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Watershed Development Plans as an Approach to Rediscover Lost Crops in the Sarguja Division of Chhattisgarh, India †

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Abstract: Over the last three decades, the Government of India (GOI) has used watershed management as a solution to solve issues concerning sustainable agricultural output in rainfed areas. Additionally, since 2003, the GOI has made watershed management a national policy. A lot of thought is given to all of the significant crops that have disappeared from farming systems in the watershed development programs (WDPs) of India's current development plans, which are primarily focused on increasing and sustaining productivity levels. In the Sarguja division of Chhattisgarh, the present study attempted to document the on-site and off-site effects of these watershed development programs, as it observed an increase in the ground water level, a rise in the surface water and stream flow levels, a reduction in runoff as well as in soil erosion, increased agricultural and dairy production, improved livelihood and employment generation, and changes in the land use and farming patterns. These findings showed that the percentage of cropland increased in both Kharif and Rabi, because they started planting crops in Zaid, particularly cucumber, melon, and vegetables, that had been kept fallow. The patterns of land usage in the WDP regions have improved over time; due to farmers utilizing more wasteland for productive reasons, there has been a rise in the net sown area of these locations. Additionally, it has been claimed that many crops that were previously abandoned due to water shortages and other requirements are now being cultivated. Responses from the region's population have been in favor of the introduction of innovative techniques like Agroforestry systems.

Keywords: watershed; agroforestry; conservation; runoff; wasteland

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1. Introduction

Over the last few decades, the Government of India has undertaken many initiatives for the development of watershed structures. To further address the sustainable agricultural productivity of the rainfed areas, the Government of India adopted the watershed development policy in 2003 and has been constantly improving it ever since. However, the major problem of this country is its environmental degradation and the lack of water needed for agriculture and domestic purposes. This has led to a decline in the per-capita production of agricultural produce. Many previous research studies have highlighted that the management of water resources and rainwater harvest management and utilization have helped in increasing the production rates of agricultural produce. However, systematic assessments of on-site and off-site impact studies of watershed development are lacking.

Watershed development programs (WDPs) have been accorded high priority in India's development plans and have started to improve and sustain the production potential of the dry and semi-arid regions of this country through the adoption of appropriate production and conservation techniques [1]. The main objective of these watershed management programs is to focus more heavily on water for improving India's agricultural productivity, through moisture conservation techniques, which in turn helps the socio-economic development of the rural people [2]. The general focus of the watershed improvement plans is on enhancing and fostering a variety of land areas. These programs sought to assist in boosting and raising the level of productivity in these chosen land regions through the adoption of appropriate production and conservation measures. The current thorough study on watersheds was conducted with the goals of analyzing the consequences of watershed development initiatives and documenting their off-site and on-site effects. This was undertaken in order to learn more about how watershed management initiatives were carried out and to find ways to accelerate their development and impact.

2. Methodology

The study site, Sarguja, lies to the northern part of the Chhattisgarh state of India. About 58% of the area in this district lies under forests. The borders of the Uttar Pradesh, Jharkhand, Orissa, and Madhya Pradesh states are adjoining to the district. The population of the Sarguja district is 2,359,886 (Table 1). It lies between 23°37′25″ and 24°6′17″ north latitude, and between 81°31′40″ and 84°4′40″ east longitude. It is 244.62 km long, east to west, and 167.37 broad, north to south. This land has an area of about 16,359 km^2. Its major population includes a tribal population; among these primitive tribes are the Pando and Korwa tribes. The study site of the Sarguja district consists of Ambikapur, Sitapur, and Batauli. The climate of Sarguja is hot-humid tropical, with an average annual rainfall of 1100–1250 mm, which gradually decreases from the south–east direction to the north–west direction. About 80 per cent of this annual rainfall is received from south–west monsoons, from June to August. The number of annual rainy days varies from 90 to 100 days. The mean monthly maximum temperature ranges from 28.2 °C in January to 42.5 °C in May, and the mean monthly minimum temperature ranges from 20.4 °C in December to 27.3 °C in May. The mean annual maximum and minimum temperatures of the study area are 35.4 °C and 20.5 °C, respectively. The soil of the Sarguja district can be broadly classified into four major types: red and yellow soils, alluvial soils, laterite soils, and medium blue soils. Red and yellow soils are found particularly in east Sitapur and south Ambikapur. These soils are poor in potash, nitrogen, humus, and carbonate and differ greatly in consistency, colour, depth, and fertility. This is important as the management of water in agriculture and freshwater resources has become a challenging task owing to climate change, which can substantially reduce agricultural yields and deplete existing water resources, as reported by the Intergovernmental Panel on Climate Change [3].

Table 1. Population structure of Sarguja.

Population	Males	Females	Households
2,359,886	1,193,129	1,166,757	383,217

Source: Population District Surguja, Government of Chhattisgarh, India.

The present study was based on extensive and intensive field surveys carried out during 2022. The first-hand information or primary data was recorded during field visits to the study area. Information was collected through questionnaires and personal interviews conducted on the spot. Secondary data was then collected to complement the new information collected from the field work, from Panchayat and the Department of Agriculture, Sarguja, Chhattisgarh.

Field surveys were performed to explore the impact of watershed development programs on-site as well as off-site through a semi-structured questionnaire method. In the interview, a total of 150 informants from all age groups, except children below 18 years, were interviewed to gather related information. The informants were also requested to join the field surveys. In cases of illiterate informants, the questionnaires were filled out according to their responses. Friendly conversation was made with teenagers and youngsters of both genders, to collect information from people of different age groups. Adopting a participatory and group interaction approach, the data were further cross-checked.

3. Results and Discussion

3.1. Demographic Profile

In the study site, the demographic profiles were as follows:

Most of the male informants were from the '36–45 years' age group and most of the females were from the '26–35 years' age group, i.e., 24 percent and 14 percent, respectively. The age group with the smallest numbers of male and female informants was above 55 years' age group i.e., 2 percent and nil, respectively (Figure 1a). The educational levels of the respondents were highest among the male informants, i.e., 24 percent at fifth pass; whereas the female informants had the highest percentage of illiteracy, i.e., 14 percent. The percentage of male and female informants who were postgraduate-level and above was the smallest, at 2 percent and nil, respectively (Figure 1b). The annual income of the respondents fell mostly in the 'less than 50,000' group, i.e., 50 percent, followed by the '100,000–200,000' group, i.e., 30 percent; the 'more than 300,000' annual household income group had the least informants, i.e., 6 percent (Figure 1c).

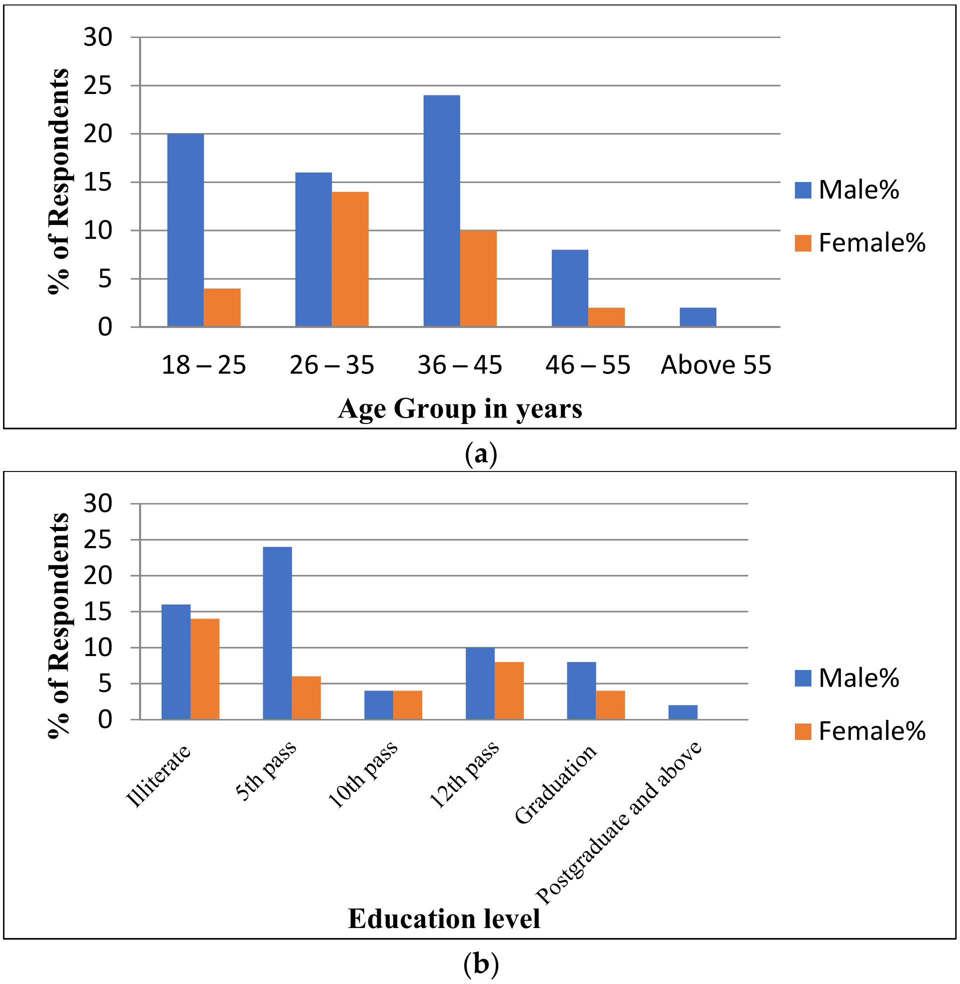
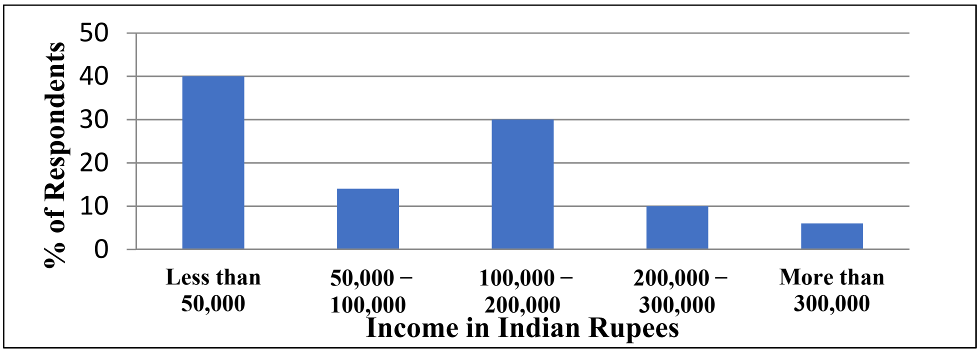


Figure 1. *Cont.*



(**c**)

Figure 1. Demographic profiles of the study site. (**a**): Ages of the respondents; (**b**): educational levels of the respondents; (**c**): income levels of the respondents, in Indian Rupees.

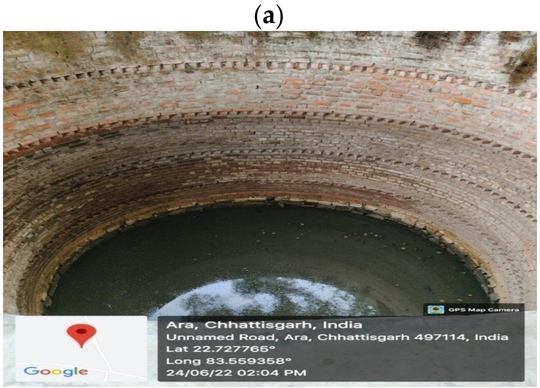
3.2. The main Watershed Development Structures

- **Boulder check dam:**

  The boulder check dam was primarily built to stabilize gully heads and manage channel erosion. Its purpose is to prevent waterfall erosion by stabilizing gully heads and to control channel erosion along the gully bed. The beginning and tiny gullies, as well as the branch gullies, of a continuous gully or gully network, are stabilized using loosestone check dams (Table 2, Figure 2).

(**a**)

(**b**)



(**c**)

(**d**)

Figure 2. Watershed structures in the study site. (**a**) Boulder check dam; (**b**) gabion check dam; (**c**) well; (**d**) stop dam.

Table 2. The financial details of a few watershed structures from the study site.

S.N.	Watershed Structure	Construction Year	No. of Structures	Cost (Rs.)		Total Cost (Lac Rs.)	Source
				Labor	Material		
1	Boulder check dam	2021–2022	05	55,795	3932	0.59728	Tec. Assistant Deogarh
2	Gabion check dam	2015	01	17,565	28,443	0.46000	Tec. Assistant Petla
3	Dabri	2021–2022	01	274,400	24,694	2.99095	Tec. Assistant Guturuma
4	Stop dam	2015	01	213,307	786,468	10.00	S.D.O. R.E.S. Petla
5	Kuaa (well)	2015	01	64,027	152,041	2.16	S.D.O. R.E.S Guturuma
6	Pond deepening	2021–2022	01	423,035	30,943	4.53980	S.D.O R.E.S. Sitapur

- **Gabion check dam:**

  To combat soil loss and reservoir siltation, gabion check dams (GCDs) are among the most widely employed soil and water conservation techniques. GCDs are specifically adaptable, permeable structures erected in gullies to produce a sedimentation bench that lowers the typical upstream slope (Table 2, Figure 2).

- **Dabri/pond:**

  Farm ponds are small pools of water that are created by digging an outcropping, building a short embankment or dam over a watercourse, or both. Typically, water is drawn from a small catchment area and used for irrigation over an extended period of time. More recently, ponds have appeared vital for the provision of new climate spaces as a response to global climate change [4]. The farm ponds are used to collect surplus runoff during rainy seasons, store water for supplemental crop irrigation, provide drinking water for livestock during times of drought, and spray pesticides, all while preserving the soil and its moisture (Table 2).

- **Kuaa (well) and pond deepening:**

  A well for water conservation and pond for water conservation was constructed in the study site wherever required (Table 2, Figure 2).

3.3. On-Site and Off-Site Impact Assessment of the Watershed Development Programs in the Study Area

- The most important details within this text are the on-site and off-site impacts of a successful watershed project. One of the key quantitative indicators of a successful watershed project is an increase in the ground water table in the watershed regions. Land development measures such as contour bunding, land levelling, and agricultural operations have been used to reduce soil erosion. There was a rise in production in Kharif, Rabi, as the cultivation area increased and farmers started harvesting crops in Zaid, which was otherwise fallow (Table 3). In an effort to establish Chhattisgarh as the millet hub of India, the state government announced Mission Millet Chhattisgarh in September 2021, promoting the growth of kodo millet (*Paspalum scrobiculatum*), small millet (*Panicum sumatrense*), and finger millet (*Eleusine coracana*), often known as ragi, in India. The tribes of the study site responded that they once saw these millets as poor people's bread; nevertheless, they now welcome these millets in their farming methods. The largest area under cultivation is used for finger millet (ragi), followed by kodo and small (kutki) millet, respectively. Due to a rise in demand for millets as well as the Watershed Program, which supported farmer efforts, millets (kodo, kutki and ragi) have found a place in the farming systems of the study site.

Table 3. Farming season status in relation to the cultivated area.

Before Watershed Structure			After Watershed Structure		
Kharif	**Rabi**	**Zaid**	**Kharif**	**Rabi**	**Zaid**
Rice (30–50%)	Pulses (20–30%)	Fallow	Rice (60–70%)	Pulses (35–40%)	Cucumbers (25–30%)
Maize (10–12%)	Vegetables (10–12%)	Fallow	Maize (15–20%)	Vegetables (30–35%)	Melons (20–40%)
Vegetables (8–10%)	Wheat (30–35%)	Fallow	Vegetables (25%)	Wheat (40–45%)	Vegetables (35–40%)

The best performing watersheds are those where soil erosion was reduced by more than 50%. The WDPs (watershed development programs) have also helped improve land use pattern and agricultural productivity across different watershed regions, with positive changes in land use due to vegetable cultivation and a decrease in cultivable wastelands due to the WDPs. In high-population areas, land degradation is directly linked with food security, both in terms of upland watersheds and downstream effects [5].

The farming frequency, cash crop, horticulture, and crop area increased due to watershed construction, etc. Milk production increased by 50–100% of the average output. Roughly 90% of the working population depends on agriculture. The unavailability of water for irrigation over most of the area, improper drainage, difficulty in digging wells due to rocky foundations, and undeveloped means of communication and transportation have restricted the extension of the study area's cultivated land. Soil properties may show significant spatial variations [6].

4. Conclusions

With the introduction of watershed structures in the Sarguja division, there have been significant positive impacts on various biophysical aspects, such as soil and water conservation, soil fertility, changes in farming methods, and changes in farming intensity; there has also been a massive positive impact on the water table and increases in the water levels. The planned WSD project included measures for soil and water conservation, improving agricultural productivity, and enhancing the livelihoods of landless and poor households. Apart from this, the creation of Mitra Kissans and the formation of self-help groups (SHGs) ensures people's participation. Support was also provided to landless laborers, women, and marginal farmers by creating employment opportunities for the households in the watershed areas. Livestock developments involving providing animal camps for the care of their animals were among the other important activities undertaken in watershed area. With the available water harvesting structures, farmers are inclined to new farming methods and agricultural diversification. Both agricultural diversification and intensification lead to increases in agricultural productivity in the regions where watershed programs are effective. There was a rise in production in Kharif and Rabi as the cultivation area increased and farmers started harvesting crops in Zaid, which was otherwise fallow. Due to a rise in demand for millets as well as the watershed program, which supported farmer efforts, millets (kodo, kutki and ragi) have found a place in farming systems.

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Conflicts of Interest: The authors declare no conflict of interest.

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