices and new varieties of seeds.
- (C) Rainwater harvesting and groundwater recharge,
- (D) Water pollution
- (E) Raising awareness among people in general and farmers in particular.
- (F) Other relevant aspects arising during the period of study.

**Methodology** of study comprised gathering information from documents, interaction and spot observation. Discussions were held with knowledgeable persons in Indore, Bhopal (M.P.) and Bilai (C.G.) to sort out difficulties, obstacle and confusions as well as to provide direction to study.

### **Summary of the study**

**1. Salient features of the central zone:** --- The central zone as accepted by the board of governors, I.W.P., comprises states of Madhya Pradesh and Chhattisgarh. It was one single state of Madhya Pradesh, out of which Chhattisgarh region was declared a separate state in the Union of India in the year 2000. Taken together, it is heart of India. It has a total area of 4, 49,841 square kilometers which is approx. 14.5 percent of total area of the country. Its population is approx. 85 million of which 35% lives below poverty line. It is a landlocked area and distance of any of its place from sea is not less than 300Kms. It is surrounded by plains of upper Ganges in the north, Godavari Valley in south, plains of Gujarat in west and Orissa and Bihar in east. Vindhya, Satpura and Mekaal ranges are spread east – west in the region. As a result of its geographical setting, all rivers flow out of it. Major rivers are – Narmada, Tapti, Chambal, Mahanadi and Indrāvati. It receives rains mainly from south western monsoons but eastern part receives rainfall from Bay of Bengal also. Average rainfall is approx. 800 mm but the wetter western part, particularly the Malwa-Nimar area, has been receiving steadily reducing rainfall over last 30 years, as much as 20% in some locations. Besides the water management challenges represented by extreme seasonality of hydrological events, it suffers from climatic extremes and other counter productive phenomena, e.g. drought, floods and hailstorm. From 1986-87 to 1999-2000, this zone had only one year (1993-94) which was free from problem. The record shows that in all other years this zone faced climatic problems of varied intensity and nature.

It has four broad categories of agricultural soils, namely shallow and medium black (10%), deep medium black (53%), alluvial (11%), mixed red and black (26%). It is divided into 11 agro climatic zones as below :---

- (i) North hill region (rice zone)
- (ii) Kymore plateau and Satpura hills (wheat rice zone)
- (iii) Central Narmada valley (wheat zone)
- (iv) Vindhya Plateau (wheat zone)
- (v) Gird region (wheat sorghum)
- (vi) Bundelkhand (wheat sorghum)
- (vii) Satpura plateau (wheat sorghum)
- (viii) Malwa plateau (wheat sorghum)
- (ix) Nimar plains (cotton sorghum)
- (x) Jabua hills (cotton sorghum)
- (xi) Chhattisgarh plains (rice zone)

**2. The Indigenous and traditional methods** ----The states of Madhya Pradesh and Chhattisgarh have numerous evidences of wisdom of the bygone societies in the field of hydraulic engineering – construction of tanks and dams as well as distribution of water. To mention some of them are – construction of lake in Bhopal by King Bhoj of Parmar dynasty in 11<sup>th</sup> century, Chandela tanks in Tikamgarh district, water harvesting structures and supply system in Islamnagar (earlier called Jagdishpura, which later became the first capital of Nawabs of Bhopal), and so on. **Waterworks of Burhanpur town** is a marvel of Moghul engineering, conceived in 1615 A.D., it works on zero cost basis. Eight systems of waterworks were constructed, of which some are still functioning and supplying water to the city. Based on gravity, the system has *bhandaras* or underground storage tanks which collect groundwater from the underground springs flowing down from the Satpura hills towards Tapti. Its capacity has now reduced and it is facing problem of pollution.

The study included a short survey of indigenous and traditional methods of conservation and supply of water for agricultural and drinking purposes. Although many examples of local wisdom, community efforts and old techniques in the development of water bodies with minimum cost are available as references in various documents and published works, most interesting among them were selected to suit the time frame of the study. One among them is the **PAT system of irrigation** adopted by the tribal of Jabua, and Barwani districts of western M.P. Here Bhil tribal take advantage of the peculiarities of the terrain to divert water from swift flowing hill streams into irrigation channels. It looks like against the law of gravity but it is a reality and being practiced by Bhils since more than last four decades. The principle is simple. A stream is embanked at a place to provide a static head of 30 to 60 cm, sufficient to divert water into channels the gradient of which is less than that of streambed. In effect water from hilly streams (nallas) flows into which irrigate fields at higher altitudes than the stream-bed. Bhils select spots from their experience. **O.P. Mishra**, executive engineer, Water Resources Department, Govt. of M.P., who was then on deputation at Kukshi (Dhar), told the story of a *Pat* near Aththa village in Jabua district. It is at a place where stream Kari meets Narmada river. This place provides a different look with green cropped area and forests compared to places at distance with barren land and denuded hillocks. The Bhils in this area join together to repair bunds and pats after monsoons. One member from each family comes to work here. **K.P. Pachouri**, Consultant, World Bank Horticulture Development Project,

Barwani, has seen Pat irrigation very minutely in Barwani district. He tells, "In Paati development block of Barwani district., BandhavRelchand and BahadiaBidla of Anwali village and Bhulsingh and MehlaJamsingh of Sanwariapaani village, have constructed *Pats* to irrigate their fields. Except for labour, no cost is involved in them. The marvelous observation and skill of these tribal people competes with that of formally educated engineers of the modern days." The area under *Pat* irrigation is increasing and the story is encouraging.

Away from the hilly terrain of Jabua district, lie the plains of Jabalpur and Narsinghpur districts in Mahakoshal region of Central zone. It is in the upper part of Narmada Valley. A cultivation system based on water harvesting and run-off farming has been in practice here since long. It is called **Haveli system**. It is a traditional method of water harvesting, the cost of which is too less. The area is not suitable for Kharif crops like paddy or cotton. But it is good for Rabi crops like wheat, gram etc. as heavy black clay soil holds large amount of water. "Because of the climate, even with high rainfall, cropping in Kharif has been difficult in this area. So, farmers developed a system to get at least one assured crop that fulfilled their minimum needs for livelihood", **Ram Murti Tiwari**, a prominent farmer in **village Sethan**, near Gadarwara (Narsinghpur) told and added that rainwater is stored in fields which have *bunds or bundhaan* i.e. embankments, approx. one meter high; on four sides. When sowing time for Kharif crops arrives, water is allowed, gradually, to flow out from the fields by making a cut, first a narrow one, and then deeper in the *bundhaan*. This cut is called *mongha*. There is always an understanding amongst farmers as when to release water which flows from one field to another and then to another till it reaches a nallah, river or lake. Sowing takes place, no sooner the land is dry. Thereafter, no irrigation is required. But this system is now "dying" for three reasons:-(1) Change in cropping pattern:-Farmers are sowing soybean in Kharif, and don't allow fields to be filled with water.(2) Sprinkler irrigation is increasing (3) Tube wells are coming up in large numbers. A visit to area and interaction with farmers revealed its good and bad effects which need further study.

**3. Innovative and sustainable farm practices:**--Sustainable agricultural development is important to preserve the agricultural base of soil, water, and atmosphere and thereby enable future generations to retain the capacity to feed themselves with sufficient, safe, and wholesome food. Age old experiences and informal experimentation by farmers has resulted in adoption of many practices which are commonly known as indigenous knowledge or indigenous technological knowledge. Many of modern technologies of agriculture and natural resource management are not suitable for small holdings in India. Therefore a number of researchers have started examining innovations for improving natural resource management. **Arun Dike** is such a farmer. Although he studied modern agricultural sciences, he has adopted "natural farming". He experimented in his small field in Village Rau near Indore in M.P., and the results are encouraging. He is inspired by Shripad Achyut Dabholkar, agriculture scientist of Kolhapur and zero tillage method of Masanobu Fukuoka of Japan. He chose an old local variety "Munda Pissi" of wheat for sowing in his field of one acre. The variety has become almost extinct in this area because of two main reasons. First, it is prone to rust disease and second, adoption of Mexican variety by farmers on a large scale. Dike adopted organic method of farming for taking a crop of this variety of wheat. Instead depending on chemical fertilisers and a number of irrigation, he used wormy compost and just limited watering of the field. He had sown by dibbling of pellets keeping plant to plant distance one ft by one ft. and row to row distance one ft. Seed rate in wheat is usually 40 Kg / acre but Arun Dike used only one Kg /acre. He had sown half a Kg seed in half an acre and reaped a crop of 5.5 quintals." Method for preparing seed-pellets with soil, cow dung and cow urine is very easy and

farmers' families can do it in their leisure. Moreover, it is a saving of 38 kg of seed per hectare and irrigation", says Dike reaffirming that the experiment can be a boon to small farmers. There are some other farmers –like Ravi Thakur of Morodhaat village and Anandsingh Thakur of Umaria village (near Indore) who have now adopted organic farming with sole aim of saving water and costly inputs. They have been taking good crops and thus benefitting themselves.

Technologies in rain fed areas to harness the soil moisture by matching its availability with crop maturity are very crucial. Due to the fear of water logging and loosing Rabi crop, approx. two million hectare agricultural land in Madhya Pradesh is kept fallow. In *Vidisha district* in central Madhya Pradesh, ICRISAT- led consortium demonstrated that using broad bed furrow (BBF), short duration cultivars like *Samrat* along with balanced nutrient management and minimum tillage for chickpea/wheat crops could double farmers' incomes and minimize land degradation. .

**4. Enhanced rainwater use–efficiency:** ---Enhanced rainwater use efficiency could increase crop per drop and the income of farmers. Hyderabad based International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)-led consortium had observed that vast rain fed areas(80-100% farmers' fields) from Rajasthan to Madhya Pradesh to Tamil Nadu are critically deficient in micro and secondary nutrients such as zinc, boron and sulphur along with nitrogen and phosphorous. Dr.S.P.Wani, Scientist, ICRISAT revealed that amendments with deficient micronutrients showed 30 to 70% increase in crop yields (maize, soybean, sorghum, gram, chickpea, pigeonpea, wheat, mustard, pearl millet etc). Balanced fertilizer application (N, P, K and deficient micronutrient) doubled the crop productivity. Mandsaur (M.P.) based private company "Micro Chemicals" has been pioneer in production of micronutrients for agriculture in India. Through its research and extensive farmers' education programmes undertaken during last more than three decades, it has emphasized the need for improving soil health. Many of its products have been very popular among farmers and they were benefitted with increased yield. But in many other parts, scenario is quite different. Farmers are seen indiscriminately using high analysis fertilizers which while requiring more water for crops, increase deficiency of micronutrients in soil and degrade it. **Narendra Sipani, Chairman and Managing Director, Micro-Chemicals, Mandsaur**, says, "Looking to the increasing water scarcity conditions micronutrient management and awareness campaigns are more relevant now compared to thirty years ago. Future crop management cannot be done without nutrition management in the soil"

**5. Development of varieties:** ---Apart from micro nutrient management, use of improved or location specific crop varieties is an important component of water saving technologies. It is a fact that having enough water alone cannot bring fortunes to farmers. ICRISAT study revealed that improved cultivars can enhance crop productivity from 10 to 50%. Use of short duration varieties ensure soil moisture use and crop yield. In central zone, research scientists have done untiring work to evolve such variety of seeds of different crops which can even withstand water stress conditions and could give sufficient yield. **Dr.H.N.Pande**, formerly Chief Scientist I.A.R.I., made a laudable contribution in wheat research for M.P. region. During his tenure as presiding scientist, Regional Wheat Research Center, Indore, he evolved and succeeded in getting released more than 20 varieties suitable for climatic conditions here. He gave particular attention toward the fact that water sources in central India dry up very soon after monsoon. He evolved HW-2004 (Amar), HI-1500 (Amrita), and HI-1531 (Harshita) which can grow in just one irrigation. "Amar" gives a yield of 30- 35 quintals per hectare while "Harshita" gives 40-45 quintals per hectare. These varieties are in "Chandausi" group which is M.P.wheat. Another series of

varieties HB-4672 (Malavratna), HI-8627 (Malavkeerti) and HI-8638 (Malavkraanti) are in the Malwi group which have good nutritional value. "Malavratna" and "Malavkeerti" are dwarf varieties, suitable in rainfed conditions. "All these varieties are resistant to rust disease. They will not allow rust disease to spread in epidemic form." Dr. Pande told and added, "Durum has been brought back in these varieties, which means it has an element of a basic science research. With these varieties, a great genetic diversity has been created in wheat. The farmers in the region have now multiple choices."

Jawaharlal Nehru Agriculture University, Jabalpur and recently established Vijayaraje Scindia Agriculture University Gwalior along with their research centers situated at different places in M.P. have also contributed in evolving varieties requiring less irrigation. So has been done by Indira Gandhi Agriculture University, Raipur and its research centers in Chhattisgarh. *Jaldubi* developed by selection method of genetic material of rice in Sarguja district is a worth mentioning achievement of IGAU Raipur. This variety has been found very appropriate for *Bahra* conditions in Sarguja, Jashpur, Korra Dantewada and Bastard districts. Its average yield capacity is 36 quintals / hect. Growing up to a height of 140—150 cms, it matures in 135 to 140 days.

Private entrepreneurs in agricultural research have also made significant contribution in central zone. **Sipani Krishi Anusandhan Farm (SKF), Mandsaur**, is foremost among them. *Arhar* (Pigeon pea) is an important crop of central India. As for varietal development for increasing its area and production, major problem is non availability of its short duration and high yielding genotypes, which may be suitable for double cropping. Only the non-determinate types are available, which lead to number of problems including disease and pest menace. Scientists at SKF took note of these problems and developed Shivna, Changli, Shipra, Godavari and SKF-205. **Narendra Sipani**, chairman and managing director of the company says, "These are dwarf, short duration, suitable for double cropping, compact varieties. They are determinate type, fertilizer responsive with podborer tolerance. They accommodate more plants per unit area and yield potential is two tons per hectare and above. With all these qualities, they provide good returns to farmers intending to take good crop for every drop of water available. These varieties are sown at the onset of monsoon and harvested just before the end of it. While no irrigation is required for these crops, they fix nitrogen and provide organic material in the soil making it healthy for the next crop." Usually, the average yield in *arhar* in M.P. has been 900 kg/ hect. But as claimed by Mr. Sipani, the SKF varieties have been giving 100% more yield i. e. upto 1800 kg/ hect. They have become popular among farmers in 10 to 12 districts of Mandsaur, Ujjain and Bhopal divisions of M.P.

**6. Rainwater harvesting and groundwater recharge: ---**The central zone is having diversified geological, climatological and topographic set up. Groundwater conditions in different parts are also diversified. Eighty percent of the area is covered by hard rock. The rock formation, which control occurrences and movement of ground water, ranges age-wise from Achaean to Recent. The availability and utilisation of ground water in this zone is not uniform. In certain parts, especially in Malwa Nimar region, over exploitation of groundwater resources resulted into the lowering of water table. In many villages of Malwa region, pre monsoon ground water level declined by more than 5.00 mtrs during last ten years. However campaigns for rainwater harvesting, particularly *in-situ* conservation, and artificial recharge efforts have given good results and there are number of success stories. Changing scenario of Jhabua district in western M.P. is the best example. During 1966-68, Jhabua witnessed famine. There was severe drought in Jhabua in 1985 when only 308 mm rainfall was recorded there, which was lowest since 1911. It was chronically drought-prone in the 1980s. The area

was a moonscape then, with barren hills and vast tracts of unproductive land. But watershed development programmes in mission have regenerated Jhabua, and neighboring Dhar district vast part of which had also same problems. Hills are getting back their lost cover and availability of grass, water and food has increased. With the help of watershed-based soil and water conservation measures, the soil has improved, leading to increased fertility. There are a number of examples of individual farmers who are benefitted. In the western part of central zone i.e. in Chhattisgarh also, watershed management projects showed signs of bringing prosperity to farmers. In village Jobaof Gariaband development block in Raipur district, farmers could take only single crop of paddy. Second crop was very less. Moreover there was a problem of floods in streams, breaking away the bunds of the fields and taking away the fertile soil in another stream in the area. A watershed development programme, aided by Govt. of India, started there in 2002 -2003. Under this programme, 24 boulder check dams were constructed to stop floods. The water was diverted in percolation tank. Ten other tanks were also constructed. Two of them retain water for the whole year. These are suitable for fisheries. Ground water level in the wells in the village has risen. Farmer in this village are now harvesting good Kharif crops and also taking Rabi crops. They are also growing vegetables and selling them in Gariaband. Per capita income of villagers has thus increased.

**7. Water pollution:** ----Pollution of surface and ground water is now a cause of serious concerns such cases are increasing. It poses a serious threat to human and livestock health. Most of water bodies, especially those in urban areas, are facing serious threats due to pressure of population. According to an estimate, about 90% of the sewage is discharged, almost without any treatment, into natural drainage or water bodies. A number of rivers are polluted as they receive industrial effluents. Tapi river is polluted by paper mills in Napa Nagar (Distt. Burhanpur) Up to 40 kms of its downstream is unfit for use. River Chambal has been polluted because of effluents from the industries situated at Ghatabillo industrial complex in Dhar distt. and chemical and fiber manufacturing industries in Ujjain distt. Nearly the entire length of river Khan is polluted with domestic and industrial effluents from Indore city, just 16 kms from its source. It meets river Kshipra near Ujjain city which is a great pilgrimage city of Hindus as Mahakaleshwar temple is situated here and Mahakumbhmela (great fair) is organized here every 12<sup>th</sup> year. The total length of river Khan is approx. 70 kms. In monsoons, the polluted waters of the river cause problems of algae bloom at its confluence with river Kshipra. From November onwards, the river only flows a distance of 35 kms. River Kshipra considered one of the holiest rivers in the country, besides being polluted by the sewage brought through river Khan from Indore, further receives combination of untreated / partially treated sewage, solid waste and industrial effluents making it eutrophic. Downstream of Mahakaleshwar temple, pollution load makes it unfit for drinking purposes. Then there is river Betwa, which receives industrial effluents from industrial growth centers in Mandideep (Raisen district) and Vidisha and causes severe pollution to the water system. In Chhattisgarh, the Iron Ore Project at Beladilla in Dantewada distt. has been responsible during last decades for polluting Sampini and Daakinirivers, subsidiaries of Indravati river.

Apart from rivers, there are number of natural lakes, manmade reservoirs, tanks and other surface water bodies receiving municipal waste and other effluents. Upper lake in Bhopal, located on river Kolar and having an area of about 31 sq.kms is one among them. It is the main source of drinking water for the city of Bhopal. The very high value of Chemical Oxygen Demand (COD) and Bio-chemical Oxygen Demand (BOD) indicates alarming level of pollution in lake water.

Although central and state Pollution Control Boards and other regulatory bodies have been exerting pressure on individual industries, semi-government and government bodies to establish effluent and wastewater systems to keep rivers clean and free from health hazard contents, the progress in both the states of M.P. and Chhatisgarh is rather slow.

**9. Raising awareness:** --The second World Water Forum, The Hague, The Netherlands, 2000, while highlighting "Business as usual is not an option" and that "Making water everybody's business" is necessary, pledged water security in the 21<sup>st</sup> century. To achieve, this "Vision to Action Report" prepared and presented by Global Water Partnership, Stockholm emphasized the need for raising awareness among all stakeholders. It is also acknowledged as an important aspect of Integrated Water Resources Management (IWRM) strategy. Hence, the role of media to inform and educate people in all water related issues has been considered vital.

The 59<sup>th</sup> round of National Sample Survey (NSS) showed the effect of improved communication facilities and better connectivity on people's approach to modern techniques, which has registered an increase. Farmers are getting correct information on time and hence more people are able to use new technologies. In M.P., television is the source of getting such for 6.6 percent families, radio for 8.4 percent families, news papers for 3.4 percent families and extension employees for 9.00 percent families. Although this is less than all India average figures, it is a fact that communication facilities, especially mass communication facilities, has opened new avenues for farm families to receive information on modern agri-techniques which comprise water saving technologies, as well. Sixty six percent of the total families taking information on agriculture through television told that the quality of such information has been "good". Sixty two percent of families receiving such information from radio told that the quality of information has been "moderate". Very clearly, modern sources of information and communication have become medium for getting qualitative information on modern techniques of agriculture. Better quality information leads to better options and better decisions. The availability of information has now become one of the indices of human development.

Since last decade, media has taken proactive role in mobilizing people for conservation/ harvesting of water. Media organizations have been seen engaged, through N.G.Os promoted by themselves or others, in raising awareness by organizing seminars, meetings etc to highlight need for conservation as well as organizing demonstrations of water harvesting techniques or making suitable models for the purpose. "NaiDunia" Hindi daily Indore did a pioneering work in this regard. It was the first media organization in the country, which supported field activities to make people aware of rainwater harvesting in rural areas and roof top rain harvesting in cities. A campaign was started in Malwa Nimar area in the year 2001-2002 making the funds available from "NaiDunia JanSeva Trust" which it had established in early 1990s as part of its social responsibilities. Initially, twelve voluntary organizations, six each in rural and urban areas, were provided funds and other facilities. The response was good. Indore Municipal Corporation also joined the campaign. An exhibition was arranged at Rajwada, the palace of Holkar kings, where models of different water harvesting methods were shown. "NaiDunia" printed and distributed nice monsoon greeting cards and stickers highlighting save water messages and techniques of conservation. While campaign is now continuing in other forms, other newspaper organizations have also started their campaigns to mobilize people to save water.

**10. Conclusions: ---** Many thought-provoking view-points emerged from the study, which are summarized as below:--

- (a)** The central zone has many age old water sector engineering marvels, working on low cost and zero energy principles. They need to be preserved and studied further so as to expand our knowledge base with a view to set or amend guidelines of modern societies.
  - (b)** Local wisdom, indigenous and traditional methods of water harvesting should be revitalized in order to promote low cost water management. Though a lot of technological advance has come up in recent years, application of traditional wisdom in water management should not be overlooked. Local systems like Pat and Haveli can be further studied with an aim to reveal the possibilities of replicating them elsewhere and to provide efficient background for the use of advanced technology in water management.
  - (c)** To save water and reduce cost in agriculture, recognition must be given to innovative and sustainable farm practices, even if they are in experimental stage. Farmers should be encouraged to use inputs which require less irrigation in a crop season. Organic farming has answers to many problems arising nowadays in chemical farming. Farmers showing ways to improve agriculture with low cost inputs with water saving technologies should be rewarded by village panchayats and other govt. bodies. Comprehensive documentation of achievements of such farmers should be available in panchayats and district head quarters.
  - (d)** To enhance rainwater efficiency, maintaining soil health should be accorded a priority. Wherever required use of micro-nutrients should be encouraged. Soil testing must be done before recommending use of micro-nutrients which should also balance application of fertilizers (N, P, K). Emphasis should be given on research and use of improved or location specific crop varieties which is an important component of water saving technologies. Public Private Participation and extension agencies play a vital role in developing and popularizing such varieties.
  - (e)** Over-exploitation of groundwater causing depletion of water table is of serious concern in central zone. To check it, rainwater harvesting, particularly *in-situ* conservation, and artificial recharge measures, with community participation, must be taken upon a large scale.
  - (f)** Pollution of surface and ground water is also a cause of serious concern. Most of the rivers, lakes and tanks as well as groundwater in central zone face the threat of pollution and deterioration of water quality. Further studies are required to find out and check the root causes of pollution in this area.
  - (g)** Raising awareness on water sector issues is necessary. Cooperation of media is important in informing people in rural areas on low cost water technologies. Hence a water-media network in central zone should be established within the framework of Global Water Partnership (GWP).
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