



INITIATIVE ON
Agroecology

Agroecological Insights for Mandla, Madhya Pradesh, India: A contextual analysis for sustainable transformation

Authors

Sudharsan Malaiappan¹, Smitha Krishnan², Pragya Gadewar³, Himani Sharma⁴, Pratiti Priyadarshini⁴, Anoop Thakur⁴, Swapnil Ganvir⁴, Pradyumna Acharya⁴, Gopal Kumar¹, Meghajit Sharma Shijagurumayum², Sonali Singh⁵, Ayan Samaddar⁶, Muzna Alvi⁵, Gulshan Borah¹, Alok Sikka¹

¹ International Water Management Institute (IWMI), New Delhi, India

² Alliance - Bioversity and CIAT, Bengaluru, India

³ Professional Assistance for Development Action (PRADAN), Mandla, India

⁴ Foundation for Ecological Security (FES), Anand, India

⁵ International Food Policy Research Institute (IFPRI), New Delhi, India

⁶ WorldFish, Bhubaneswar, India

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Executive Summary

This report examines the agroecological, environmental, economic and social dimensions of Mandla district in Madhya Pradesh, India. Agroecological dimensions include recycling, input reduction, soil health, animal health, biodiversity, synergy, economic diversification, co-creation of knowledge, social values and diets, fairness, connectivity, land and natural resource governance, and participation. The report also highlights the challenges and opportunities for sustainable agroecological transformation.

Mandla, a tribal dominated district faces challenges such as land degradation, poor soil conditions, poor land productivity, biodiversity loss, and socio-economic disparities. To address these challenges, CGIAR initiative on Agroecology established Agroecological Living Landscapes (ALLs) in Mandla district. The initiative identified key challenges, captured the vision of local communities, assessed existing farming practices, and developed new agroecological practices to address some of the challenges.

Local communities **recycle** resources such as crop residues, animal manure and invasive plant species to prepare compost, farmyard manure and biochar to a limited extent. There is significant increase in synthetic fertilizer use in the last few decades, however some farmers are applying some amount of locally prepared compost, and operating at low input-output conditions, leaving scope of improvement in production with **input reduction**. The district, predominantly characterized by black cotton soil, faces challenges like soil erosion, low organic content and nutrient deficiencies. Conservation practices such as green manuring, mulching, bunding, silt application, bio-fertilizer, compost application and crop rotation are practiced sporadically to maintain **soil health**. Cattle and livestock are integral to farming system. Department of Animal Husbandry and local animal health workers are primarily involved in maintaining **animal health**. Penning, timing open grazing, prohibition of grazing in some areas, and cattle shed flooring are recent introduction for sustainable feeding regimes. The district is rich in natural **biodiversity** with wide range of flora and fauna, however due to increasing chemical fertilizer use and unsustainable farming practices has led biodiversity loss. **Synergy** between various farming system, including crop-livestock, agroforestry, NTFP in the landscape need improvement through targeted interventions. Local communities depend on agriculture, Non-Timber Forest Products (NTFP), and fisheries for livelihood, contributing to **economic diversification**, however dwindling natural resources poses risks to the community livelihood. Farmer to farmer interactions, traditional fairs, informal gatherings, seed festivals, farmers field schools, and formal institutions such as NGO's, government institutions facilitate **co-creation of knowledge**. Local communities prioritize diverse, nutritious and traditional diets but shrinking production poses a serious threat to dietary diversity. Seasonal festivals and community gatherings also play a key role in maintaining **social values and diets**.

Limited access to resources, market information, transportation, price disparities and monopoly markets are some of the value chain challenges faced by local communities. Community practices such as wage fixing, labour pooling and labour exchange help maintain **fairness**. However, **Connectivity** among various food system and value chain actors is weak and need strengthening. **Land and natural resource governance** is managed by district administration, state forest department, and local communities including gram sabhas and panchayat committees, which usually adhere to traditional tribal practices. **Participation** of community organizations such as NGO's, tribal knowledge networks, state agricultural department, Krishi Vigyan Kendra, department of rural development, Farmers producers' organization, self-help groups, and Joint Forest Management Committee is crucial for agroecological transition.

The assessment reveals that while agroecological practices are being practiced in Mandla, they are fragmented and implemented at smaller scale but shows potential for scaling up. National and state policies, including Mahatma Gandhi National Rural Employment Guarantee Act, National Rural Livelihood Mission, Paramparagat Krishi Vikas Yojana, Pradhan Mantri Krishi Sinchayee Yojana, and local NGO's can play a pivotal role in agroecological transition. Large scale adoption of agroecology can be achieved by establishing multistakeholder platform, farmers networks and knowledge sharing platforms, access to markets and value chains, capacity building programs, infrastructure and policy support, nature-based solutions, financial mechanisms and incentives, participatory research and trial establishment, inclusive governance structures.

Abbreviations

ALL	Agroecological Living Landscapes
CLF	Cluster Level Federation
cm	centimetres
DI	Diversity Index
d/ha	number per hectare (density unit)
F	Frequency
FPO	Farmers Producer Organization
FYM	Farm Yard Manure
ha	hectare
IMD	Indian Meteorological Department
IUCN	The International Union for Conservation of Nature
Km	Kilo meter
KVK	Krishi Vigyan Kendra
LULC	Land Use Land Cover
mbgl	meters below ground level
m	meter
MGNREGA	Mahatma Gandhi National Rural Employment Guarantee Act
mm	milli meters
MT	Metric Ton
NGO	Non-Governmental Organizations
NTFP	Non Timber Forest Produce
NRLM	National Rural Livelihood Mission
PCS	Primary Cooperative Societies
PRA	Participatory Rural Appraisal
SHGs	Self Help Groups
VO	Village Organizations

Introduction

Globally Food, Land, and Water Systems are being degraded rapidly, especially in a country like India, where agriculture is heavily dependent on natural resources. Agriculture plays a significant role in India's \$3.55 trillion economy (World Bank, 2023), employing 43% of the available labour force (World bank, 2024). The share of agriculture and allied sectors in total gross value added (GVA) in is 18.3% during 2022-23 (MoAFW, 2023). It is critical to manage the available resources for achieving livelihood, water, food and nutritional security. Agroecology has gained momentum in recent years in India. Central, as well as several state governments, are promoting agroecological principles based farming including natural farming (natural farming comes under the broad umbrella of Agroecology) in its various form (Malaiappan, et al., 2022).

Madhya Pradesh – located in central India is the second largest state with an area of 0.308 million Km², which occupies 9.38% of India's land area. In 2024, Madhya Pradesh is projected to be 5th most populated state in India with a population of 88 million, which accounts for 6.3% of India's population (MoH&FW, 2020). The state is primarily agrarian and pastoral, which contributes to 45% of the states \$162 billion Gross Domestic Product (GDP). The state contributes a sizeable proportion of the country's minerals including Coal, Copper, Molybdenum, Diamond, Manganese, Phosphorite, Bauxite among others (Ministry of Mines, 2024). Major crops grown in the state are wheat, soyabean and sorghum (Jowar). Paddy, coarse millets, pulses, cereals, groundnuts and cash crops such as cotton, sugarcane and oil seeds are also grown in different parts of the state (GoMP, 2024). The state is also classified into seven physiographic regions - Malwa Plateau, Plateau of Central India, Bundelkhand Plateau, Rewa and Panna Plateau, Narmada-sone valley, Satpura and Maikal Plateau, and Eastern Plateau. The state has six major river basins (Ganga basin, Narmada basin, Godavari River basin, Tapi basin, Mahi basin, Mahanadi basin) (DoLR, 2023). Madhya Pradesh generally experiences a subtropical climate with hot summers (25-45°C), moderate monsoons (750-1,200 mm annual rainfall), and cool winters (10-25°C). Administratively, Madhya Pradesh is divided into 55 districts with 54,903 villages.

CGIAR initiative on Agroecology aimed to develop and scale agroecological practices and innovations with small-scale farmers and other agricultural and food system actors by establishing Agroecological Living Landscapes (ALLs) in Mandla district in Madhya Pradesh, India (Figure 1). These ALLs are multi-stakeholder, territorial spaces where agroecological innovations are co-designed, tested, and implemented by a diverse range of actors, including small-scale farmers, local communities, researchers, NGOs, and government bodies. Mandla is a tribal district located in the east-central part of Madhya Pradesh with numerous rivers and rich forests. Majority of the district falls within Narmada - Sonne rift valley and the catchment area of Narmada River and its tributaries. Within Mandla, agroecological interventions, including co-designed experimentation, were primarily concentrated in the Narayanganj block (Figure 1). Meanwhile, insights from impact studies of past landscape-level activities in other blocks were leveraged to develop scalable agroecological models applicable to Mandla and other districts.

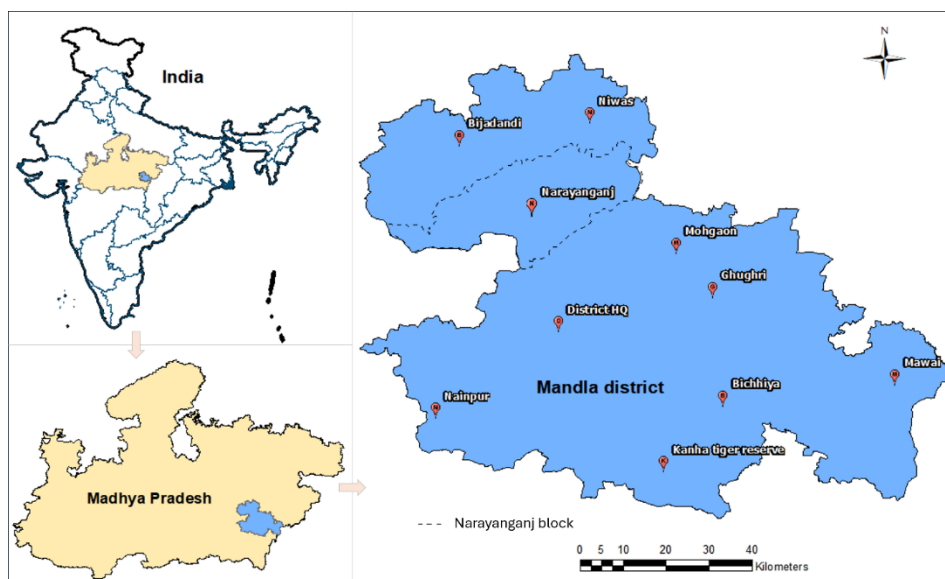


Figure 1 : ALL establishment in Mandla district (Created by Authors)

Mandla lies between latitudes 22°13' and 23°11' North and longitudes 79°57' and 81°12' East, at an altitude ranging from 443 to 1,100 meters above sea level. As per census 2011, Mandla comprises 6 tehsils⁷, 9 blocks⁸ (Table 1), 490 gram panchayats⁹ and 1,221 habitable villages having population of 1.05 million. The literacy rate of the district is 68.3%. Male literacy is 79.5% and female literacy is 59.2%. The climate of the district can be classified as continental with high temperatures in summer and very low temperatures during winter. The primary occupation is agriculture and allied activities, and major crops grown in Mandla are paddy, wheat, maize, millets and oil seeds including niger and linseed, (Rao, 2012).

Table 1: Tehsils and blocks of Mandla district

Sr. No.	Tehsil names	Sr. No.	Block names
1	Bichhiya	1	Bichhiya
2	Ghughri	2	Bijadandi
3	Mandla	3	Ghughri
4	Nainpur	4	Mandla
5	Narayanganj	5	Mawai
6	Niwas	6	Mohgaon
		7	Nainpur
		8	Narayanganj
		9	Niwas

⁷ **Tehsil:** A subdivision within a district, managing local administration and revenue.

⁸ **Block:** A block-level governing body coordinating multiple Gram Panchayats.

⁹ **Gram Panchayat:** A village-level local government body overseeing rural governance.

Section I:

Environmental, economic, social
and political context of Mandla



1. Environmental Context

Climate / Climatic Zone

Agroecological region of Manda is classified as "Central Highlands (Malwa and Bundelkhand), Hot Subhumid (Dry) Eco-Sub region", and the agroclimatic zone is classied as "Eastern plateau and Hills region (VII)" (ICAR, 2017).

Analysis of rainfall data from 1980 to 2017 revealed that average annual rainfall of Mandla ALL (Narayanganj block) is 1298 mm (Figure 2), and majority of the rainfall (89%) is received during south-west monsoon season (June to September) (Figure 3). Analysis of rainfall data from 1980 to 2017 indicates a declining trend in rainfall with increased variability since the beginning of 21st century. From 2000 to 2017, the district recorded below average rainfall for 11 years, with extreme dry spells happening in 2007, 2009 and 2017 (Figure 2)

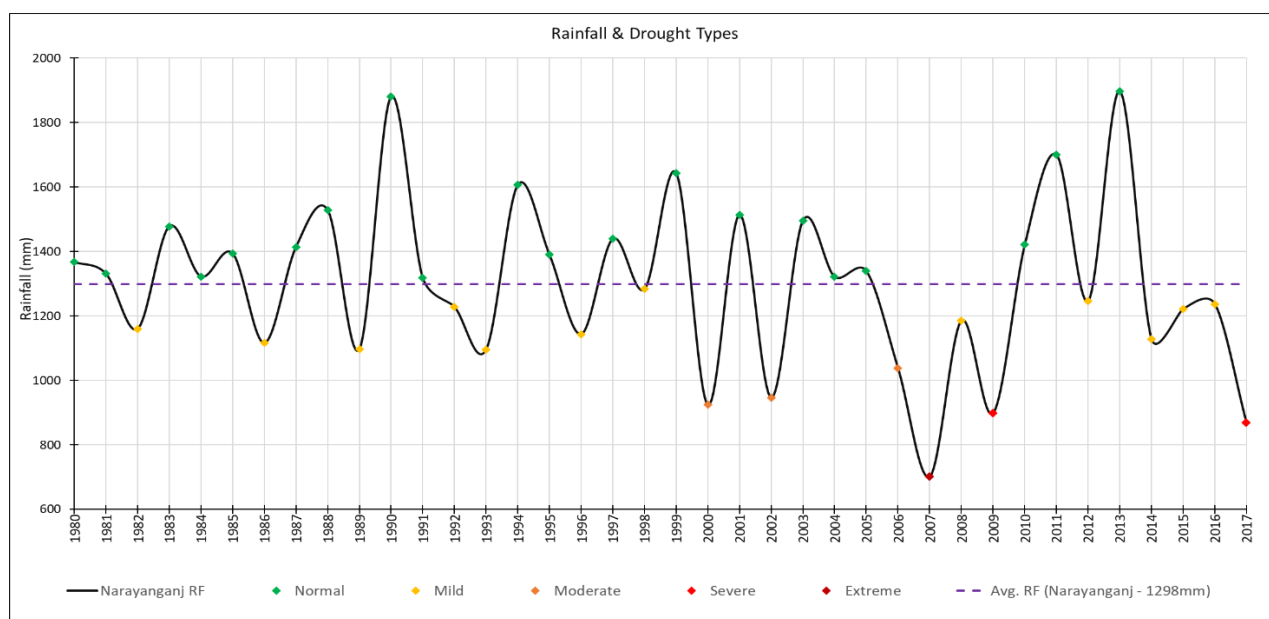


Figure 2 Annual rainfall trend of Narayanganj block from 1980 to 2017 (Source: Authors analysis using IMD data)

The reduction in the rainfall was apparent during the pre-monsoon and post-monsoon periods. July and August are the wettest months, while the dry months are January to May and October to December.

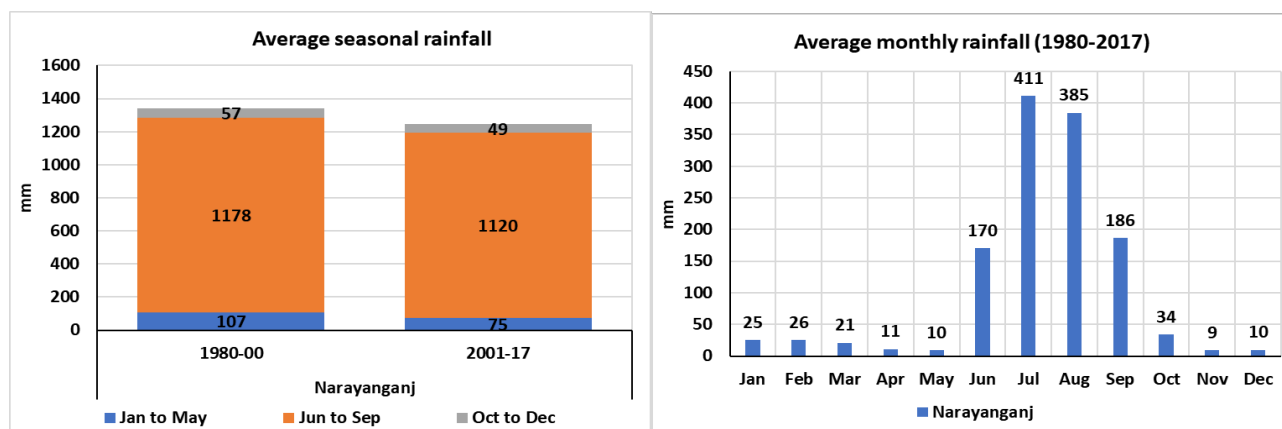


Figure 3 Seasonal and monthly rainfall trend of Narayanganj block (Source: Authors analysis using IMD data)

Figure 4 shows rainfall variability in Mandla district from 2001 to 2024, with higher standard deviation in regions like Niwas and Nainpur blocks indicating high variabilities (220 – 270 mm/year), while Bichhiya block has low variability

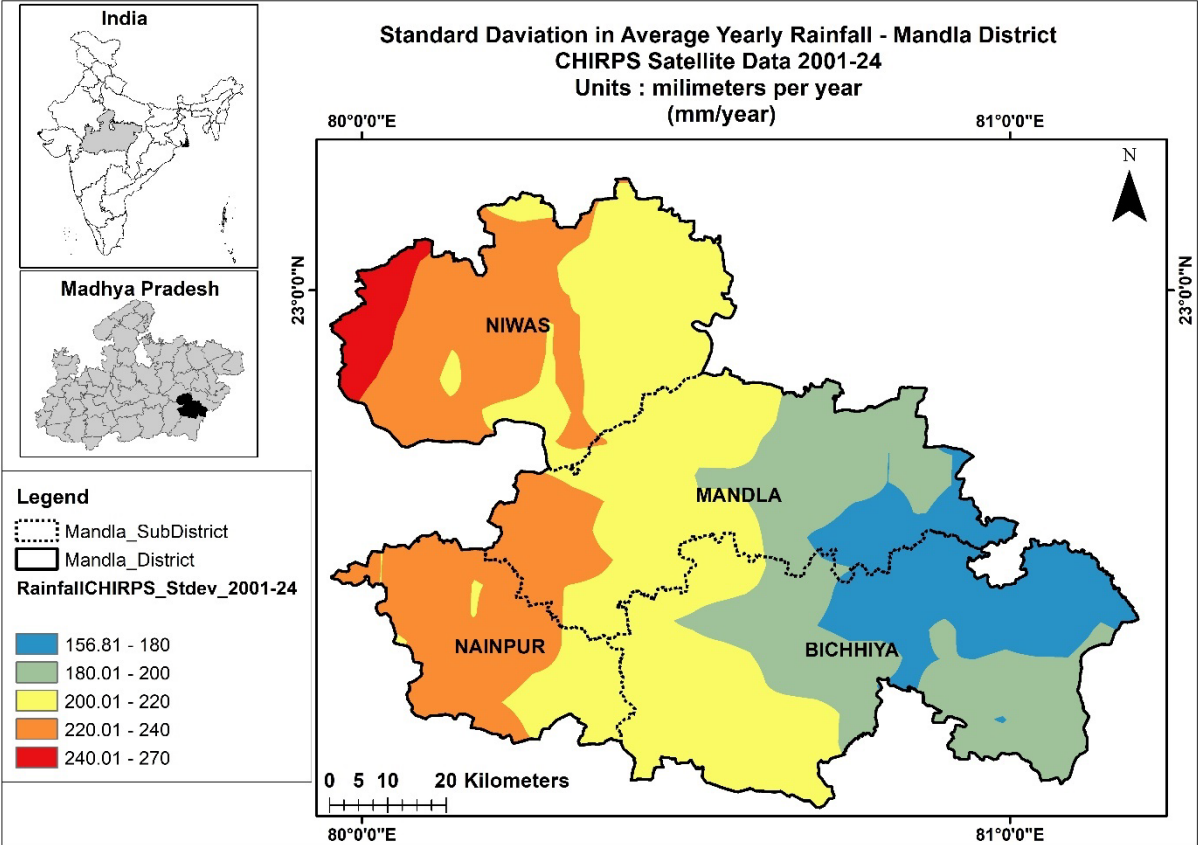


Figure 4 Rainfall standard deviation of Mandla district (Source: Authors analysis using CHIRPS satellite data)

(156.81 - 180 mm/year) with more consistent rainfall patterns. This variability impacts agricultural stability and water management across the district.

The year is categorized into four distinct seasons: cold season from December to February, hot season from March to mid-June, the southwest monsoon season from mid-June to September, and the post-monsoon or retreating monsoon season from October to November. The driest period of the year is the summer season (March to April). May is the hottest month of the year with mean daily maximum temperature of 41.4°C and mean daily minimum temperature of 26.5°C. January is the coolest month with mean daily maximum temperature of 25.6°C and mean daily minimum temperature of 8.4°C (CGWB, 2013).

Major environmental challenges, climate change impacts projected or currently being experienced

Climate change is likely to increase unpredictability in weather patterns, leading to more frequent occurrences of extreme seasonal variations. An analysis based on the Climate Vulnerability Index (CVI) (Sushant, 2013), which considered social, economic, agricultural, water resource, forest, and climatic parameters, indicates Mandla as one of the districts highly prone to the adverse impacts of climate change. The primary factors contributing to the district's vulnerability include drought, rising temperatures, extreme heat events, and decrease in precipitation. Among these, the prolonged scarcity of rainfall stands out as the major concern. The resulting impacts of climatic stress in the region includes crop losses, structural damage to homes, decreased availability of water for both consumption and irrigation, and increased vulnerability regarding household food security. The overarching view is that Mandla faces a complex challenge stemming from climate change, with impacts spanning across various sectors that are critical to the well-being of its residents (Sushant, 2013).

In Mandla ALL, where about 88 % of the cultivated area is rainfed, variability in rainfall and temperature have significant impact on agricultural productivity.

State of natural resources, land/soil, water and biodiversity

Soil

The Mandla district predominantly comprises black cotton soil (vertisols), accounting for approximately three-quarters of its total area. Figure 5 shows the broader classification of soil types in Mandla district (CGWB, 2022).

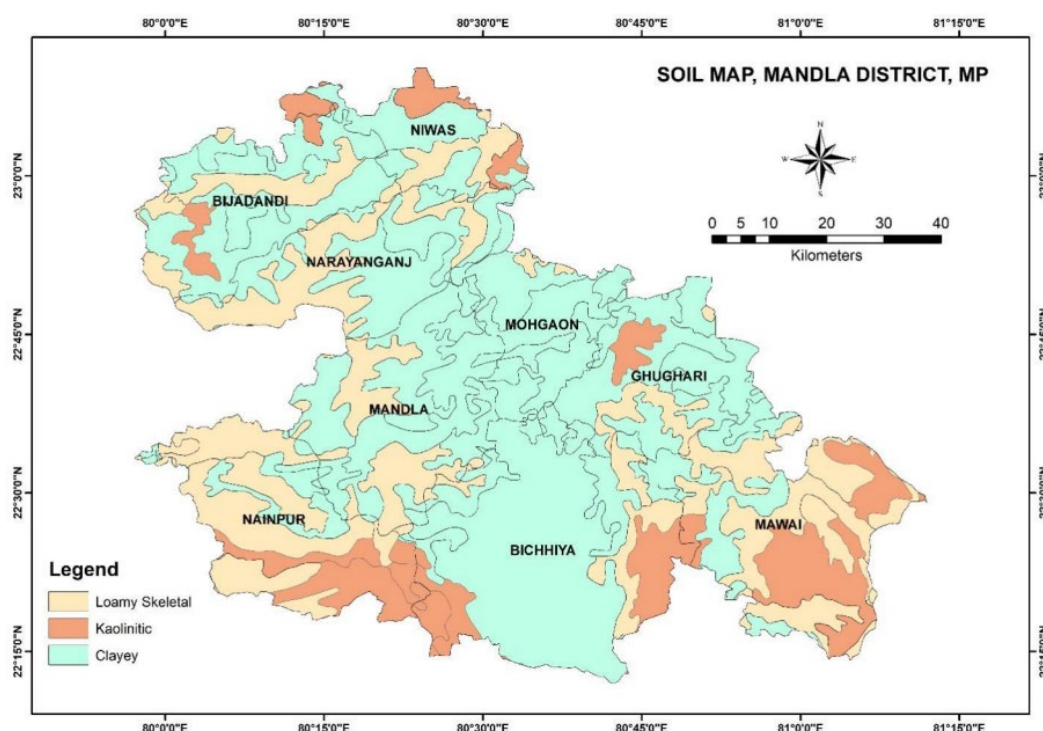


Figure 5: Soil map of Mandla district (CGWB, 2022)

Further classification shows that 70.8% of the area is covered by black soil, 11.8% by red soil (acrisols), 4.7% by sandy loam soil, 3.5% by sandy soil and 9.2 % by other soils (CGWB, 2022).

Land use

Figure 6 shows the Land Use Land Cover (LULC) map with data on land type classification of Mandla district derived from Sentinel-2A imagery.

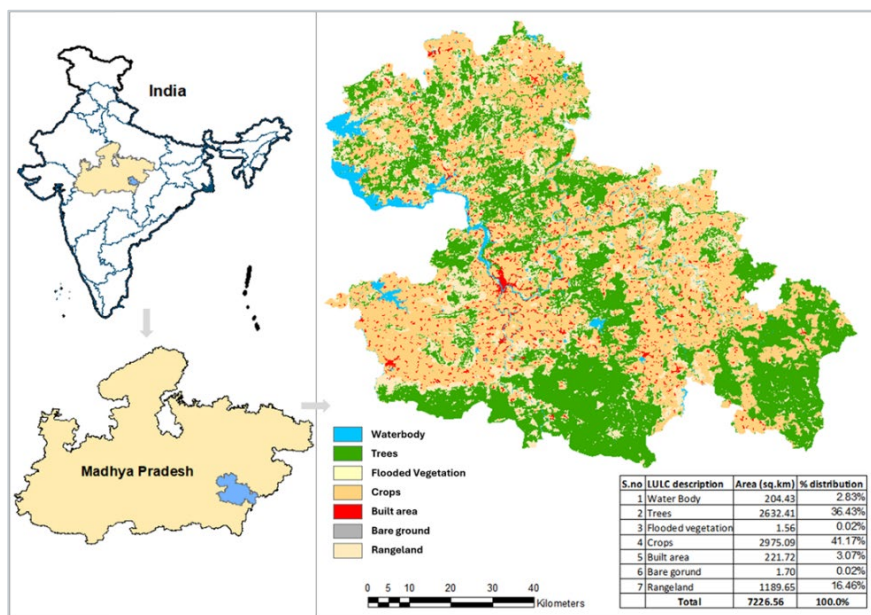


Figure 6 LULC of Mandla district (Created by: Authors using Sentinel-2 imagery)

Water

Major rivers in the Mandla district are Narmada River in the north and the Wainganga River in the southwest. The Narmada River and its tributaries drain the northern and northwestern regions, while the Wainganga River's tributaries cover the southwestern part. The Banjar River, a major Narmada tributary, flows northward through the south-central area. The tributaries of both rivers have intermittent flow patterns, with peak flows during the monsoon season when full soil moisture capacity is reached. Smaller streams are mostly ephemeral, flowing briefly and gaining runoff downstream. Figure 7 shows the overview of water bodies in Mandla district. According to official statistics, the district has 50 reservoirs and 1321 ponds, minor water bodies, and tanks, totaling an effective water area of 2864 hectares, which facilitates the production of aquatic food. Furthermore, the region contains 325 kilometers (km) of the River Narmada that is used for catch fishing, which is Mandla's main source of aquatic food.

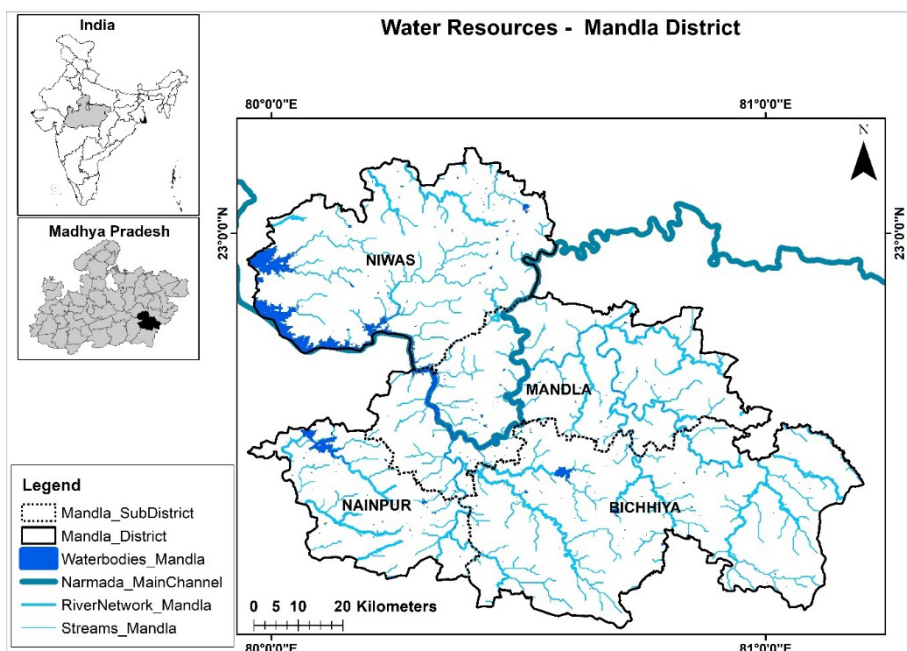


Figure 7 Water Resource map of Mandla district (CGWB, 2022)

Groundwater

Mandla is majorly covered with hard rocks and alluvium. According to Central Groundwater Board, during pre-monsoon data (CGWB, 2022), the water level depth varies from 2.5 to 10.5 meters below ground level (mbgl). The pre-monsoon water table is monitored during the month of May. As per Central Groundwater Board the generic depth of water level during this period ranges from 3-6 mbgl. The north-eastern part of the district observes the water level in between 5-10 mbgl, whereas the north-western and some parts of the centre, shows the shallow water level, which ranges from 0-3 mbgl.

Forests, nature reserves, protected lands

In Mandla, more than 50% of the district's geographical area is covered with trees and rangelands, which are crucial for biodiversity conservation, local ecology, and supporting the livelihoods of indigenous and tribal communities. The forest is divided into two administrative divisions – East Mandla and West Mandla forest division (FES). Mandla is home to the world-renowned Kanha National Park, a prominent wildlife sanctuary and tiger reserve known for its diverse flora and fauna. The park is divided into two zones: a core zone covering 410 km² and a buffer zone spanning 406 km². Mandla's protected areas are part of the Central Indian landscape, contributing significantly to conservation efforts and tourism.

The district predominantly consists of four dominant types of forest (FES): Sal Forest, teak forest, mixed deciduous forest, and bamboo forest. Dominant species of each forest type is listed in Table 2.

Table 2: Forest types and dominant tree species (FES)

Forest types	Dominant species
Sal forest	<i>Shorea robusta</i> , <i>Terminalia tomentosa</i> , <i>Ougeinia dalbergioides</i> , <i>Helicteres isora</i> , <i>Heteropogon contortus</i> , <i>Bauhinia vahlii</i>
Teak forest	<i>Tectona grandis</i> , <i>Terminalia tomentosa</i> , <i>Ougeinia dalbergioides</i> , <i>Woodfordia floribunda</i> , <i>Heteropogon contortus</i> , <i>Bauhinia vahlii</i> .
Mixed deciduous forest (Dry deciduous forest)	<i>Anogeissus latifolia</i> , <i>Sterculia urens</i>
Mixed deciduous forest (Moist deciduous forest)	<i>Syzigium cuminii</i> , <i>Adina cordifolia</i>
Bamboo forest	<i>Bambusa arundinacea</i> , <i>Dendrocalamus strictus</i>

2. Economic Context

Key farming systems

For most of the farmers, the rainfed farming supports food requirement for six months and people depend on sale of forest produce and other jobs such as waged labour, away from the villages for the rest of the year. Sale of forest produce contributes to about 28% of the total income. Forest resources also contribute directly towards food security in the form of tubers, fruits, flowers, mushroom and vegetables. Tribal communities largely depend on the surrounding forest resources for domestic needs such as small timber for house building, fodder, medicines, agriculture tools and fuel wood. Current trends point towards a fast-degrading natural resource base, which impacts wildlife and the dependent community.

In Mandla district, analysis of crop data from 1998 to 2021 (Figure 8) indicated a significant increase in the cultivation area for rice, pulses, and wheat, indicating a shift towards these crops. However, oilseeds have seen a steady decline in Mandla, and other minor crops have maintained a smaller share. The total cultivated area has expanded considerably, reflecting changes in agricultural practices and crop preferences in the region. Rice remains the dominant crop, with its cultivated area steadily increasing from ~90,000 ha/year in 1998-99 to ~180,000 ha/year in 2020-21. Wheat cultivation also shows significant growth after 2009-10, while maize cultivation remains relatively stable. There has been a notable increase in the area under pulses since 2011.

Factors impacting agriculture / food production system

The key factors limiting food production systems in Mandla area:

- Poor resource base - More than 28% of the population in Mandla district is living below the poverty line (Niti Aayog, 2023) and not in position to invest.
- Limited awareness and access to credit institutions
- Land degradation, difficult terrain and poor soil conditions
- Land ownership pattern
- Inadequate infrastructure
- Climate variabilities

Avenues to credits, loans and savings

The district possesses numerous traditional avenues for credit and savings, including regional rural banks, commercial banks, and cooperative banks. However, communities are hesitant to reach credit and saving institutions. According to the SLBC report (Central bank of India, 2024), the banking network comprises of various banks, with 93 branches across the district. These banks play a significant role in facilitating financial inclusion, providing loans, and offering various banking services.

In the last decade, Mandla has experienced substantial growth in the Self-Help Group (SHG) over time, driven by both government and non-government organizations. SHGs are the primary institutions to leverage the credits from the formal banking system and promotes financial inclusion of women, particularly in rural areas, enabling their participation in the banking sector and assisting them with banking activities. Mandla district has 3,323 SHGs with 42,061 members (NRLM, 2024).

In Mandla, SHG-bank linkages are well established and supported by the State Rural Livelihood Mission (SRLM), which addresses both the demand and supply sides to promote financial inclusion in rural areas. The government offers an interest subvention for SHGs that repay their bank loans on time, significantly reducing the interest rates on these loans. SHG loans are typically used for daily needs, special requirements such as health, marriage, or education, and for purchasing inputs. According to RBI guidelines, commercial banks offer loans to SHGs at a 7% interest rate, and SHGs subsequently lend to their members at an annual interest rate of 8-12%.

Farmers also depend on the local lenders to arrange money for their agricultural operations. In this process they either mortgage their ornaments or pay a higher interest rate in comparison to banks on a monthly basis. It is noticed that after the harvest of crops, farmers normally repay the loan with compound interest.

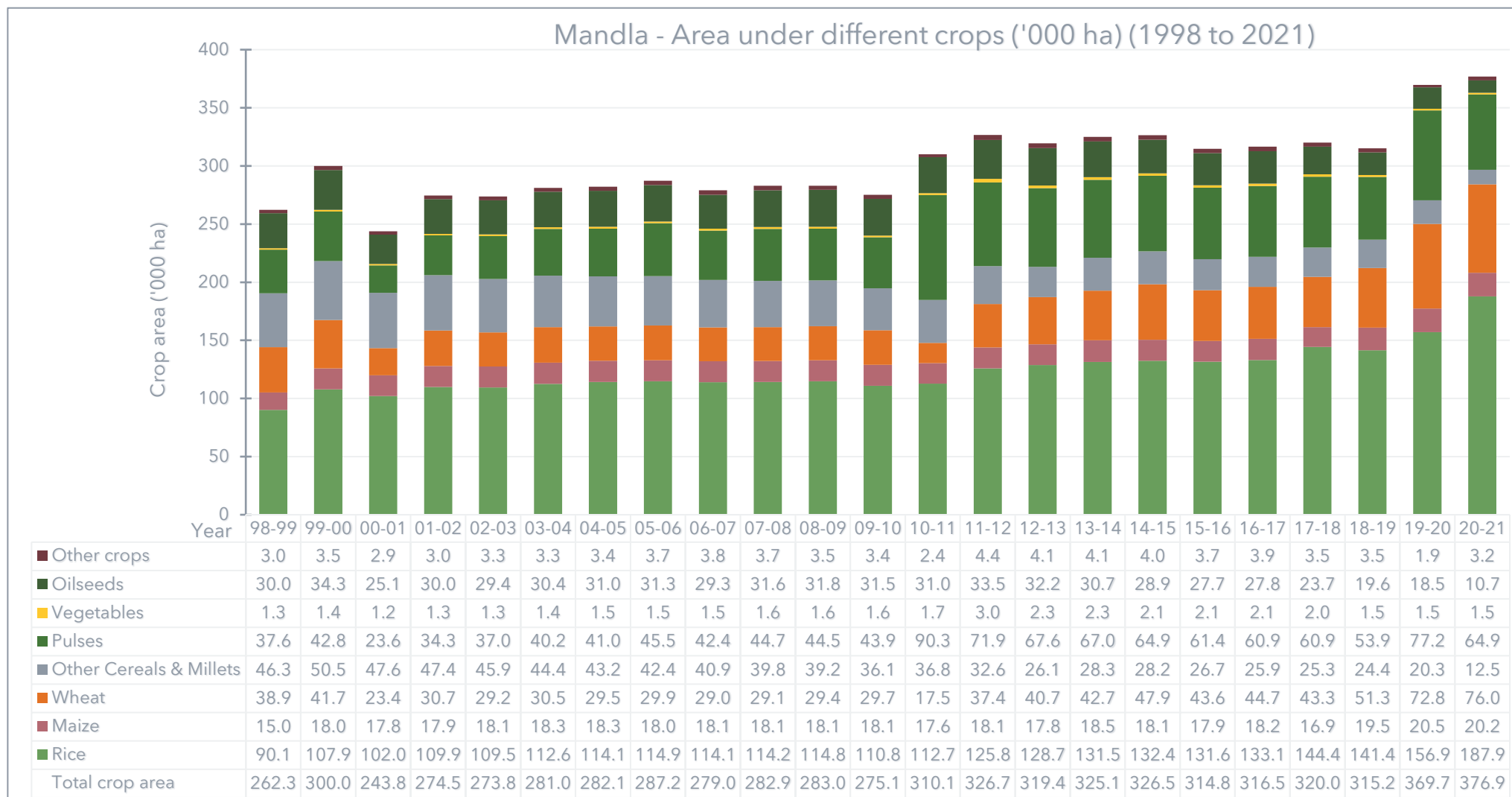


Figure 8 Area under different crops grown in Mandla from 1998 to 2021 (Source: Authors analysis using DACNET data)

Land tenure

Operational Holding

Table 3 lists the land holding pattern details of Mandla district. Around 63% of the farmers are classified as marginal farmers holding less than 1 acre. Around 60% of the area is owned by small and marginal farmers. On a contrary, 40% of the remaining area is owned by 7% of the farmers (small-medium, medium and large farmers). Around thirty thousand farmers (18.5% of the total farmers) are landless.

Table 3: Categories of landholding size for Mandla as on 2013 (Source - Madhya Pradesh District Factbook- Mandla district).

Classification of holding	Farmers		Area	
	Numbers	%	Hectares	%
Landless	30,596	18.6	0	0
Marginal (less than 1 ha)	104,053	63.1	58,043	41.5
Small (1-2 ha)	17,380	10.5	25,478	18.2
Semi-Medium (2-4 ha)	9,518	5.8	28,449	20.4
Medium (4-10 ha)	1,585	1	8,521	6.1
Large (10 ha & above)	1,676	1	19,217	13.8
Total	134,212	100%	139,708	100%

Access to assets and markets

People usually travel to nearby cities such as Mandla or Jabalpur to purchase heavy items such as agricultural inputs (tractors, harvesters, thresher etc.). For the basic amenities such as vegetables, fruits, clothing, and appliances etc., the rural citizens travel to nearby villages for weekly market. The local market is at a distant of 2-12 kms from the nearby villages. There are 39 wholesale units comprising of 3 state marketing federations, 2 district co-operative societies, 5 marketers and 28 private wholesalers. Additionally, there are 187 retailer units consisting of 5 state marketing federations, 4 district co-operative society, 136 private retailers and 42 Primary Agricultural Credit Societies (PACS).

Equipment including tractors, harvesters, thresher, cultivators etc. are limited in number and most of the farm operations are done manually.

Available infrastructure

Mandla district has three mandis¹⁰ each at Bichhiya, Mandla, and Nainpur blocks, which covers 441, 540, and 167 villages respectively. The district has 104 godowns for storage of various commodities (Source - MP warehousing and Logistics corporation)¹¹.

¹⁰ Mandis is a large agricultural market

¹¹ https://mpwarehousing.mp.gov.in/Warehouse/StatePages/Rpt_Godown_wise_Stock_Position.aspx

Electricity

As of 2011, Mandla has a total of about 0.25 million households, and 57.7% of the households had access to electricity and 41% of households used kerosene (fossil fuel). In rural households, 53.64% of households had access to electricity and 45% of households used kerosene.

Drinking water

Within Mandla district, there is a vast difference in the water sources between rural and urban areas. Approximately 57% of households in urban areas use tap water as their main source of drinking water, however, only 7% of the rural households use tap water. Figure 9 Figure 10 shows the overview of various sources of drinking water.

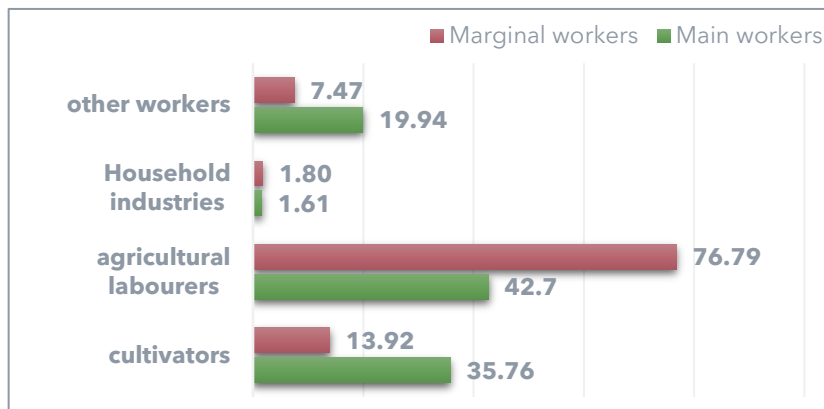


Figure 9 Types of employment carried out by main and marginal workers
(Source - Madhya Pradesh District Factbook- Mandla district)

Employment opportunities within and outside agriculture

Figure 10 shows the distribution of main and marginal workers¹² across different occupations. People rely on the agricultural sector for employment, with ~77% of marginal workers and ~43% of main workers engaged in this sector, reflecting the reliance on agriculture for employment.

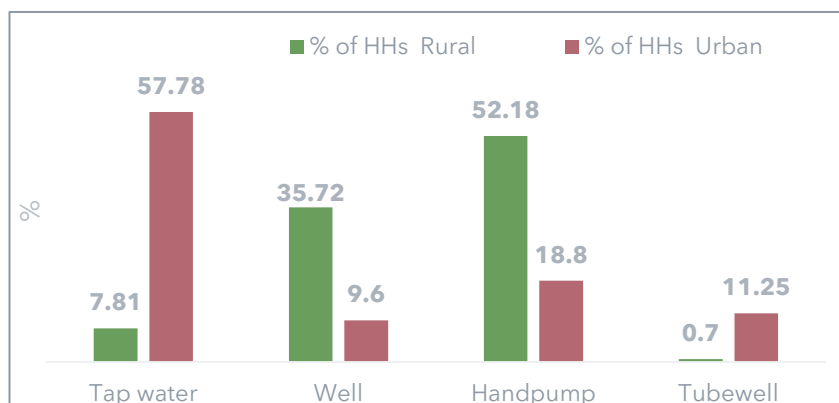


Figure 10 Different sources of drinking water used by rural and urban household
(Source - Madhya Pradesh District Factbook- Mandla district)

¹² Main workers are someone who worked 6 months or more in a year. Marginal workers are someone who worked less than 6 months in a year.

3. Social Context

Ethnicity

A majority of Mandla district's population is Scheduled Tribe (ST), with major sub-castes being Baiga, Gond, Kol, and Pradhan. Additionally, forest fringe areas of the district are home to Scheduled Caste (SC) communities such as Bahna, Bahana, Balahi, Chidar, and Holiya, whose livelihoods are significantly dependent on the forest produces. As per the 2011 census, the district's literacy rate was 67%, with male literacy at 77% and female literacy at 56%¹³.

In Mandla, about 80% of the population are Hindus, about 16% belief in tribal religions and only 1.6% and 1.2%, respectively are Muslims and Christians. Other demographic details of Mandla district are listed in Table 4.

Table 4: Overview of the demographic detail of the district as on 2011 (Source - Madhya Pradesh District Factbook- Mandla district)

Total Geographical area (sq.km.)	5800
Tehsil	06
Gram Panchayat	493
Janpad panchayat¹⁴	09
Total Households	2,50,146
Population (Year, 2011)	1,054,905
Male	525,272
Female	529,633
Rural population	924,716
Male	459,151
Female	465,565
Urban population	130,189
(a) Male	47,225
(b) Female	44,689
Population density (per sq. km.)	182
% of rural population in total population	87.7
Population of Scheduled Tribes	610,528
Population of Scheduled Caste	48,425
Below poverty line (BPL) families	136,867
Farmers	
(a) Landless	54%
(b) Marginal	30%
(c) Small	16%

¹³ Madhya Pradesh District Factbook- Mandla district

¹⁴ **Janpad Panchayat**: A block-level governing body coordinating multiple Gram Panchayats.

Education level

As per 2011 Census, the count of literate individuals in the district is 0.60 million in which 0.34 million are Males and 0.25 million are females. Table 5 lists the literacy rate in Mandla. There is still a large gap of 21% in the literacy level between males and females (Table 6). There are 2416 schools, 9 universities and 2 non-grant colleges in Mandla. Out of 2416 schools, 1590 schools are primary level (grade I-V), 473 schools are primary with upper primary (grade I-VIII), and 42 schools are primary with upper primary secondary and higher secondary (I-XII).

Table 5: Literacy rate (Source - Madhya Pradesh District Factbook- Mandla district)

	Population literacy	Male literacy rate	Female Literacy rate	Gap in male/female literacy rate
Mandla	67 %	77%	56%	21%
Rural	64%	75%	53%	13%
Urban	87%	92%	82%	10%

Table 6: Count of students based on education (Source - Madhya Pradesh District Factbook- Mandla district)

Educational Level	Count of Students (Census 2011)
Illiterate	449,943
Literate	604,962
Literate without Educational Level	24,424
Below Primary	150,415
Primary Education	183,746
Middle education	118,425
Secondary education	54,745
Higher Secondary	36,087
Graduate and above	33,155
Post graduate Degree	2,374

There are students pursuing non-technical and technical diploma certificates, which are not equivalent to degree courses. Additionally, approximately 18,000 students have graduated in non-technical subjects, and around 12,000 students hold postgraduate degrees in non-technical fields

In technical disciplines, students typically choose fields such as Engineering and Technology, Education (for teaching), Medical Science, and Agriculture and allied branches for their studies. As per National Family Health Survey (NFHS) report 2019-21, 66.5% women are literate and 30.5% of women have attended schools for 10 years and more.

Health status

As of March 31, 2022, the district is equipped with a total of 275 Sub Health Centres (SHCs), 33 Public Health Centres (PHCs), 10 Community Health Centres (CHCs), 1 Sub Divisional Hospital, and 1 District Hospital (MoHFW, 2022). Data from 2019-20 shows a prevalence of diseases such as pneumonia, diarrhoea, and malaria among children aged 0-5 years. Table 7 lists the number of children affected by these major diseases.

Table 7: Count of children under 5 years of age suffering from different diseases (Source – Madhya Pradesh District Factbook- Mandla district)

Diseases (in age group of 0-5 years) (2019-20)	Count
Pneumonia	595
Asthma	63
Sepsis	118
Tetanus Neonatorum	1
Tuberculosis	22
Acute Flaccid Paralysis	4
Measles	8
Malaria	43
Diarrhoea	3546

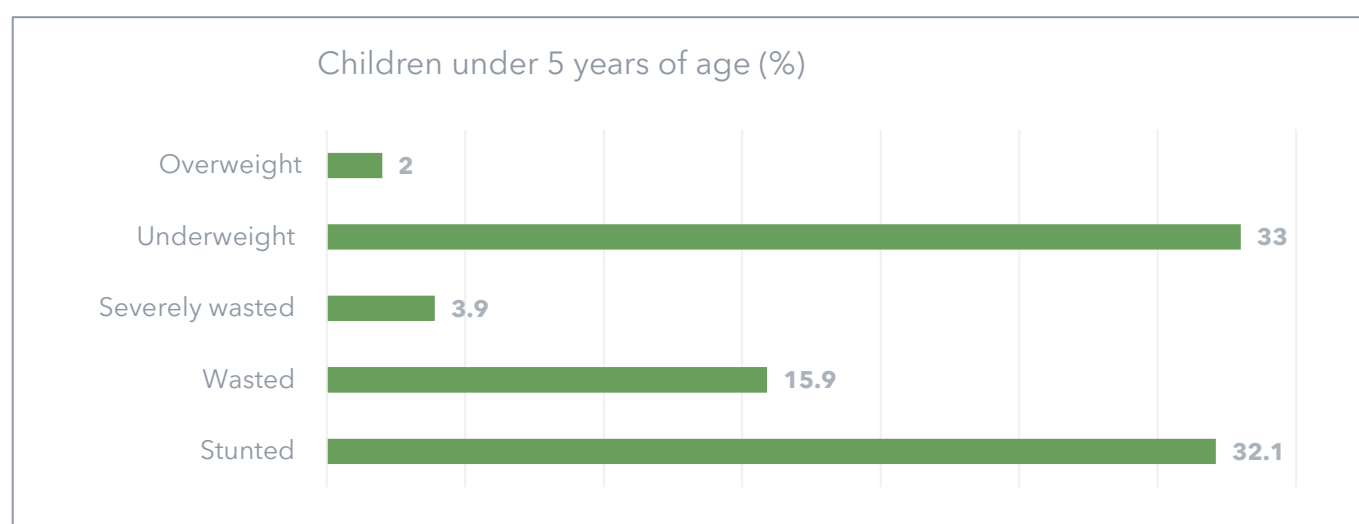


Figure 11 Percentage of children under 5 years of age suffering from different health issues (Source – National Family Health Survey)

According to National Family Health Survey, 2019-21, 33% of children under the age of 5 years are malnourished and underweight. Additionally, 32.1% of children have slowed down or stopped their growth as shown in Figure 11.

These health issues shown in Figure 11 have long-term consequences as it affects the cognitive, sensory, social and emotional development of a child. These diseases are the consequences of inadequate care of women and girls, especially pregnant women who deliver low-birth-weight babies.]

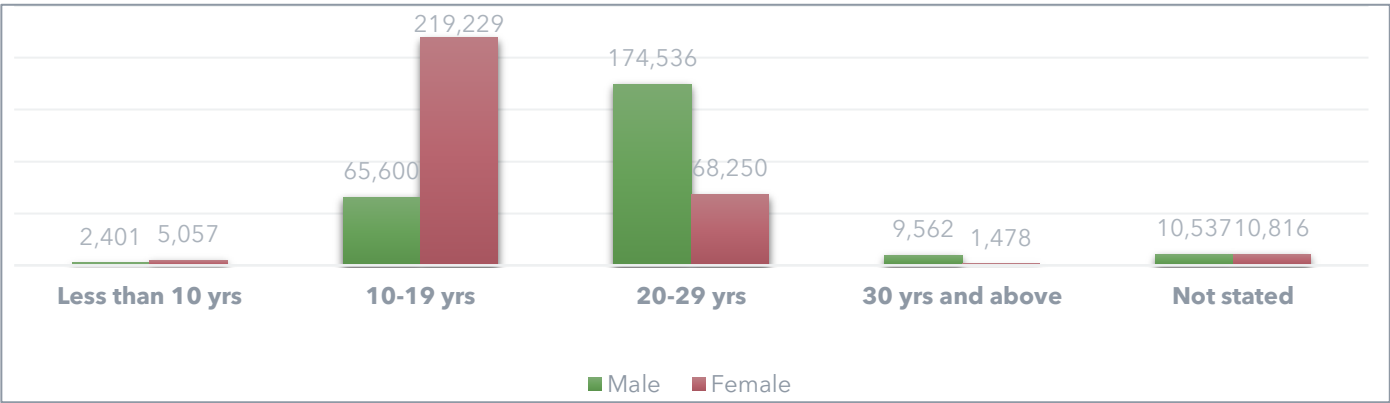


Figure 12 Age wise marriage status of Mandla district as on 2011 (Source – Madhya Pradesh District Factbook- Mandla district)

Marital information

Figure 12 shows that most women marry between the ages of 10 and 19, while most men marry between 20 and 29. Marriages among both males and females above 30 are quite rare. The data also indicates that some girls and boys marry before the age of 10, which violates marriage laws.

4. Political Context

National policies/ schemes helping ALL sites

National political dynamics and policies play a critical role in shaping Mandla's development landscape, providing essential support for the Agroecological Living Landscape (ALL) in Mandla. Among the most impactful policies is the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA), which guarantees employment to rural households and has been instrumental in poverty alleviation and infrastructure development in Mandla's marginalized, largely tribal communities. By engaging the rural workforce in labor-intensive tasks such as water conservation, soil and water conservation structures like bunding, afforestation, and road construction, MGNREGA aligns with the ALL-initiative's focus on sustainable resource management. This emphasis on strengthening rural infrastructure and community development indirectly supports ALL's agroecological goals by enhancing local ecosystems and improving livelihood opportunities for marginalised communities.

The National Rural Livelihood Mission (NRLM) also has a transformative impact, particularly by promoting Self-Help Groups (SHGs) in Mandla. These SHGs, primarily composed of women, are empowered through financial inclusion, enabling members to access credit and engage in income-generating activities. Many SHG members invest in sustainable agricultural practices and small-scale enterprises, directly supporting the goals of ALL by fostering community-led models of agroecology. With NRLM's backing, SHG members become critical agents of change, participating actively in decisions related to micro savings, small agri-business, agriculture and natural resource management, and enhancing women's roles within the agroecological landscape of Mandla.

In addition, national agricultural policies promoting sustainable and organic farming practices have spurred significant progress in Mandla, where traditional farming methods can often be environmentally taxing. Programs such as the Paramparagat Krishi Vikas Yojana (PKVY) encourage farmers to adopt organic fertilizers, composting, and natural pest control, which align with ALL's objectives to reduce chemical dependencies and increase biodiversity. Other schemes like the Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) focus on efficient water management, supporting initiatives like farm ponds, rainwater harvesting, and micro-irrigation systems that are especially beneficial to Mandla's rainfed agricultural landscape. These programs make sustainable practices more accessible and economically feasible for smallholder farmers, who are integral to the ALL's mission.

Moreover, community-based policies such as the Green India Mission (GIM) complement ALL's efforts by funding projects that enhance forest cover and biodiversity, thus strengthening local ecosystems. The Deendayal Antyodaya Yojana-National Urban Livelihoods Mission (DAY-NULM) also supports ALL's agroecological goals by connecting rural areas to urban markets, providing market access for eco-friendly products, and boosting income opportunities for those engaged in sustainable agriculture.

Women in local organisations

In Mandla, women have opportunities to become local leaders. Women can hold leadership roles, including sarpanch (village head), sachiv (village secretary), and Community Resource Persons (CRP) within Self-Help Groups (SHGs). Such positions allow women to play active roles in local governance and decision-making, enhancing the representation and influence of women within their communities. Moreover, SHG structures in Mandla, encourage women to engage in economic activities by facilitating their participation in decisions that affect the well-being of their families and communities.

Local civil society organisations in Mandla play a crucial role in strengthening women's leadership capacities and increasing their participation in governance.

Governmental Decision-Making and Youth Participation

The government plays a key role in decision-making through panchayat institutions and district-level administration. However, decision-making power often resides with influential individuals or families, especially those with economic or political ties. Youth engagement in political processes is limited, though some initiatives encourage youth involvement in community service and vocational training. Expanding youth and women's roles in governance could bring new perspectives to address local challenges.

Real Power and Basis of Authority

In Mandla, political power is primarily held by traditional authorities, with key institutions such as the Zila Panchayat, the District Collector's office, and the Forest Department playing central roles in decision-making processes. The Panchayat system, based on India's decentralized governance model, is responsible for local administration and governance, including the implementation of development projects, management of resources, and maintenance of public services. At village panchayat level panchayat leaders, elected by local villagers, hold considerable influence within the community and are instrumental in addressing local issues, from infrastructure to social welfare programs. The District Collector's office, representing the state administration at the district level, holds significant authority over Mandla's governance, including coordinating with government departments, managing law and order, and implementing state and national policies. This office acts as a bridge between state-level decision-making and local governance, ensuring that government policies reach rural areas and are effectively implemented. The Forest Department, due to Mandla's substantial forest cover and tribal population, wields considerable power over land use, forest conservation, and the distribution of forest resources, all of which directly impact the livelihoods of the local and tribal communities who rely on forest resources for sustenance.

A defining feature of Mandla's political landscape is interplay between formal governance structures and the traditional practices and informal systems deeply rooted in the tribal communities. As a Fifth Schedule area under the Indian Constitution MMP India¹⁵, Mandla holds special provisions for self-governance and the protection of tribal rights, granting local institutions such as panchayats additional authority in managing resources and governance. These provisions aim to harmonize modern administrative mechanisms with the customary rights and practices of tribal populations. The Fifth Schedule status empowers local governance through institutions like panchayat committees, granting them greater autonomy over decision-making in areas such as natural resource management, land use, and welfare programs. Panchayats in Mandla have a pivotal role in implementing schemes related to education, health, employment, and infrastructure development, as well as in safeguarding the cultural heritage and traditional practices of the tribal population. Committees such as the Forest Rights Committee (FRC) and Natural Resource Management Committees (NRMCS), which operate under the panchayat system, play a significant role in ensuring that tribal communities have access to and control over forest resources and other communal assets. These committees are particularly vital in enabling tribal populations to exercise their rights under the Forest Rights Act (FRA) of 2006, which recognizes their historical dependence on forests and aims to secure their livelihood and cultural practices.

At the same time, informal systems within tribal communities, such as councils of elders or community leaders, continue to function alongside these formal structures. These councils are often entrusted with resolving disputes, overseeing traditional resource-sharing mechanisms, and preserving local customs. They provide a culturally relevant form of governance that resonates with the tribal population's identity and values. However, this dual governance model creates a complex dynamic where informal systems and formal authorities, such as panchayats and district administration, must navigate overlapping roles and occasionally conflicting mandates. The Forest Department, for example, holds regulatory authority over large tracts of forestland, which often leads to disputes when traditional practices such as shifting cultivation or forest product collection are restricted under conservation laws. Tribal communities sometimes view such restrictions as encroachments on their customary rights, creating friction between the Forest Department and local governance bodies like panchayats.

¹⁵ Fifth Schedule details: <https://mmpindia.in/amendment/orders/fifth-schedule-details.html>

Section II:

Current State of Agroecological Principles in the ALL



1. Recycling

The tribal community in the district has been involved in sustainable agriculture practices. These practices include minimizing external resource use, reducing waste generation, and utilizing farm waste along with locally available organic inputs.

Resources available at farm level for recycling

Crop Residues: Recycling of various crop residues and animal manure is a common practice in Mandla. Crop residues typically include millet straws, paddy straws, maize stems, invasive species including *Lantana camara* (lantana), while animal manure includes cow dung, cow urine, poultry and livestock litter.

The type of crop residues produced depends on the type of crop land. In Mandla, there are four categories of cultivable land (Figure 13): Uplands, midlands, lowlands and homesteads.

Uplands are typically located on forest fringes and are prone to erosion due to their sloping terrain. The soils are very shallow to moderately deep (up to 30 cm depth) and stony locally known as "mooroom" (*Leptosols*). In these uplands, millets and cultivated and scattered presence of tendu (*Diospyros melanoxylon* - slow growing tree) is common. Millets such as kodu (*Paspalum Scrobiculatum*) and kutki (*Panicum Sumatrance*) are grown in monsoon (kharif) season, while tendu leaves are harvested in summer (zaid) season. One of the major crop residues produced from these lands are millet straws, which are used as mulch for various crops grown on homestead land.

Midlands are much more productive due to its good soil depth (very deep- 1.5 to 1.8 meters), supporting the cultivation of pulses, oilseeds and paddy. The crop residue from paddy and pulses are used as cattle fodder, while pulse residues are also used as firewood.

In the **lowlands**, paddy is the primary cultivated crop. Paddy residue is often used as cattle fodder, and the resulting compost is applied in the agricultural fields.

Homesteads are primarily used for the cultivating maize during monsoon (kharif) season, oilseeds and vegetables in winter (rabi) season. The crop residues, including the crop biomass and oilseed cake are recycled and applied on the homestead land.

Cattles also graze in the landscapes, and dung they leave behind adds to the fertility of the landscape.

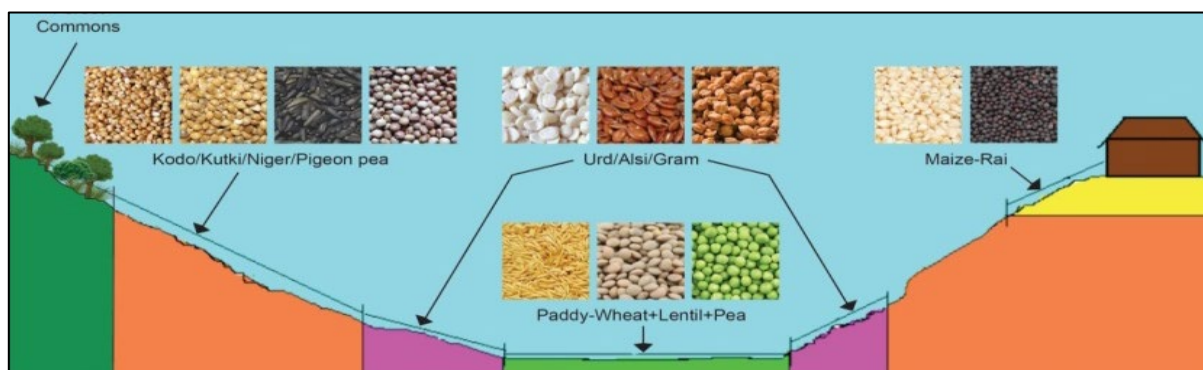


Figure 13 Types of cultivable land in Mandla (Source: FES)

Competition for use of such resources

There are several valuable resources in the landscape such as crop residues, animal manure, rainwater harvesting, each of which has multiple uses in the field. These resources are utilized through various recycling practices such as preparation of Farmyard Manure (FYM), vermicompost, crop residue compost, biochar from invasive species, biofertilizers and biopesticides. Annexure 1 provides information on vermicompost, biochar and crop compost.

2. Input reduction

Type of inputs used for production, and how producers acquired such inputs

The tribal community in the district have traditionally practised minimal usage of external resource, low waste generation, utilization of farm waste and locally available organic inputs for agricultural activities. These practices include utilization of animal manure, locally prepared compost, utilization of crop residues/plant biomass, efficient water use practices and utilization of local seeds. Figure 14 shows some of the practices followed by local communities in Mandla.

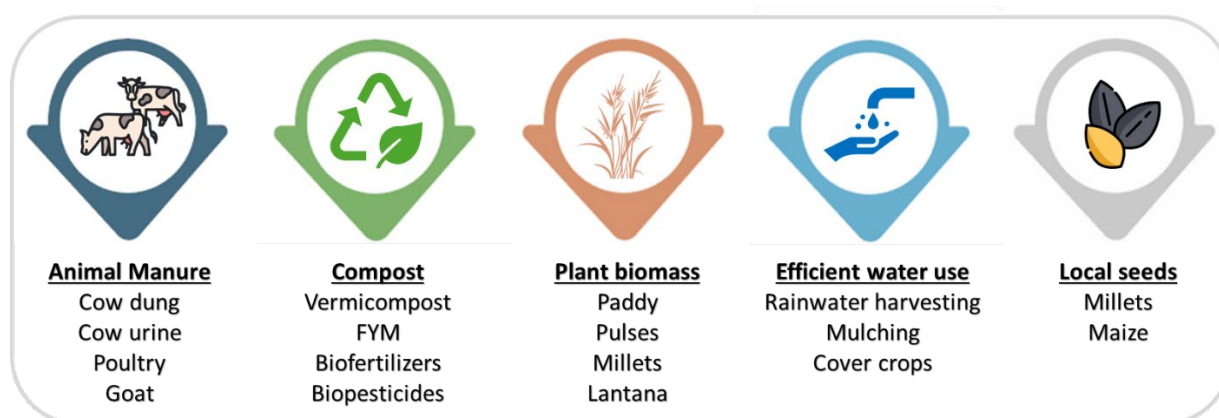


Figure 14 Input reduction practices in Mandla (Designed by: Sudharsan Malaiappan)

There are several valuable resources including locally produced compost, crop residues, animal manure (dung and urine), each of which has multiple uses in the field, that reduces the dependency on external resources. These resources and practices include Farmyard Manure (FYM), vermicompost, biofertilizers, biopesticides, local seeds, mulching, rainwater harvesting, weeding, bio resources centers and farm mechanization (details provided in Annexure 2).

Trend of input use

Chemical fertilizer consumption in Mandla district increased significantly over the past few decades. Consumption rose from 408 Metric Ton per year (MT/year) in 1980-81 (ICRISAT, 2024) to 25,579 MT/year in 2022-23 (Indiastat Publications, 2024) (Figure 15), growing at a CAGR¹⁶ of 10.1% from 1980 to 2023, indicating that on average, consumption grew by 10.1% per year over the last four decades.

Fertilizer consumption per hectare of Gross Cultivated Area (GCA) increased from 0.86 kg/ha/year in 1980-1981 to 66.6kg/ha/year in 2022-2023, growing at a CAGR of 10.64% (Figure 16).

¹⁶ CAGR – Compound Annual Growth Rate. CAGR represents the mean annualized growth rate for compounding values over a given time period. It gives a smoothed rate of growth that shows how much values that show how much consumption grew or declined per year, on average, over that time period.

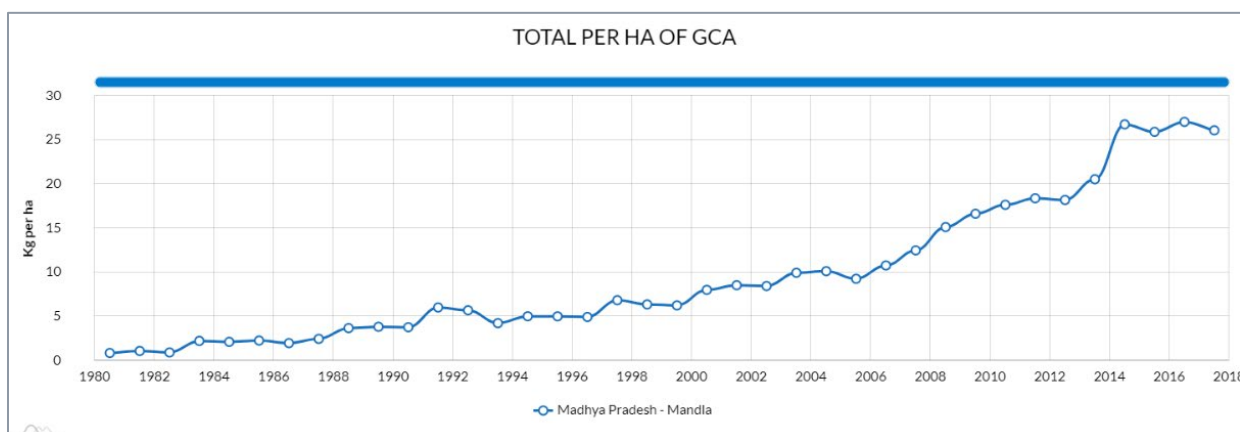


Figure 15 Total fertilizer consumption per ha of gross cultivated area (GCA) (1980 to 2017)
(Source: District Level Database (DLD), ICRISAT)

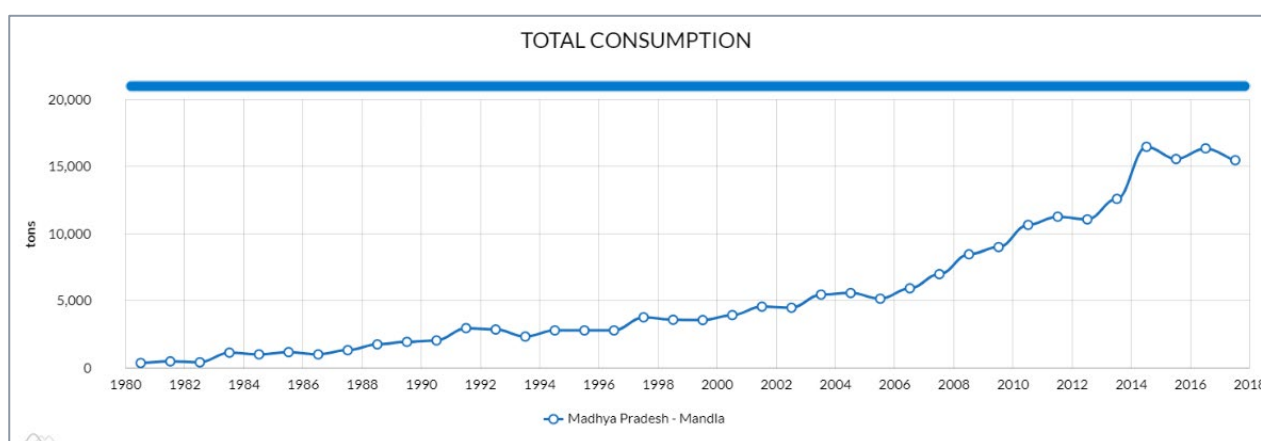


Figure 16 Total fertilizer consumption of Mandla from 1980 to 2017) (Source: District Level Database (DLD), ICRISAT)

Even with a conservative estimate of 5% increase in chemical fertilizer consumption, it is projected to reach 39,681 MT/year by 2033 and 55,835 MT/year by 2040, and per hectare consumption is also expected to rise, reaching 103 kg/ha/year by 2033 and 145 kg/ha/year by 2040.¹⁷

Limitations and options available to farmers to reduce the dependance on synthetic fertilizers and pesticides

In the Mandla district farmers use organic compost, vermicompost, cow dung compost in the form of Farmyard manure (FYM) as alternatives to synthetic fertilizers. They also use biofertilizers such as *beejamrit*, *jivamrit*, *whapasa*, and biopesticides such as *neemastra*, *bhramastra*, *agniastra* for plant protection. These biofertilizers and biopesticides are cow dung and cow urine-based inoculants¹⁸ (NITI Aayog, 2021).

To improve organic carbon and useful microbes in the soil, farmers apply FYM, Jivamrit, or combination of vermicompost and Jivamrit. Additionally, farmers apply ash soaked in cow urine to increase the phosphate and nitrogen content in the soil. To increase germination rate and prevent seeds from deteriorating, farmers coat seeds with *beejamrit* and cow urine.

One of the major limitations in shifting from synthetic to bio fertilizer/pesticides is amount of physical labour required to produce such inoculants, and shorter shelf life of some of the bio-fertilizer/pesticides.

¹⁷ Authors estimate

¹⁸ Methods for preparing biofertilizers & biopesticides: <https://naturalfarming.niti.gov.in/components/>

Water use for production in the case of irrigated production systems and an inventory of various techniques used for irrigation

Agriculture in Mandla is predominantly rainfed, but over the last decade, irrigated area has increased from 9% in 2011 to 28% in 2021 (Figure 17).

To enhance the water availability on farms, solar based micro lift irrigation system has been introduced in a few villages. In this model, water from perennial source is lifted to lands in the upper catchment through solar powered pumps and transported through underground PVC pipelines. A solar-powered pump of 5HP can be used to discharge 20 thousand liters of water, enabling irrigation for 15 to 20 acres. This model helps the farmers to increase their productivity and ultimately their income.

As of 2020-2021, 43% (45,763 ha) of the irrigated water is sourced from canals, 27% (28,766 ha) from wells, and 27% (28,423 ha) from other sources. There is a steep increase in usage of tube wells, from 0% in 2016-2017 to 13% (13,484 ha) in 2020-2021, indicating that the trend will lead to over extraction of groundwater (Figure 18).

Inventory of water management practices

There are various water management practices such as drip irrigation, sprinkler irrigation, Alternate Wetting and Drying (AWD), rainwater harvesting, recycling and conjunctive use of water, check dams, farm ponds, below ground storage structure (locally known as "Jal Kund"), contour and field bunds, soak pits, trenches (staggered/contour), community ponds and recharge pits.

Sources of energy used at farm level

Multiple energy sources are utilized for farm activities. The usage of animal power is significant during field preparation. However, due to mechanization, these animals are now replaced with diesel tractors. During irrigation, farmers use heavy motors to extract the water from nearby water sources. Recently farmers have started using solar lift irrigation systems in few locations.

Substitution of fossil energy by renewable energy on farm

Solar lift irrigation system is installed at few locations of the district. In Narayanganj ALL, there are few villages (*Chimkatola, Jujhari, Kunda, Kevlari, etc.*), where farmers irrigate their farmlands with solar based irrigation system. Biomass energy is also used at farm level.

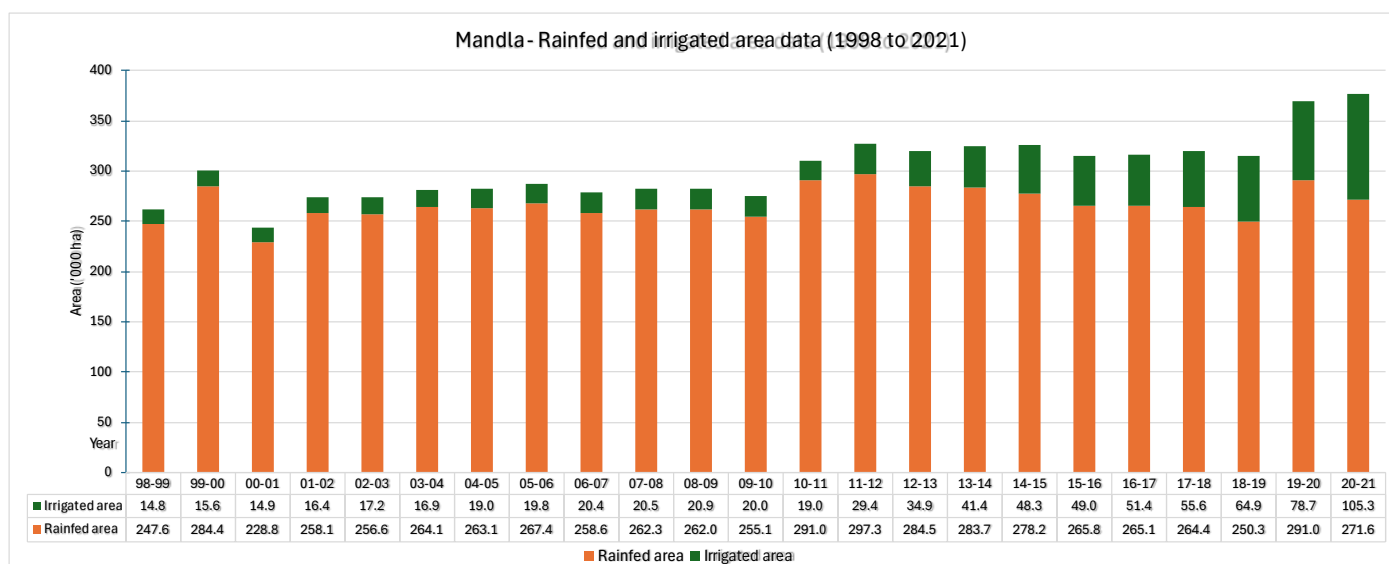


Figure 17 Rainfed and irrigated crop area of Mandla 1998 to 2021 (Source: Authors analysis using DACNET data)

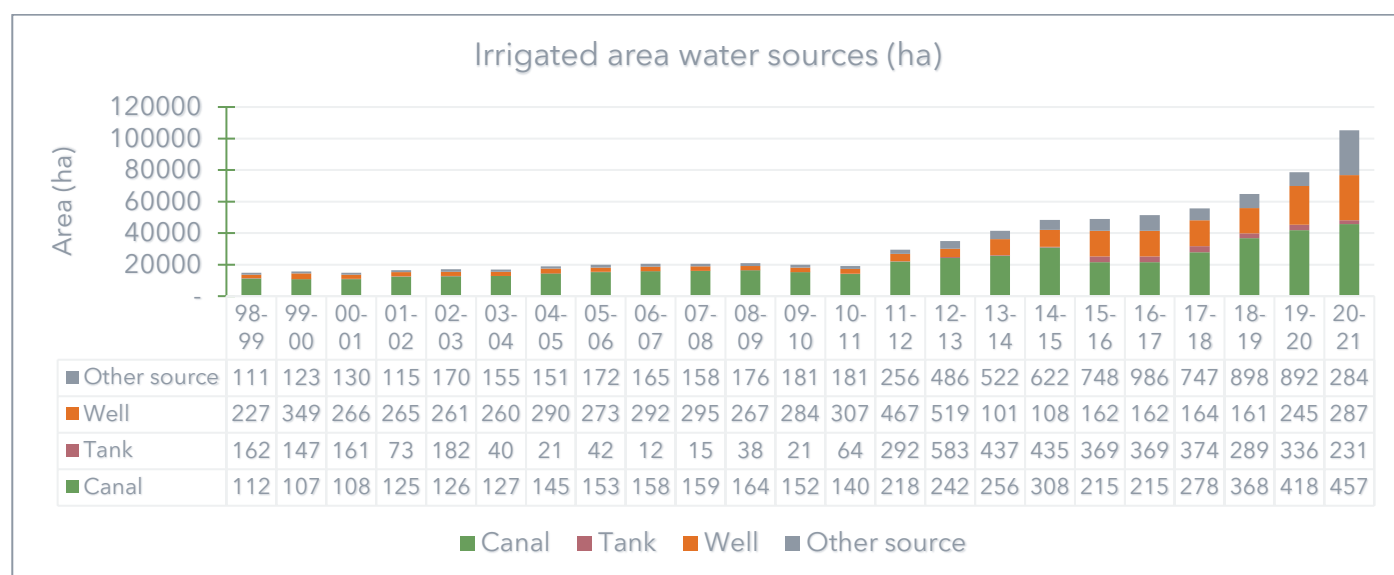


Figure 18 Irrigated water source area for Mandla from 1998 to 2021 (Source: Authors analysis using DACNET data)

3. Soil health

Overview of soil health in Mandla

Mandla holds mix of red and black soil types (*vertisols*) and sandy loam (*leptosols*). Black clayey soil cover approximately 70 % of the district followed by Sandy loam soil. In local terminology, soils are categorized into four classes based on crops grown: *Kabar or Kanbar, Morand or Mund, Sahra and Barra*, with each type further subdivided into two classes (SFRI).

Kabar or Kanhar (vertisols) is a “bluish – black”, clay of extreme depth and fertility; soft and sticky when wet, very hard and heavy when dry. Locally, it is known as *gobra, badi kanbar, asli kanbar and Kichua Kabar*. It is an inferior quality with gritty, lighter in colour, less in depth and often containing small black kanbar pebbles. It is locally known as *gobra, non kanbar, choti or halki kanbar, dudh sahra and mut sahra or mota sahra*.

Mund / Morand

Mund (Vertisols) – is a black cotton soil, black or darkish, grittier and more friable than *kabar* with white limestone pebbles. It is locally known as *mund, morand, sahra, kaitha* and occasionally *mutsahra*.

Mund II (Cambisols) - It is an inferior variety of *Mund-I*, which is lighter in colour and outturn, sandy and often containing large quantities of white limestone which materially reduces its productivity. It is locally known as *morandi, sahri or sometia*.

Sahra (Arenosols)

Khisa sahra: This soil type is pure sand, pale yellow, friable, unfit for rabi or spring crops, but given good rains, paddy can be grown in low lying or irrigated areas.

Kaitha sahra: Locally known as *domatia*, is a very sandy variety of *mund*, suited only to lighter rabi, but good for growing paddy. This class of soil is locally known as *jhigra sahra or jhigra*.

Barra (Luvisols / Ferrasols)

Mutbarra: It is not a specific soil, but a comprehensive term applied to red or yellow soil, free from stone, capable only of growing kharif crops.

Barra: This type of soil is the predominant type in Mandla, with approximately 57% of soil in the Niwas block falling into this category. *Barra* encompasses red or yellow varieties, as well as poorer qualities of black soil. It is often described as red gravelly or *murram* soil, sometimes with underlying rock within 20 to 30 centimetres. Large stretches of red *barra* soil are commonly found on flat hilltops known as *dadar*. These soils predominantly support grasslands with sparse tree coverage and are not suitable for paddy cultivation. However, they support crops with lower water requirements such as maize, oil seeds like rapeseed and niger seeds, and minor millet crops like kodo and Kutki (FES).

Existing soil management practices

Various soil conservation practices in Mandla are green manuring, mulching, bunds (stone, contour, farm bunds) to arrest soil erosion, silt application, bio-fertilizers, compost application, crop rotation and crop wise nutrient application. Farmers also traditionally planted custard apple on the farm bunds which helps to harbor beneficial fauna and coexist with other flora.

Estimate of fires, grazing and compaction

Grazing of animals on farmland is a prevalent practice in Mandla. Livestock feed on crop residues left after harvest and other biomass, effectively clearing the fields. This practice not only provides a source of nutrition for the animals but also helps in maintaining the cleanliness of the farmland by reducing the amount of plant debris that could potentially harbor pests or diseases. This practice also adds organic materials in the form of dung.

In addition to grazing farmland, animals often graze on forest lands as well. Forest grazing involves livestock feeding on the natural vegetation found in forest areas. This practice can be beneficial for managing undergrowth and

preventing forest fires by reducing the accumulation of dry plant material. However, it needs to be carefully managed to avoid overgrazing, which can lead to soil erosion, loss of biodiversity, and degradation of forest ecosystems. Overall, the integration of livestock grazing in both farmland and forest areas reflects a traditional approach to land management.

Farming practices that enhance and protect soil health

Practices such as mulching, organic compost, stone bunding, green manuring, silt application are widely used for management of soil health (Details provided in Annexure 3)

Soil organic carbon content

Soil organic carbon (SOC) stock (top 1m) in Mandla is ranging from 20 to 140 MT/ha, whereas in most of the mid to low land used extensively for cultivation the SOC stock is about 70 MT/ha whereas in case of upland it is between 15 to 30 MT/ha (ISRIC, 2024)¹⁹. The low to midlands generally exhibit medium to high SOC levels (as per Indian standards), whereas the uplands are characterized by poor SOC levels. SOC stock is influenced not only by concentration of organic matter in the soil but also by soil depth and gravel content.

Recently, farmers in the region have adopted the practice of crop residue burning to control weeds and pests for subsequent crops. However, this practice can have a detrimental impact on soil health, leading to a loss of organic carbon and compromising the long-term fertility and productivity of the soil (Kumar et al., 2019).

Soil erosion

Owing to concentrated rainfall, undulated topography and poor soil conditions, Mandla is affected by soil erosion, with ~44% of the district is affected by medium (15-30 t/ha/year) to catastrophic soil loss (>100 t/ha/year) (Raj et al., 2024) (Figure 19). The soils infested with lantana are also prone to erosion due to poor soil cover provided by lantana leaves. Moreover, lantana weeds prevent undergrowth and as a result the soil is exposed and hence prone to erosion.

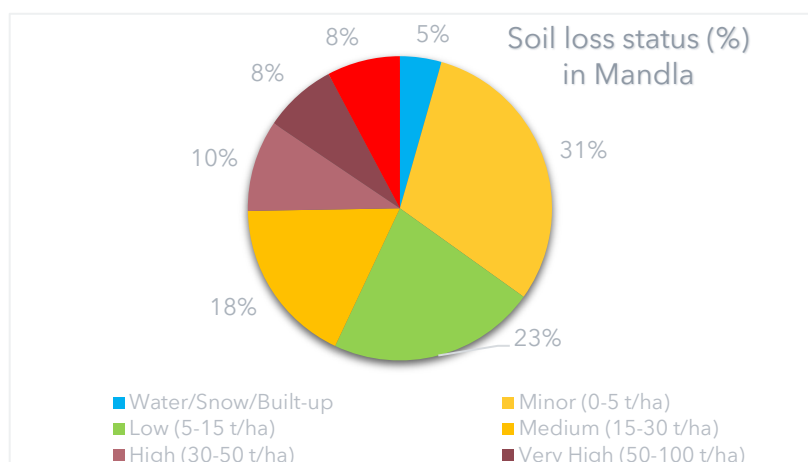


Figure 19 Soil loss status in Mandla

Nutrient balance

As per Soil health Card (SHC) scheme classification (MoAFW, 2024), ~94% (708,211 ha) of the district has low nitrogen content (<280 kg/ha), and ~74% (553,542 ha) of the district has medium phosphorous content (10 to 25 kg/ha), and ~94% (706,024 ha) of district has medium potassium content (120 to 280 kg/ha). Figure 20 highlights

¹⁹ 250m x 250m soil organic carbon stock grid data for the Mandla district was sourced from Soilgrids.org and analysed by the authors.

widespread deficiency in nitrogen, with most of the region falling within the low category, while phosphorus levels are predominantly medium, and potassium is also largely in the medium range.

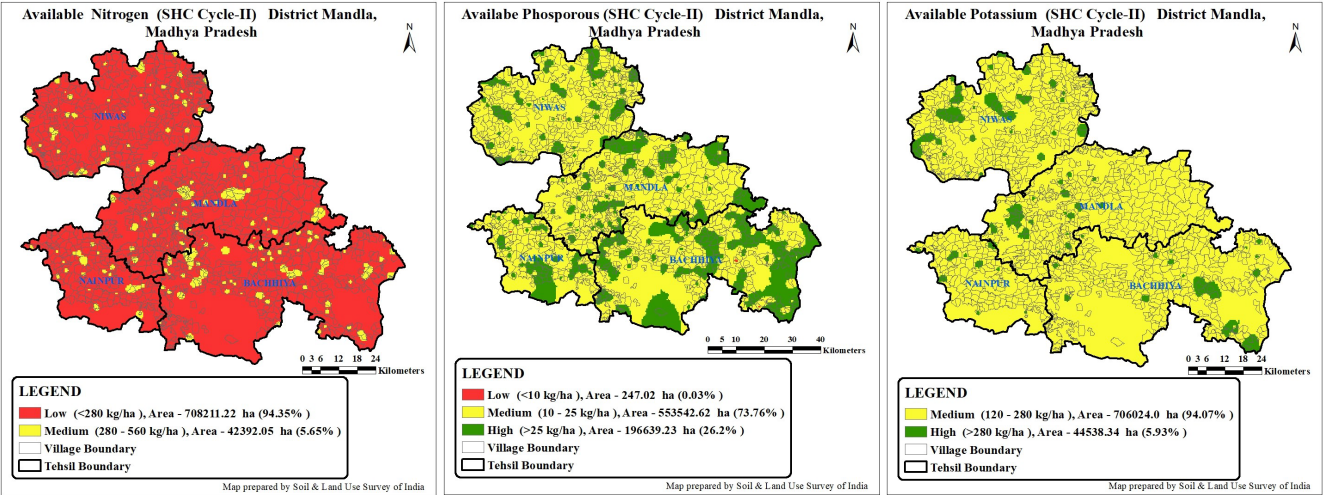


Figure 20 Status of Nitrogen (N), Phosphorous (P), Potassium (K) in Mandla (Source: Soil Health Card Scheme)

4. Animal health

Mandla, farmers practice rearing of small ruminants, poultry and piggery. Each household owns 3-4 cattle that provide input for their agriculture. Farmers mostly depend on the commons or forest for grazing; stall feeding is rarely practiced. Ensuring year-round fodder availability, particularly in summer is a challenge. Farmers lack knowledge about diseases and treatments, leading to losses, especially in poultry. The Department of Animal Husbandry in Madhya Pradesh runs programs for livestock and poultry treatment, vaccination, and disease control, alongside schemes for dairy, poultry, pig, and goat development.

Livestock description, types and numbers

Total livestock population of Mandla district is about 1.05 million, which includes cattle, buffaloes, goats, pigs, sheep, horse and poultry (MoFAHD, 2021). Species wise population of Mandla district is given in Figure 21

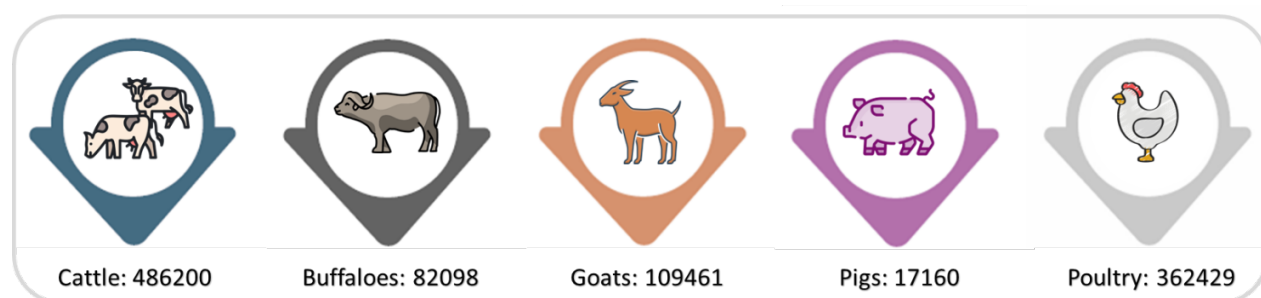


Figure 21 Livestock population of Mandla (MoFAHD, 2021) (Design by: Sudharsan Malaiappan)

Some of the factors affecting animal health in Mandla are:

- Drinking water scarcity during summer months because streams are turning seasonal.
- Excessive heat leading to increased animal mortality
- Limited access to commons/forest for grazing
- Increase in invasive species across grazing land and forests, resulting fodder shortage
- Poor maintenance of cattle sheds, leading to foot, mouth and skin diseases

Types of feed and quality

Cattles feed on grazing pastures, hay and straws. A common practice in the villages is to let animals graze on the common lands and fringe forest where they get fresh grass. To feed poultry, farmers use locally produced grains, corn, barley, wheat, etc.

Animal rearing conditions and feeding regimes

Penning is widely practiced in Mandla district. Penning is a traditional livestock rearing practice where livestock are kept in temporary enclosures or pens, usually made from natural materials like wooden poles, bamboo, or ropes. Penning provides a natural way to enhance soil fertility and helps in maintaining the health and nutrition of the livestock. It is often coordinated with crop cultivation activities, where farmers rotate the animals to different parts of their fields to efficiently manage their farms. It also gives autonomy to the farmers to plan out their pastureland.

Timing of open grazing: Local communities follow a system to control grazing mechanisms. A person is appointed by the village to manage all the cattle in the village to a particular area for grazing. The appointed person takes care of the cattle from starting of monsoon (Kharif) season till the harvesting of winter (rabi) season crop. Then the cattle are left for open grazing. The institutional control of grazing serves two purposes in the context of agriculture. First, the crop loss because of the cattle is minimized, and the manuring of the field during the dry season.

Prohibition of grazing in certain areas: To harness all kinds of land, the regular grazing regime (which is open grazing in winter (rabi) season) is controlled on some lands. For instance, in some villages, the lands around the streams are

cultivated multiple times. Such lands are not grazed by traditional sanctions. Similarly, on some lands, where winter (rabi) season cultivation only takes place, grazing is prohibited in monsoon (Kharif) season, allowing the growth of fodder to be used as green manure later for wheat cultivation. The local customary control is essential to ensure continuity of such land use.

To reduce the wastage of fodder, keeping the cattle healthy, and for easy collection of cow dung and cow urine, cattle shed flooring are being improved in some villages as shown in Figure 22



Figure 22 Cattle shed flooring. (Photographs: FES)

Additionally, there is lack of knowledge among animal rearers concerning diseases and potential treatments. Within the framework of MGNREGA²⁰ (Mahatma Gandhi National Rural Employment Guarantee Act), there is provision for constructing permanent shelters for various domesticated animals, including cows, buffaloes, goats, and poultry. However, the design of these shelters is uniform, regardless of the type of animal to be housed. Specifically, the goat sheds lack a raised platform, while the cow and buffalo sheds do not include a separate drinking facility.

Methods for managing pests and diseases

To manage pest and diseases, farmers usually consult with animal health workers, locally called as *pashu sakhis*, in case of outbreak of diseases in animals. *Pashu sakhis* are trained extension personnel who provide door-to-door first aid and counselling services for disease prevention and management. The capacity building of these *pashu sakhis* is conducted by Madhya Pradesh State Rural Livelihood Missions. They provide timely vaccination and treatments to the village animals. They also conduct the workshops regarding animal healthcare, nutrition management, and vaccination techniques etc.

Vaccinations, immunization and natural remedies are practiced in Mandla to prevent animals from major pest and diseases. To cure a viral disease, Ranikhet, B1 Lasota is injected during initial vaccination of chickens on their eyes or nose. Sometimes, cattle and poultry animals also face the problems of worming in their stomach because of unhygienic living condition, ingestion of unwanted materials such as bugs, soil, and litter etc. Hence, Albendazole is given to the infected animals to deworm.

²⁰ MGNREGA - world's largest social welfare scheme introduced nationwide in 2005, guarantees "right to work" for individuals residing in rural areas, with the focus on

1. 100 days of paid work for rural unskilled adults per household each financial year.
2. Development of rural infrastructure for individual and community benefit, including construction and maintenance of durable assets.
3. Rejuvenation and optimal use of local natural resources.
4. Job security and fair wages to improve livelihoods during seasonal or chronic unemployment.

Natural occurring solutions for pests and diseases such as bio-control agents that substitute synthetic products.

To control livestock pests and diseases multiple methods are used. Farmers spread a thin layer of paddy straw to avoid wetness in the shed, to reduce the chance of skin diseases. The farmers also mix few drops locally made limestone concoction and into water and feed them to the cattle.

For poultry, the practice of feeding turmeric water to prevent diarrhea is followed in Mandla. To prevent poultry from newcastle disease (locally known as *ranikhet*), locally prepared natural concoction is fed to the poultry. The concoction is prepared by mixing cumin seeds, jaggery, pepper, garlic, ginger, and mint leaves with water and boil it down to half. In some parts of Mandla (Bichhiya and Niwas block), traditional practices are used to treat cattle (Table 8).

Table 8: Traditional practices for treating cattle in Mandla

Herbs/Shrubs/Creepers (local name)	Animals	Purpose of use	Process of preparing
Narbod tuber	Cattle	For healing wounds	Raw tuber mixed with feeds
Van-tambaaku	cattle	For healing the wounds	Directly with fodder
Golar root	Cattle	Clear the lice and skin infections	Root is boiled in water which is used to wash the cattle
Arjun, Jamun and Khair leaves	Cattle	For diarrhoea	The leaves are pounded together and given to cattle

Water used for animal feeding and its quality

Consumption of water depends on the kind and size of animal, its physical state, level of activity, dry matter intake, quality of water, temperature of water and environmental temperature. Villagers use normal drinking water for the animals. However, in case of any symptoms detected for bacterial or fungal diseases, villagers mix a few drops of natural solutions or synthetic medicines in the water so that they can be cured before the infection spreads. Animals also consume water from nearby water bodies such as rivers, streams, and canals etc.

5. Biodiversity

Wildlife and natural biodiversity

Mandla district is famous for its rich natural biodiversity, encompassing a wide variety of flora and fauna. This district is an essential ecological hub, with notable conservation efforts and diverse ecosystems, particularly in and around Kanha National Park. The combination of dense forests, riverine ecosystems, and protected zones contributes significantly to the district's biodiversity.

Flora: According to a floristic survey (SFRI), Mandla is home to a total of 1,006 species of plants belonging to 310 genera of 133 families. Among the 133 families, 42 families represent only one species each, 21 families represent two species each. 14 families have 3 species; 8 families have 4 species, 4 families have 5 species, and 8 families have 6 species each. Fabaceae is the most dominant family with 96 species, followed by Asteraceae with 83 species and Acanthaceae and Rubiaceae with 53 and 42 species respectively.

Mandla is rich in herbaceous species compared with other adjoining districts, which helps to sustain wildlife population and other ecosystem services. Table 9 lists number of plant species under different habitats. A Survey on Sacred Groves identified 30 sacred grooves in Mandla (SFRI, 2009).

Table 9: Number of plant species under different habits

Habit	Number of species
Trees	162
Shrubs	71
Herbs	681
Climbers	51
Epiphytes / Parasite	2
Grasses / Bamboo	39
Total	1006
For more details: https://www.mpforest.gov.in/mpsbb/completedProject/MB.pdf	

Fauna: Mandla and Kanha national park (tiger reserve) is home to many endangered species (FES) like Royal Bengal Tiger (*Panthera tigris*), Indian Gaur (*Bos gaurous*), Indian Wild Dog (*Canis alpinues*), and holds the last surviving population of the Barasingha or the Central Indian Swamp Deer (*Cervus duvauceli*) and vultures (*Gyps bengalensis*, *Gyps tenuirostris*). The Barasingha (*Cervus duvauceli branderi*) is one of the three endangered sub-species, which is now endemic to Kanha.

Recent study on spider diversity lists 113 species from 30 families of spiders in Mandla district (Singh & Sharma, 2022), making it one of the more diverse districts in Madhya Pradesh.

A measure of the state of the natural biodiversity

Mandla is primarily divided into two forest divisions – East Mandla Region and West Mandla region. Diversity and phytosociological attributes of these two divisions are listed in Table 10 and Table 11 (SFRI). East Mandla forest range have more species and higher floral diversity when compared to ranges of West Mandla forest division. Diversity index of species is more in East Mandla (2.70) than in West Mandla (2.64).

Table 10: Phytosociological attribute of plant species diversity in East Mandla forest division (SFRI)

Tree					Shrub			Herb		
	Range	Diversity (nos)	d/ha	DI	Diversity (nos)	d/ha	DI	Diversity (nos)	d/ha	DI
1	Bichhiya	22	382	2.83	15	3766	1.67	43	326000	3.45
2	Ghughari	22	359	2.76	22	10444	2.40	48	137666	3.75
3	Jagmandal	16	310	2.50	9	13288	2.10	39	68019	3.66
4	Mawai	26	308	2.68	44	24523	3.55	132	1236133	4.78
5	Mohgaon	28	445	3.06	12	8552	1.32	44	532000	3.62
6	Motinala	22	448	2.40	25	14429	3.09	68	598444	4.14
	Average		375	2.70		12500	2.36		483044	3.90
Diversity represents number of species, d/ha is number of tree/shrub/herb per hectare, whereas DI is Diversity index										

Table 11: Phytosociological attribute of plant species diversity in West Mandla forest division (SFRI)

Tree					Shrub			Herb		
	Range	Diversity (nos)	d/ha	DI	Diversity (nos)	d/ha	DI	Diversity (nos)	d/ha	DI
1	Bamhni	20	206	2.46	12	3488	1.94	14	192666	2.34
2	Barela	20	295	2.41	14	14952	2.42	16	394571	2.53
3	Beejadandi	25	358	2.85	37	27555	3.39	28	499666	3.02
4	Kalpi	42	448	3.36	18	11026	2.63	44	517800	3.51
5	Maharajpur	23	173	2.77	7	4733	1.58	8	6400	1.97
6	Mandla	10	176	2.11	7	8933	1.69	18	197333	2.71
7	Niwas	14	38	2.40	6	6833	1.67	21	202500	2.96
8	Tikariya	21	229	2.75	9	8247	1.96	16	218285	2.70
	Average		240	2.64		10721	2.16		278652	2.72

Occurrence of invasive species

Lantana Camara is the most dominant invasive species in Mandla. The analysis of Lantana across the East Mandla and West Mandla forest divisions reveals its significant presence and dominance as an invasive species (SFRI). Range wise data of each forest division is listed in Table 12. In East Mandla region, Lantana shows an average frequency (F%) of 68%, with a density (d/ha) of 3330/ha, reaching its highest density and Importance Value Index (IVI) in the Mohgaon range. The average frequency of Lantana appears to be higher in West Mandla. At a representative sampling site in the Bamhni range, its frequency was recorded at 92%, with a density of 2,420 individuals per hectare, marking its highest density and Importance Value Index (IVI). The relatively low diversity indices observed in both divisions suggest that Lantana is suppressing native vegetation and adversely affecting local biodiversity.

Table 12: Phytosociological attributes of *Lantana camara* in Mandla (SFRI)

East Mandla Forest division	Range	F%	d/ha	IVI	DI
	Bichhiya	75	1483	93	0.36
	Ghughari	100	4466	82	0.36
	Jagmandal	28	3000	56	0.32
	Mawai	69	2717	24	0.21
	Mohgaon	71	5823	153	0.34
	Motinala	66	2488	34	0.25
	Average	68	3330	74	0.31
West Mandla forest division	Range	F%	d/ha	IVI	DI
	Bamhni	100	1822	108	0.37
	Barela	100	3295	49	0.30
	Beejadandi	100	1422	13	0.14
	Kalpi	86	2906	49	0.30
	Maharajpur	75	1566	86	0.36
	Mandla	77	2377	72	0.34
	Niwas	100	2733	93	0.36
	Tikariya	100	3238	86	0.36
	Average	92	2420	70	0.32

Plant/crop diversity (including genetic diversity)

The agricultural landscape of Mandla district features a diverse range of crops (Table 13). Key crops include grains like wheat (*Triticum aestivum* and *Triticum durum*), paddy (*Oryza sativa*), maize (*Zea mays*), and millets such as kodo

and kutki. The district also cultivates pulses like gram, pigeon pea, lentil, and various oilseeds such as mustard, linseed, and soybeans. Table 13 list major crops grown in Mandla.

Table 13: Major crops grown in Mandla (SFRI)

S.No.	Name of Crop	Scientific Name	Family	Varieties
1	Mustard	<i>Brassica compastris</i>	<i>Brassicaceae</i>	
2	Kodo	<i>Paspalum scorbiculatum</i>	<i>Poaceae</i>	
3	Kutki	<i>Picrorhiza kurroa</i>	<i>Plantaginaceae</i>	
4	Maize	<i>Zea maize</i>	<i>Poaceae</i>	JM - 12, JM - 8
5	Millet	<i>Hordium vulgare</i>	<i>Poaceae</i>	
6	Paddy	<i>Oryza sativa</i>	<i>Poaceae</i>	JR-201, Doobraj, HMT, swarna, MTU - 1010, Hybrids, IR - 64, Luchai, Mahamaya, PS - 3
7	Ragi	<i>Eleusine coracana</i>	<i>Poaceae</i>	
8	Wheat	<i>Triticum astivum</i>	<i>Poaceae</i>	WH - 147, LOK - 1, Sujata
9	Wheat	<i>Triticum durum</i>	<i>Poaceae</i>	GW - 273, JW - 17, HD - 2004
10	Lin seed	<i>Linum uritatisissimum</i>	<i>Linaceae</i>	
11	Gram	<i>Cicer aretenum</i>	<i>Fabaceae</i>	JG - 74, JG - 315
12	Lentil	<i>Lens esculanta</i>	<i>Fabaceae</i>	
13	Pea	<i>Pisum sativum</i>	<i>Fabaceae</i>	JP - 885
14	Pigeon pea	<i>Cajanus cajan</i>	<i>Fabaceae</i>	
15	Sesamum	<i>Guizotia abyssinica</i>	<i>Asteraceae</i>	
16	Soyabean	<i>Glycine max</i>	<i>Fabaceae</i>	JS - 335, NRC - 37, Js - 90-41
17	Urad	<i>Vigna mungo</i>	<i>Fabaceae</i>	
18	Niger	<i>Guizotia abyssinica</i>	<i>Asteraceae</i>	Ootacmand, IGP - 76
19	Urid	<i>Phaseolus mungo</i>	<i>Fabaceae</i>	JU - 2, JU - 3

Vegetable cultivation in Mandla is equally diverse, featuring leafy greens, tubers, climbers, root vegetables and shrubs. Table 14 lists the major vegetables grown in Mandla.

Table 14: Vegetables grown in Mandla (SFRI)

S.No.	Local Name	Scientific Name	Family
1	Lal bhaj/sag	<i>Amaranthus gangeticum</i>	Amaranthaceae
2	Sooran	<i>Amorphophallus campanulatus</i>	Aracaceae
3	Ghiya	<i>Colocassia esculenta</i>	Aracaceae
4	Poi sag	<i>Basella alba</i>	Basellaceae
5	Kundru	<i>Boswellia serrata</i>	Bursaceae
6	Spinach	<i>Spinacia oleratia</i>	Chenopodiaceae
7	Chauli sag	<i>Chenopodium album</i>	Chenopodiaceae
8	Cabbage	<i>Brassica oleracea</i>	Cruciferae
9	Radish	<i>Raphanus sativum</i>	Cruciferae
10	Gourd	<i>Luffa achinata</i>	Cucurbitaceae
11	Pumpkin	<i>Lagenaria sicceraria</i>	Cucurbitaceae
12	Bitter gourd	<i>Momordica charantia</i>	Cucurbitaceae
13	Cucumis	<i>Cucumis utilissimus</i>	Cucurbitaceae
14	Cucumber	<i>Cucumis sativus</i>	Cucurbitaceae
15	Luffa gourd	<i>Luffa cylindrica</i>	Cucurbitaceae
16	Mint	<i>Mentha arvensis</i>	Labiatae
17	Lady finger	<i>Abelmoschus asculantus</i>	Malvaceae
18	Drum stick	<i>Moringa oleifera</i>	Moreingaceae
19	Green Pea	<i>Psium sativum</i>	Fabaceae
20	Beans	<i>Vigna unguiculata</i>	Fabaceae
21	Bean	<i>Dolichas lablab</i>	Fabaceae
22	Maithi	<i>Trigonella foenum</i>	Fabaceae
23	Potato	<i>Solanum tuberosum</i>	Solanaceae
24	Tomato	<i>Lycopersicum asculentum</i>	Solanaceae
25	Brinjal	<i>Solanum malengina</i>	Solanaceae
26	Coriander	<i>Coriandrum sativum</i>	Umbaliferae

Livestock and aquatic animal breeds (including genetic diversity)

The district's animal breeds include common livestock such as cows, oxen, buffaloes, and goats, and other domesticated animals as listed in Table 15.

Table 15: Animal breeds in Mandla (SFRI)

S.no	English Name	Breeds	Scientific Name	Family
1	Cow	Local	<i>Bos indicus</i>	<i>Bovidae</i>
2	Ox	Local	<i>Bos indicus</i>	<i>Bovidae</i>
3	Buffalo	Local	<i>Bubalus bubalus</i>	<i>Bovidae</i>
4	Goat	Local	<i>Capra indica</i>	<i>Cervidae</i>
5	Chicken	Local	<i>Gallus gallus</i>	<i>Phasianidae</i>
6	Rabbit	Local	<i>Leapus nigricolis</i>	<i>Leporidae</i>
7	Pig	Local	<i>Sus indica</i>	<i>Suidae</i>
8	Dog	Local	<i>Canis familiaris</i>	<i>Canidae</i>
9	Cat	Local	<i>Felis domestica</i>	<i>Felidae</i>
10	Pigeon	Local	<i>Columba livia</i>	<i>Columbidae</i>
11	Parrot	Local	<i>Psittacula cremerii</i>	<i>Psittacidae</i>

In terms of aquatic life, Mandla hosts various fish species primarily belonging to the family Cyprinidae, under the order Cypriniformes. Some of the Pisces found in Mandla is given in Table 16. The region also cultivates aquatic plants such as lotus and water chestnuts.

Table 16: Pisces in Mandla (SFRI)

S.No	Zoological Name	English Name
Order : Cypriniformes		
Family : Cyprinidae		
1	<i>Aspidopariya jaya</i>	-
2	<i>Barilius bendelisis bendelisis</i>	-
3	<i>Catla catla</i>	Catla
4	<i>Chela cachius</i>	Chela
5	<i>Chela laubuck</i>	Winged Rasbora
6	<i>Cirrhinus reba</i>	Reba
7	<i>Danio devario</i>	Danio
8	<i>Danio rerio</i>	-
9	<i>Esomus danricus</i>	Flying Barb

10	<i>Garra lamta</i>	Stone Sucker
11	<i>Garra mullaya</i>	Stone Sucker
12	<i>Puntius amphibious</i>	Scarlet Banded Barb
13	<i>Puntius chola</i>	Green Barb
14	<i>Puntius conchoni</i>	Stigma Barb
15	<i>Puntius punjabensis</i>	-
16	<i>Puntius sophore</i>	Stigma Barb
17	<i>Puntius ticto</i>	Fire Fin Barb
18	<i>Rasbora rasbora</i>	-
19	<i>Tor putitora</i>	Mahur

Efforts by farmers to maintain natural biodiversity

The continuation of such rich agrobiodiversity is closely linked to traditional land ownership pattern. Majority of the households own all categories of land, though the poorer households may have most of their land in the upper reaches, with limited valley land. Valley lands and medium lowlands tend to be fertile and have higher clay content, while medium uplands tend to be sandy and mildly acidic. The uplands are generally gravelly, sandy with degraded soil over grazing and erosion. Despite the variabilities, all land categories can support diverse range of crops. Traditional inheritance system ensures that all inheritors obtain all kind of lands.

In recent decades, the adoption of high yielding inorganic agriculture practices has become prominent. Farmers are dependent on market supplied seeds often untested for climate resilience which adds to farmers vulnerabilities. Availability of indigenous variety of seeds have reduced. Millets which are climate resilient are not as popular as was in the past. Similarly, indigenous variety of poultry is being replaced by farm-bred varieties that required special care.

These changes in farming practices have impacted the nutritional dependency of the communities, as traditional foods started disappearing from their diets. There are few civil society organizations working to reintroduced traditional and indigenous variety of seeds. Interventions include promotion of indigenous seeds and agroecological practices through farmers fairs, a regular feature in the landscape. These fairs provide a platform to share and sell the indigenous variety of seeds, facilitate discussion on various local issues, provide information on existing policies and schemes that farmers can benefit, including participation of women in agriculture.

The intervention also includes stump dressing to restore forest green biomass. that involves identification of live stumps, cleaning of damaged and decayed parts and applying calcium carbonate solution.

Uncultivated Plant/crop diversity from forest commons

Forests serve as a gene bank, rich source of biodiversity and food bank for tribal communities in Mandla. Forests contribute extensively to the local economy in terms of non-timber forest produce and towards the overall food security of the families, especially for the marginalised. Communities harvest many leafy vegetables, tubers, mushrooms and fruits from the forests. Mahua (*Madhuca longifolia*) fruits are used for extracting edible oils, whereas Chironji (*Buchanania lanzan*) is used for both consumption and sale.

Uncultivated foods contribute hugely to the nutrition requirements of tribals. Some of the uncultivated foods such as aonla (*Embllica officinalis*), mahua (*Madhuca longifolia*), chironji (*Buchanania lanzan*) are rich sources of vitamins and protein and act as a security during low food availability. Agroforestry is another concept that the farmers are practicing. They cultivate multiple crops along with useful trees such as mahua, bamboo, mango etc. It not only maintains the natural biological diversity but also enhances the economic status of the farmers. The farmers plant *Jatropha curcas*, *Lawsonia inermis* (henna plant), *Lantana camera* (Lantana), *Carrisa caranda* (Karonda), cactus plants as a hedgerow to protect the farm field from animals and forming a natural green fencing. It enhances natural diversity as some of these plants attract birds, and bees for pollination.

In the Narayanganj block of Mandla, some farmers practice organic farming using indigenous methods to protect soil and crops from pests and degradation. They rely on preparations like *Agniastra* and *Neemastra* for pest management, cow dung manure for soil enrichment, and jaggery solutions for seed treatment, avoiding chemical inputs. For reforestation and habitat restoration, the seed ball method is employed, where seeds are coated with clay, compost, and organic materials to shield them from birds and harsh climates. These seed balls are dispersed in common areas near villages just before the monsoon, aiding ecosystem restoration. Local government bodies, such as gram panchayats, support these efforts by distributing saplings of species like mango to enhance local ecology.

6. Synergy

Mixed farming, including animal manure for crop production

Agriculture is based on subsistence cropping system with focus on food crops. Most small and marginal farmers practice mixed cropping as an insurance against risks, since mostly rainfed agriculture is practiced. The farmers grow Maize or Kodo/kuti millet once in three years on their land. In general crop is grown with low input-output scenario under natural management. Though dairying is not a commercial enterprise in the region, farmers used to maintain 5-8 cattle heads per family mainly for dung and to limited extent for milk. The FYM prepared from cattle manure is applied to the crops in the homestead farms as well as the agricultural fields. After the winter (rabi) season, tendu leaves (natural occurrence) are harvested. In midlands, moisture is enough to grow one kharif crop followed by a very short duration pulse crop. However, lowlands are inundated with sufficient water and normally two crops are grown. Submerged paddy was once very widely grown in the lowlands. It was well adapted to the lowlands where water levels are high. Moreover, apart from grain yield, submerged paddy used to provide ample straw which is used as fodder for the cattle. The change in crop varieties has brought shortage of fodder, and the cattle health is affected during the lean months i.e. Jan to June. The shortage of fodder has reduced the number of cattle per household (less than 5). A good synergy can be seen between livestock and crop cultivation each depending on other, however there is scope of improvement of integration for better resource efficiency.

Comprehensive Homestead Model (CHM) being promoted by NGO and adopted in improved form for co-design experiment under Agroecology initiative is an integrated and holistic approach land management. It is particularly designed for homestead land using regenerative agriculture practices, principles of ecological planning, sustainable water management and promotion of diversified livelihoods.

Agroforestry and shade enhancement

In Mandla, trees such as mahua (*Madhuca longifolia*), bamboo (*Bambusa vulgaris*), and khmer (*Gmelina arborea*) are strategically planted along the boundaries of farms where millets like kodu (*Paspalum scrobiculatum*) and kutki (*Panicum sumatrense*) are cultivated. Mahua and khmer serve as shade trees, offering critical protection against water and wind erosion while safeguarding crops from grazing. These plants hold multiple local uses and play an integral role in the food system through their synergistic contributions. The traditional and local knowledge regarding the utilization of these plant species is detailed in Table 17.

Table 17: Inventory List of Ethno-Botanical Diversity in Mandla (SFRI)

S.No.	Scientific Name	Part used	Mode of Application
1	<i>Adhatoda vasica</i>	Leaves	Juice of Adusa leaves along with honey is taken early in the morning to cure asthma and old cough.
2	<i>Madhuca longifolia</i>	Fruits	Asofoetida is added in the Mahua liqueur and dried. It gives relief in cough breathing and problems.
3	<i>litrullus tonatus</i>	Seed	Indrayan seeds are burnt and its smoke is inhaled by asthmatic patients to get relief.
4	<i>Saraca indica</i>	Seed	Crush the seed of Ashoka and make small balls of the size of wheat seed and take with leaves of beetle to cure ashtama disease.
5	<i>Phyllanthus simplex</i>	Leaves	Leaves of Bhui anola are taken with a pinch of salt to cure toothache and pyrrhoea.
6	<i>Carica papaya</i>	Root	Dried root of Papita is soaked in water for 12 hours its juice and is extracted. Tribals take this juice with sugar in the morning to cure stone.
7	<i>Momordica dioica</i>	Root	15 gm. Powder of dry Karela root is taken with milk and water to dissolve the stone.

8	<i>Xanthium strumarium</i>	Seed	Powder of dried Gokhru seed is taken with milk of sheep to dissolve the stone.
9	<i>Achyranthus aspera</i>	Root	For normal delivery tribals keep the apamarg root in a circular form just above the navel area.
10	<i>Abutilon indicum</i>	Leaves	2-3 tender leaves of Kanghi are taken early in
11	<i>Terminalia arjuna</i>	Leaves	5-10 gm of Arjun bark powder is boiled with 1 cup of milk and 3 cups water. It is cooled and then taken in the morning to give to weak strength heart.
12	<i>Withania somnifera</i>	Bark	Ashwagandha leaves are mashed by the hand and like a palliate made and taken in the morning afternoon and evening to lose 1-3 kg weight.
13	<i>Aloe barbadensis</i>	Leaves	Juice of Gwarpatha is applied on the burnt body part. It also useful in is ailments of liver and stomach.
14	<i>Musca peradisica</i>	Root	Juice of Banana root with water problems cures related to spleen.
15	<i>Bhyanopris lanoirosa</i>	Root	Spleen also gets cured by taking the powder of Sivlingi roots with water.
16	<i>Terminalia chebula</i>	Leaves and Root	The pain in spleen is checked by taking dry roots and leaves of Harra with water.
17	<i>Dalbergia sissoo</i>	Leaves and Wood	Toothache is cured by brushing teeth with the ash of burnt leaf bark of Sheesam.
18	<i>Spilanthus acmella</i>	Leaves and Fruit	By applying the leaves and fruits of Akarkara on tooth, tooth ache is cured.
19	<i>Ficus religiosa</i>	Bark	Toothache is cured by brushing teeth with the powder of dry bark of Peepal.
20	<i>Ocimum sanctum</i>	Leaves	By grinding Kali tulsi with pepper and taking it with reduces the water effect of poison.
21	<i>Calatropis gigantea</i>	Leaves and Bark	The flow of poison is controlled by taking the
22	<i>Raphanus sativus</i>	Tuber	The problems related to kidney are cured by taking 1 glass juice of Reddish with 1 tsp rock salt.
23	<i>Boerhavia diffusa</i>	Root	By taking 15 ml juice of bark of Punarnava, a kidney starts functioning again.
24	<i>Terminalia indica</i>	Seed	Paste of Imli seed is applied on the wound or cut area.
25	<i>Asparagus racemosus</i>	Root	Disease s related to kidney are cured by taking honey with the powder of Satawar roots.
26	<i>Syzygium cumini</i>	Seed	Diabetes is cured through intake of a pinch of powder of Jamun seeds of with water in morning.
27	<i>Gymnema sylvestre</i>	Leaves	Diabetes is also cured by taking four leaves of Gudmar daily.
28	<i>Clitoria ternatea</i>	Root	Te pain of spleen is cured by taking the juice of Aparajita roots with water in the morning.
29	<i>Mentha spicata</i>	Leaves	By taking appropriate quantity of mint, onion and ginger, dysentery is cured.
30	<i>Eclipta alba</i>	Leaves	Hair fall is reduced by applying the paste of Bhringraj, lemon and china rose leaves.

31	<i>Cyperus rotundus</i>	Root	Joint pain is cured by taking powder of montha grass roots with water and milk.
32	<i>Vitex nigrunda</i>	Leaves	Intake of powder of Nigundi leaves in the morning and evening cure vat disease.
33	<i>Datura alba</i>	Root	Joint pain is reduced by applying the paste of Dhatura roots.
34	<i>Ageratum conyzoides</i>	Leaves	Paste of Pisamutthi leaves acts as an antibiotic.
35	<i>Bacopa mannieria</i>	Leaves	Memory is enhanced by taking powder of Bramhi leaves black alongwith pepper and honey.
36	<i>Ricinus communis</i>	Leaves	Jaundice is cured by taking Arandi leaves with water.
37	<i>Celastrus paniculata</i>	Seed	Oil of Malkangini seeds is applied or used for massage on paralytic patients.
38	<i>Vetilago denticulata</i>	Bark	Weakness is removed by taking powder of the Tilpapda bark with water.
39	<i>Cynodon dactylon</i>	Root	To get rid of itching, paste of root Safed doob is applied at the place of itching.
40	<i>Azadiracta indica</i>	Leaves	To cure skin disease, boil the leaves of tender Neem and take bath with this water.
41	<i>Hibiscus rosa senensis</i>	Whole plant	Hibiscus is used in making medicines for jaundice and itching.
42	<i>Cordia macleodii</i>	Bark and Fruit	Its bark and fruits are used in Stomachache, vat, asthma leprosy, and uterus ailments.
43	<i>Diospyros melanaxylon</i>	Rood	After grinding, the roots of Tendu are taken with water to cure burning of stomach.
44	<i>Shorea robusta</i>	Gum	By drinking curd mixed with the gum of Sal controls loose motions.
45	<i>Boerhavia diffusa</i>	Leaves	To cure chickenpox leaves of Patharchatta are eaten.
46	<i>Abrus precatorius</i>	Root	Ground roots of Gunj are taken with water to cure loose motions.
47	<i>Cassia tora</i>	Fruit	The Chirotta fruit is used in fever.
48	<i>Lagerstroemia parviflora</i>	Root	The root of Lendia is used to reduce weakness.
49	<i>Costus speciosus</i>	Tuber	The tuber of Keokand is used for the treatment of animal disease.
50	<i>Amorphophallus sylvaticus</i>	Tuber	The tuber of Jungli suran is used to cure snake bite.
51	<i>Leucas cephalotus</i>	Fruit	The fruits of Gumma are used in the treatment of piles.

While there is integration and synergy by default among various components of the production system and the overall food system, there remains a significant gap and scope for improvement through working by design. The agroecology initiative seeks to co-experiment and develop models that can be widely adopted to enhance resource efficiency and sustainability.

7. Economic diversification

Diversity of crops and livestock and aquatic animal breeds

Farmers in Mandla practice economic diversification by cultivating a wide range of crops across different seasons. During the monsoon (kharif) season crops such as paddy, maize, millets, pulses like arhar, horsegram etc are grown. In winter (rabi) season wheat, gram, lentils, and peas, some commercial crops like mustard, linseed, soyabean, sesamum etc. add to economic diversity. Additionally, horticultural crops such as guava, mango, jackfruit, lemon, banana, watermelon etc. are produced contributing to nutritional security and potentially income diversity depending on market demand. Farmers also grow spices like ginger, turmeric, garlic, coriander, dry chillies etc. that have significant economic and cultural value.

Diversity of clients for the on-farm products

In Mandla, the farmers sell their produce to the local markets, which is one of the easiest reachable markets. The local traders evaluate the quality of produce to determine fair price. Some of the non-governmental organization including, PRADAN, is promoting women led Farmer Producers Company (FPC) registered under company act of Ministry of Corporate Affairs, Government of India in Narayanganj block, which works as a procurement agency. The FPC ensures adherence to quality standards such as moisture percentage, grain size, texture etc. and support farmers by providing an organized and efficient marketing platform.

Income from activities beyond the farm level, including wild products such as NTFPs

Non-Timber Forest Products (NTFPs) play a critical role in the livelihoods of mainly small, marginal and landless farmers and women in Mandla. These groups actively engage in the collection of NTFPs such as mahua, chironji, tendu leaves, harra, wild honey, bahera, amla, mushroom tubers etc (Table 18). Among these, mahua is particularly important, with farmers collecting its leaves, flowers, and seeds. Mahua flowers are used to make liquor, laddus (sweet) and oil extraction. Laddus (sweet) are sold in local weekly markets for \$0.12 (INR 10 per piece of about 50 gram- 2024 price) each. Besides it is also used for and vegetables adding to the nutritional security. Women also participate in exhibitions to market these products, creating an additional source of income. Mahua seeds used for oil extraction are also sold to traders at \$0.45 (INR 40) per kilogram.

Tendu leaves, another significant NTFP, are collected during May and June and sold to local government traders. The leaves are bundled in groups of 100, with 100 bundles fetching \$4.75 (INR 400). Chironji seeds, collected from the forests, are used for household consumption and sold at \$2.67 (INR 225) per kilogram to local traders. Harra, a medicinal NTFP, is valued for its use in treating digestive problems and as an ingredient in Ayurvedic medicines. Harra seeds are sold at \$0.3 (INR 25) per kilogram. Additionally, Bhelwa fruits, known for their medicinal properties in treating coughs and digestive issues, are sold in bundles of 20-25 fruits for \$0.18 (INR 15). Bhelwa (*Semecarpus anacardium*) is another medicinal NTFP collected from the forest, known for its use in treating coughs and digestive issues. A bundle of 20-25 Bhelwa fruits is sold for \$0.18 (INR 15).

Table 18: Key NTFP's produced in Mandla district (Priyam, 2017)

Local / Common name	Scientific Name	Products produced
Amla	Phyllanthus emblica	Fruit, pachhak amla (digestive product), triphala (ayurvedic powder), squash, powder, murrabha (jam), candy, pickle
Bael	Aegle marmelos	Power, squash, murrabha (jam)

Bahera	<i>Terminalia belirica</i>	Powder, extract and oil
Bamboo	Various	Fibre
Chironji	<i>Buchanania lanzan</i>	Seed, pickle
Harra	<i>Terminalia chebula</i>	Powder, extract
Imli	<i>Tamarindus indica</i>	Fruit, dry imli brick, powder, cake, sauce, acid, starch (seeds)
Jackfruit	<i>Artocarpus heterophyllus</i>	Fruit
Jamun	<i>Syzygium cumini</i>	Vinegar, powder
Karanj	<i>Millettia pinnata</i>	Oil and oil cake
Kusum	<i>Schleichera oleosa</i>	Oil and oil cake
Lac	<i>Kerria lacca</i>	Shellac
Mahua	<i>Madhuca latifolia</i>	Mahua kismis (raisins), alcoholic beverages, dry mahua, powder, jam, chikki (sweet cake), laddu (sweet), oil and oil cake
Mahul	<i>Phanera vahlii</i>	Dona and pattal (leaf crockery)
Mango	<i>Mangifera</i> sp.	Fruit; dry mango, powder, candy, pickle, juice, pulp, jam, jelly, mango pappad
Moya grass	<i>Pennisetum hohenackeri</i>	Fibre; thatch
Sisal	<i>Agave sisalana</i>	Fibres; rope, decorative goods, mats, carpet, pedestal etc.
Sita Phal	<i>Annona squamosa</i>	Fruit, jam, jelly, powder

Aquatic food system in Mandla as economic avenue

Fisheries have long been a fundamental aspect of Mandla's cultural heritage, wherein fish are traditionally caught or harvested by both male and/or female family members from various water sources using indigenous knowledge (Figure 23). It is also evident that women play an active role in post-harvest activities, including the processing and marketing of fish. Although this practice is often seasonal, it still makes a significant contribution to household's annual income. Mandla's overall average



Figure 23 Aquaculture practitioner in Mandla (Photograph: Ayan Samaddar)

fish productivity is only 60 kg/ha, which is significantly less than the usual productivity in other pertinent Indian locations. Despite Mandla produces an average of 6138 MT of aquatic animals each year (2022-2023). There were cooperative societies called Sehkari Sangh/Samiti accessible in this district, which has a total of 98 (where around 3195 people involved in fishing are enlisted). Apart from this, a total of 72,000 individuals (F: 32400, M: 39600) were involved in pisciculture and capture fisheries.

Furthermore, the government has supported climate-resilient and creative programs, and as of right now, the district has three Bio-Floc schemes, three carp seed hatcheries, and four fish seed farms. Despite the district's 19 fish markets and high demand for aquatic delicacies, most of the captured and cultivated fish are sold directly to the public or at the farm gate.

There are 27 fish varieties usually available in the local market/farm gate/catching zone/landing center, among which significant demand for Rohu, Catla, Naren, Common Carp, Pangus, and Morale fish were there and their market price varies from \$1.2 (INR 100) to \$3.6 (INR 300) per kg (*depending on size, body weight, and processing type*). Smoked Rohu, Catla, and small indigenous fish varieties are in good demand at the household level and also in the local market and there are price ranges between \$1.8 (INR 150) to \$2.61 (INR 220) per Kg. Dry fish production (Figure 24) now becoming a part of the tradition of the Mandla fish-eating/selling community, they mainly use this technique for long-term preservation of excess catches of indigenous small fish/prawn varieties especially from December to March months, which also have a significant market price (\$1.2 (INR 100) to \$4.8 (INR400) per Kg) and local demand.

Furthermore, the communities keen interest in the commercial production of water chestnuts (a crucial commercial aquatic plant item) was evident (Figure 25), with an average selling price of \$0.36 (INR 30) to \$0.47 (INR 40) per Kg. The aquatic food system has a significant role in Mandla's food security, nutrition, and livelihood. Aquatic food products have significant local demand, their detailed information has been listed in Table 19.

Table 19: Aquatic food products of Mandla having economic opportunity

Local / Common name	Scientific Name	Products produced
Padan	<i>Ompok bimaculatus</i>	Fresh, Smoked
Rohu	<i>Labeo rohita</i>	Fresh, Smoked
Kalvat		Fresh
Jhinga	<i>Fenneropenaeus indicus</i>	Fresh, Smoked, Dry
Baam	<i>Mastacembelus armatus</i>	Fresh, Smoked



Figure 24 Dry fish in Mandla's local market (Photograph: Ayan Samaddar)



Figure 25 Water Chestnut cultivator (Photograph: Ayan Samaddar)

Cotia		Fresh, Smoked
Chalar		Fresh, Smoked
Suar		Fresh, Smoked
Morale	<i>Amblypharyngodon mola</i>	Fresh, Smoked, Dry
Common Carp	<i>Cyprinus carpio</i>	Fresh, Smoked
Catla	<i>Labeo catla</i>	Fresh, Smoked
Darai		Fresh, Smoked, Dry
Bighead	<i>Hypophthalmichthys nobilis</i>	Fresh
Tilapia	<i>Oreochromis sp.</i>	Fresh, Smoked
Pangus	<i>Pangasius pangasius</i>	Fresh
Grass Carp	<i>Ctenopharyngodon idella</i>	Fresh
Singi	<i>Heteropneustes fossilis</i>	Fresh, Smoked
Rupchanda	<i>Piaractus brachypomus</i>	Fresh
Naren	<i>Cirrhinus mrigala</i>	Fresh, Smoked
Singhara	<i>Trapa natans L.</i>	Fresh, Boiled

The declining natural fish stocks and low average productivity underscore the need for sustainable management of aquascapes through agroecological practices. By integrating these practices with landscape interventions, aquascapes can be developed into a robust component of the production system, enhancing both ecological and economic outcomes. The dwindling natural fish stock and poor average productivity highlights the opportunity of sustainable management of aquascape using agroecological practices and develop it as a strong component of the production system in integration with the landscape interventions.

8. Co-creation of knowledge

Existing networks and platforms (formal and informal) for knowledge and experience sharing

Knowledge sharing among farmers in Mandla is largely informal and parental, passed down through generations and shared farmer-to-farmer. Traditional fairs, visits from relatives, and informal gatherings at common spaces serve as key platforms for exchanging ideas. During these interactions, farmers discuss challenges related to agriculture, market linkages, and production while sharing insights about successful practices and technologies that have proven profitable.

In recent past multiple formal and informal groups and networks who work collaboratively to build a platform for knowledge and experience sharing have come up in Mandla ALL. The formal platforms include cluster level federation (CLFs), Village Organization (VOs), self-help group (SHGs), agriculture extension service providers such as *Krishi sakhis*, *Krishi Vigyan Kendras*, farmer producer groups, research institutions, and non-governmental organizations (NGOs). Informal groups include farmers field schools, community gathering in the village, and informal farmers groups.

NGO's such as PRADAN conduct capacity building sessions through community engagements, exposure visits and project-based interventions. State rural livelihood mission (SRLMs) works in close association with some NGOs such as *Krishi sakhis*, *pashu sakhis* and community resource persons (CRPs) are sent to training conducted by institutions such as Panchayati raj institutions, agricultural institutions, *Krishi vigyan kendras* (KVKs) etc.

Key Stakeholders in Networks/Platforms: Roles and Responsibilities

In some parts of ALL, NGO's, Tribal Knowledge networks, Agricultural extension services, local cooperatives, microfinance institutions, Farmer Producer organization (FPO's) and Self-Help Groups (SHG's) form informal network in co-creating knowledge and sharing with wider communities. SHG's discuss socio-economic and political aspects in and around the villages. On a larger scale, CLFs conduct multiple capacity building session for the women of SHGs, and other associated cadres. They further disseminate the information to the villagers. Farmer Producer Organizations (FPOs) are formal platforms where farmers collectively engage in the agricultural activities including knowledge sharing and collective bargaining for inputs and outputs. They often conduct regular meetings with the board of directors (usually women), and exposure visit to the model farms, so that others can learn from their experiences.

Opportunities for farmers (between themselves) to plan collectively, share experience and knowledge

Bidri/Agati – *Bidri/Agati* is a seed sowing festival celebrated across Mandla, and arguably in all tribal areas of eastern Madhya Pradesh. The festival is observed before the monsoon (between the last week of May and first week of June). In *Bidri*, traditionally the farmers come to the *Khermai* (Village Goddess whose abode is usually a sacred grove) with different seeds (necessarily traditional seeds as a rule) in small quantities in a plate. The priest of the village or the oldest man of the community performs the worship of *Khermai* and the seeds. Then those seeds mixed with the other seeds available in house are sown in the fields. Violation of *Bidri* leads to punitive sanctions accordingly. Though it apparently appears as a festival, it provides ample opportunity of knowledge sharing besides collective seed sowing that helps in controlling the timing of harvest and thereby avoiding the anticipated conflict arising out of the open grazing of cattle. The rule of bringing traditional seeds to *Khermai* signifies the idea of maintaining the traditional seeds with the farmers. It helps in protecting the farmers from purchasing seeds from market and thereby maintaining the investment cost within limit. Gradually the practice of *Bidri* is weakening. Erratic rainfall event has been cited as one of the reasons for declining adherence to the rules of *Bidri*. If there is an early pre-monsoon shower, many farmers tend to violate the rule.

Strategic alliances between stakeholders

Seed pooling - Seed pooling is a regular feature among local communities. Seed pooling is exchange of seeds for seeds only. Promotion and supply of hybrid seeds, free of cost, by market is a major cause of declining of this tradition.

Bullock pooling - Bullocks are pooled for the purpose of ploughing and threshing operations. It means that two different farmers can pool their bullocks for performing their crop operations. The purpose is to reduce the costs of maintaining cattle.

Bullock exchange- Bullocks are exchanged particularly in the Kharif season i.e. between seed sowing (*Bidri to raksha bandhan*), which is a period of about three months. The rate for exchange is similar everywhere in Mandla. The practice is prevailing in all the villages.

The top-down approach and supportive policies promoting chemical agriculture, along with the subsidy schemes and provision of external inputs either free or at highly subsidized rates, may seem beneficial to the community. However, these measures come with hidden costs, including the discontinuation of traditional practices and the loss of indigenous wisdom. Promoting agroecological practices in co-experimentation mode that include reduction in use of external resources may be crucial for promoting sustainable food system.

9. Social values and diets

Information on local food-crops

In Mandla district, local food system has been traditionally shaped by mix of subsistence agriculture, agroforestry, and Non-Timber Forest Produces (NTFB), reflecting indigenous community's preferences. Major crops grown in Mandla are millets, pulses, cereals, oilseeds and seasonal vegetables and are part of dietary diversity. Figure 26 shows major crops and vegetables consumed in Mandla.

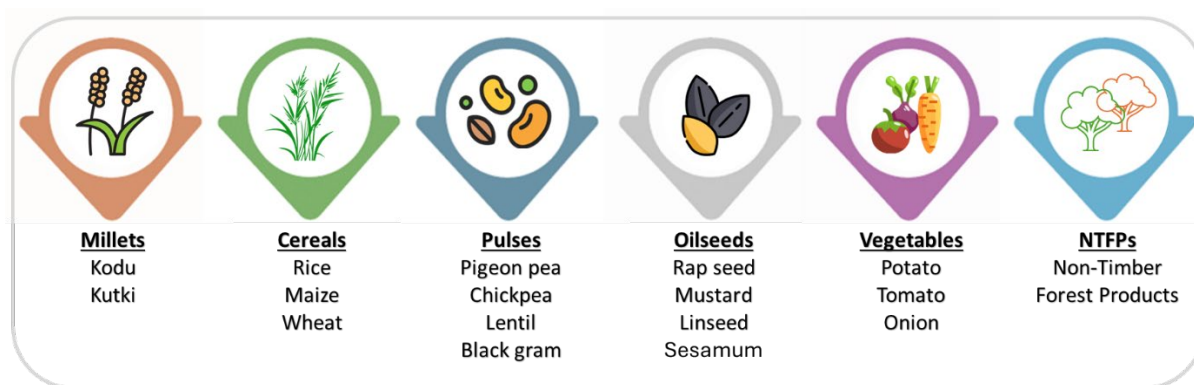


Figure 26 Major crops produced / consumed in Mandla (Design by: Sudharsan Malaipappan)

Millets, particularly Kodu (*Paspalum scrobiculatum*) and Kutki (*Panicum sumatrense*), are integral to Mandla's traditional diets and agricultural systems. Well-suited to the region's marginal lands with low soil fertility, variable climatic conditions, and water stress, these small millets are highly valued for their nutritional and ecological benefits. Kodu millet, one of the oldest cultivated crops in India, is rich in protein, phosphorus, iron, amino acids, and vitamin B, making it a resilient and nutritious staple (Bioversity International, 2018a). Similarly, Kutki millet, also known as little millet, has been grown in Asia since around 2700 B.C. and is notable for its low-fat content, high dietary fiber, protein, iron, carotene, zinc, and sulfur-containing amino acids like cysteine and methionine, which contribute to its balanced amino acid profile (Bioversity International, 2018b). However, both millets contain antinutrients such as polyphenols, tannins, and phytic acids, which reduce nutrient bioavailability. Processing methods like dehulling and decortication, along with specific cooking techniques, can significantly reduce these antinutrients and enhance nutrient availability (Bioversity International, 2018a; 2018b). In addition to millets, farmers in Mandla cultivate cereals like rice, wheat, and maize, which are dietary staples. Rice, grown as a rainfed crop during the monsoon (kharif) season, is the most widely consumed, while wheat, cultivated during the winter (rabi) season, serves as another key staple. Maize, a versatile crop, is used for both human consumption and livestock fodder. Farmers also grow pulses, essential sources of protein, and oilseeds, which are used for both local consumption and as cash crops, contributing to the region's dietary diversity and nutritional security.

Non-Timber Forest Products (NTFPs) play a vital role in the livelihoods and diets of Mandla's tribal communities, offering both cultural and nutritional value. Key NTFPs include mahua (*Madhuca longifolia*), chironji (*Buchanania lanzan*), jamun, tamarind, wild mushrooms, and amla, which form an integral part of the region's food systems and traditions. Among these, mahua and chironji are particularly significant. Mahua flowers, rich in sugar, are used to prepare traditional dishes, sweets, and culturally significant alcoholic beverages. They also serve as nutritious cattle feed, improving livestock health, while the seeds yield oil used in cosmetics and traditional remedies, and seed cakes are valued as organic fertilizers. Additionally, the leaves and bark of the mahua tree are employed in traditional medicine, emphasizing its multifunctional utility. Chironji seeds, rich in protein, healthy fats, dietary fiber, and essential vitamins, are a dietary staple in Mandla, used in a variety of sweet and savory preparations, further showcasing their cultural and nutritional importance. Together, these NTFPs sustain local diets, support livelihoods, and preserve cultural heritage in Mandla's tribal communities. The growing prominence of chemical-based monocropping, the decline in homestead activities, dwindling forest-based resources because of extractive approach of the community have led to a significant reduction in dietary diversity, jeopardizing nutritional security

and overall health. There is a pressing need to revitalize homestead farming and establish sustainable mechanisms for NTFP extraction to enhance social value and improve dietary diversity.

Knowledge of the nutritional facts of such food products

The knowledge gap in nutritional contents of various produce or harvest also led to imbalanced nutrition. A list of nutritional facts of various foods consumed in Mandla (Longvah et al., 2017) is presented in Table 20.

Table 20: Nutritional information on foods consumed in Mandla (per 100g) (Longvah et al., 2017)

	Protein (g)	Fat (g)	Fibre (g)	Carbohydrate (g)	Energy (KJ)
Maize	8.80±0.49	3.77±0.48	12.24±0.93	64.77±1.58	1398±25
Rice	9.16±0.75	1.24±0.08	4.43±0.54	74.80±0.85	1480±10
Wheat	10.59±0.60	1.47±0.05	11.23±0.77	64.72±1.74	1347±23
Lentil	24.35±1.10	0.75±0.04	10.43±0.39	52.53±1.05	1349±11
Cow pea	21.25	1.14	11.7	53.77	1340
Dal	21.70±0.50	3.26±0.03	1.56±0.03	9.06±0.30	55.23±0.83
Soybean	37.8	19.42	22.63	10.16	1579
Pigeon pea	20.47±0.72	1.38±0.08	22.84±0.43	42.48±0.77	1146±10
Peas	20.43±0.79	1.89±0.08	17.01±0.63	48.93±0.45	1269±13
Amaranthus	3.93	0.63	4.91	2.37	140
Bathua leaves	2.5	0.44	4.01	2.56	116
Jowar	9.97±0.43	1.73±0.31	10.22±0.49	67.68±1.03	1398±13
Ragi (Finger millet)	7.16±0.63	1.92±0.14	11.18±1.14	66.82±0.73	1342±10
Spinach	2.14±0.14	0.64±0.03	2.38±0.24	2.05±0.31	102±7
Bitter gourd	1.44±0.17	0.24±0.01	3.78±0.16	2.82±0.32	87±6
Bottle gourd	1.61	0.26	3.72	2.29	81
Brinjal	1.48±0.22	0.32±0.04	3.98±0.49	3.52±0.80	106±15
Cucumber	0.98	0.24	2.46	3.01	82
Drumstick	2.62±0.22	0.12±0.01	6.83±0.22	3.76±0.70	123±11
Ladies finger	2.08±0.37	0.22±0.03	4.08±0.20	3.62±0.26	115±5
Peas	7.25±1.03	0.13±0.02	6.32±0.26	11.88±0.67	340±19

Ridge gourd	0.91±0.08	0.14±0.01	1.81±0.13	1.72±0.46	55±7
Snake gourd	0.89	0.25	2.27	1.23	50
Tomato	1.12±0.08	0.27±0.07	1.62±0.08	3.18±0.40	87±7
Lin seed	18.55±0.15	35.67±0.70	26.17±0.39	10.99±0.86	1857±16
Niger seed	18.92±1.61	38.61±0.41	10.93±0.05	22.98±2.64	2144±11
Radish	0.89	0.16	2.29	6.07	130
Kodu	7.3		1.6	72	328
Jowar (Sorghum)	10.4		1.2	72.8	349
Ragi (Finger millet)	7.3		1.6	72	328
Bajra (Pearl millet)	11.6		1.2	65.5	361

Food consumption during festivals

In Mandla various tribal and non-tribal festivals are celebrated throughout the year. Food consumption during some of the festivals are part of culture and also adds to the nutrition and dietary diversity (Table 21).

Table 21: Food consumption during festivals

Festival	Community	Food Consumption
Navratra	Tribal	New rice and Torai cooked without mixing the salt in it and distributed as prasad.
Bidri	Tribal	Goat sacrifice to mark the beginning of the sowing season.
Hareli	Tribal	No work is performed; farmers worship implements and plant green twigs.
Navanna	Tribal	Cows are fed cakes made of new corn; offerings include green paddy to various deities.
Phag	Tribal	Celebrated post-harvest, with the consumption of mahua liquor.
Makar Sankranti	Non-Tribal	Laddus made of til (sesame) and jaggery are prepared and offered to God.
Aayal Ekadashi	Non-Tribal	Anola fruits are eaten and donated.

10. Fairness

Segments where intermediaries are involved in the supply chains

This section explores the principle of fairness in agroecology by examining the value chains and labor dynamics in Mandla, with a specific focus on Non-Timber Forest Products (NTFPs). It highlights challenges such as price disparities, monopolized markets, and limited access to value addition and market information, which disproportionately affect small-scale farmers and tribal communities. The section also delves into traditional labor practices like labor pooling and exchange, showcasing how they foster cooperation and resilience, yet are increasingly challenged by socio-economic changes and erratic weather conditions.

Mandla is home to various NTFP's (Table 18), which are an integral part of the tribal community's livelihood. Most of the NTFP's are tree fruits, flowers or nuts, some are plant fibres and a few are insect products (lac and honey). Tendu leaves (*Diospyros melanoxylon*) is also one of the key NTFPs in Mandla, which was the first NTFP's to be nationalized in 1964 by Tendu leaves Adhiniyam. Followed by harra, sal seeds and gums.

Collection of these NTFP's takes place based on three tier system:

- Village level: Primary Cooperative Society (PCS)
- District level: District union
- State Level: Madhya Pradesh Minor Forest Produce (MFP) Federation at the state level.

Villagers collect these NTFP's and sell it to registered buyers from forest department by paying in cash. Both men and women contribute equally to collection and sale of NTFP's. PCS manages the collection at village level, then grading and storage take place at the district level through district union. Finally, the products are acquired by MFP Federation for usage in their local brand of forest products or sold to traders for final distribution to consumers. PCS are the direct beneficiaries of all the profits. In some regions of Mandla, there is lack of knowledge and non-existence of PCS at village level (Priyam, 2017).

For NTFP that are non-nationalized, there were disputes between tribal communities and the government on the ownership of forest produces until the introduction of "Recognition of Forest Act, 2006", which helped clarify the rights issues. The "Recognition of Forest Act" has given the forest rights to Gram Sabhas, which regularly meets to decide the forest resource allocation to dependent communities, while protection forest ecosystem (Priyam, 2017).

Figure 27 shows the value chain for non-nationalized NTFPs in Mandla. Farmers who sell their products at village level weekly market, or to mobile vendors. Mobile vendors sell the products to the weekly market, where the traders procure large quantities of products which are then sold at regulated market (mandis) in Mandla city, sometimes at higher prices by exploiting the local farmers. Then bulk buyers procure the products from several district vendors and sell it to industries, exporters, and bigger buying platforms. Bigger buying also supplies industries and exporters.

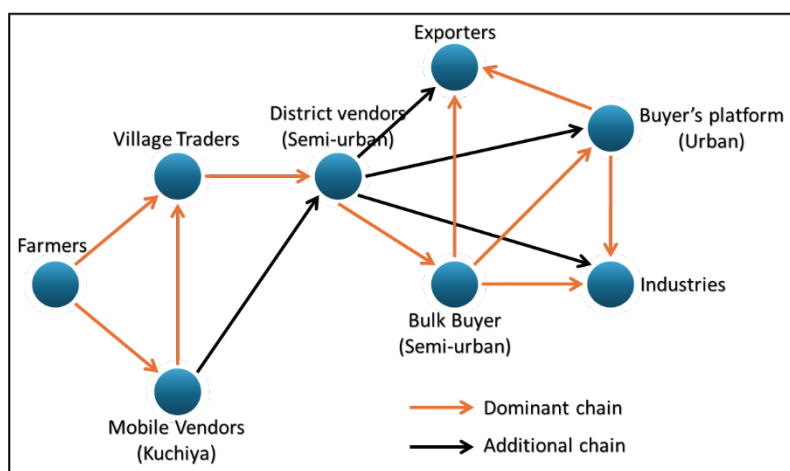


Figure 27 NTFP's value chain in Mandla District (Priyam, 2017) (Figure recreated by Sudharsan Malaipappan)

Farm-gate versus market prices of agroecological produces

The value chain for NTPS's heavily influenced by volume and transportation costs. Small farmers, lacking storage facilities, are forced to sell their products immediately (sometime at a loss) often to mobile vendors who pay about 62% of the village market price. Villagers also miss out on value added pricing due to lack of processing facilities. Legal restrictions and difficulty in obtaining licenses limit the number of traders, creating a monopoly market with few buyers.

Access to high-quality market information

Villagers often lack access to full market information and face transportation challenges, leading them to sell higher-quality products at lower prices.

Current key challenges concerning NTFP Value Chains in Mandla are -

1. **Price Disparities:** Small farmers often receive only 62% of market prices due to immediate selling needs and high transportation costs.
2. **Limited Value Addition:** The absence of processing and storage facilities prevents villagers from capturing higher profits through value-added products.
3. **Monopoly Markets:** Legal barriers and limited trader licenses result in monopolies, reducing farmers' bargaining power and creating exploitative conditions.

To ensure a comprehensive understanding of fairness in agroecological systems, it is essential to consider the dynamics of value chains and the labour and wage structures that underpin these systems. While value chains highlight economic inequities, labour practices reflect the social dimensions of fairness, including equitable access to employment and the preservation of traditional cooperative systems.

Wages for workers along agroecological value chains

In many villages, agricultural labour wages for the members of the village are fixed by the farmers themselves every year. After the Kharif harvest, in the month of January, all the farmers come to a field with a pair of bullocks and ploughing instrument, a small amount of beaten rice, sugar, beetle nut, molasses etc. Monadi (announcement about the meeting about the labour price fixing) in all the hamlets is finalised on that day. The Patel or Mukaddam (the traditional head of the village) proposes a price as labour wage which is seconded by someone else. Then unanimously they vote and decide the rate. The purpose of this practice is to keep the investment cost in agriculture low and accessible to all and is not defined by the market price. These practices are on the verge of decline.

Access to fair employment

During the agricultural season, labourers generally remain within their villages, even when external demand exists, until local cropping operations are completed. This practice ensures a steady labour supply for critical farming activities, enabling the smooth functioning of agricultural operations. Access to fair employment is essential for sustaining rural livelihoods, particularly in agrarian communities where the agricultural calendar dictates labour availability and dynamics. In these settings, traditional practices such as labour pooling and labour exchange have developed to meet seasonal demands, ensuring the timely completion of farming tasks. These systems provide not only vital support for small-scale farmers but also enhance collective resilience to challenges such as labour shortages and erratic weather conditions.

Traditional practices such as Labour pooling and exchange play a crucial role in sustaining small-scale agriculture, where timing is critical for various farming activities. Labour pooling involves mutual support among farmers where they collectively assist one another, ensuring that tasks are completed on time. This system enhances small-scale agriculture by fostering cooperation and resilience.

Labour Exchange provides a more flexible alternative to labour pooling allowing farmers to hire labour at set rates when needed. Payment for labour typically depends on whether the labour supplies implement, with village labour rates applying for work without implements and market rates for work involving tools like bullocks and ploughing equipment. This system becomes particularly crucial during periods of erratic rainfall, where farming operations must be completed within shorter timeframes. Together, these practices ensure timely agricultural operations and bolster the resilience of rural farming communities.

11. Connectivity

Information on the length of the distribution chains of farm products

In Mandla district, value chain and food system actors involved depends on the types of products. Small and marginal farmers sell their products (vegetables, fruits, small quantity grains) directly to consumers or small vendors in local weekly market, where intermediaries involvement is very minimal. Some farmers also sell directly to village level aggregators or traders, who then sell to larger wholesale markets (locally known as mandis).

For large quantity products such as grains (rice, wheat, maize), oilseeds, and Non Timber Forest Products (mahua, chironji), value chain often involves multiple layers, including commission agents, wholesalers, transporters, etc.,. Farmers usually sell to local traders, who then sell to large traders who further distribute to wholesalers at district or state level. Finally, wholesalers distribute to urban retail markets or processing industries.

Agricultural Produce Market Committee, locally named as *mandi*, also provides a major market for agricultural commodities to farmers of Mandla. It procures a variety of farm commodities such as grains, vegetables, NTFPs like mahua, and millets etc. To make the process more transparent and easier, Ministry of Agriculture and Farmers' Welfare, Government of India, has started electronic- National Agricultural Market (e-NAM) which is a pan-India electronic trading portal that connects the existing APMC mandis to create a unified national market for agricultural commodities. In Mandla, farmers e-trade millets, vegetables, pulses, mahua flowers and bamboo etc.

Existence of infrastructure to facilitate access to markets

Mandla has 7 warehouses in Bichhiya (1), Mandla (2), Narayanganj (1), Nainpur (1), Bahmnib Banjar (1), and Niwas (1) [the number in parenthesis indicates the number of warehouses in the particular locations]. The absence of post-harvest storage facilities at the district and local levels results in damage to the produce. Trunk roads connect Mandla with the nearby districts, which is the primary mode of transportation of goods. Figure 28 provides overview of road and railway networks in Mandla.

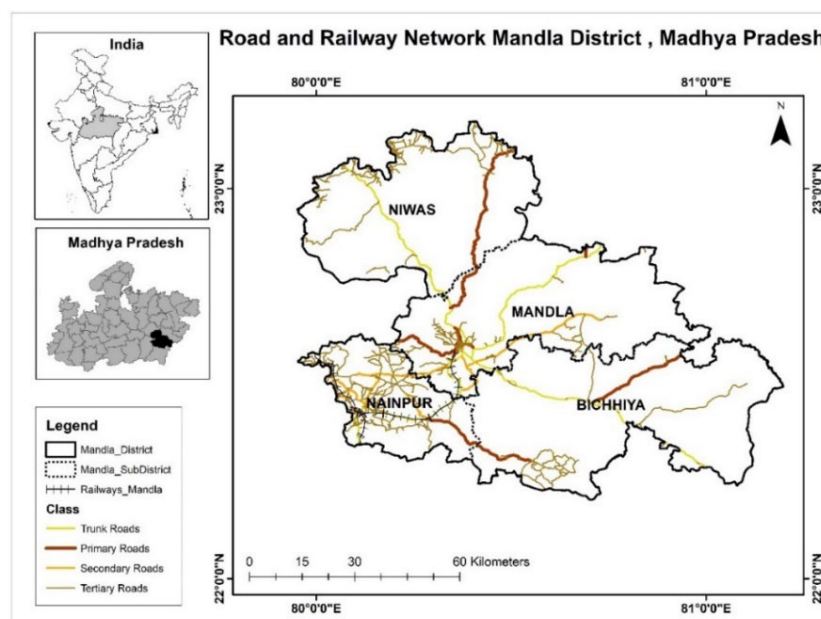


Figure 28 Road and railway networks of Mandla

Existence of communication channels between food systems actors

Communication between food system actors and market actors is established through traditional and community-based networks. Local/weekly markets serve as primary points of interaction, where farmers sell their produce directly to consumers. Additionally, Farmer Producer Organizations (FPO's), Self-Help Group (SHG's), Village Organizations (VO's) and Cluster level Federations (CLF) play a crucial role in linking producers with the market, enabling farmers to collectively discuss pricing, quality, and consumer needs. In recent years, NGO's and government stakeholders are promoting technology-driven platforms for better connect with the markets.

12. Land and natural resource governance

In Mandla district, land and natural resource governance is managed by government institutions, local communities, and traditional tribal practices. District administration and state forest department manage the governance of natural resources such as land use, forest conservation, revenue collection. The Tribal welfare department is responsible for granting tribal communities rights over land and forest resources through the Forest Rights Act (FRA). Gram sabhas and panchayat committees play a key role in managing the natural resources at the village level. Additionally, NGO's and local organizations support in management of land and natural resources.

Local community involvement in natural resource management

In some part of ALL, local community are integral part of natural resource management with the help of NGO's such as PRADAN. Within the ALL, they are educated on the importance of natural resource management through Gram Sabha meetings, where the concept of "5 J's" (Figure 29) - Jal (Water), Jeevan (Life), Jameen (Land), Jungle (Forest), and Janwar (Animals) are discussed.

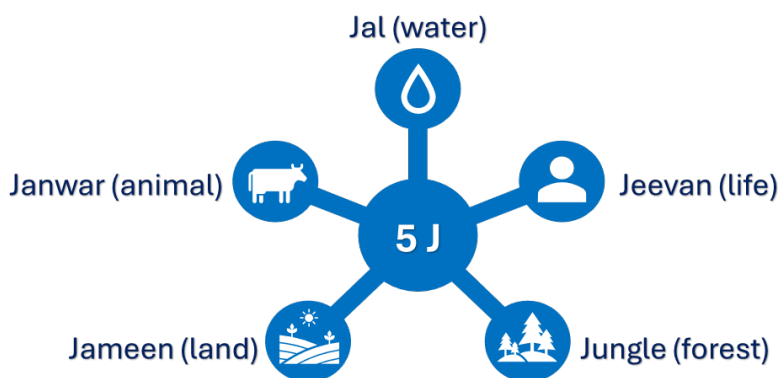


Figure 29 5J concept for natural resource management (Figure by: Sudharsan Malaiappan)

These meetings involve active participation of local leaders, women from Village Organizations (VOs), and Cluster Level Federations (CLF). The importance of sustainable management of natural resources is explained using Participatory Rural Appraisal (PRA) tools. PRA tools enable local communities to gain a deeper understanding of sustainable natural resource management through open discussion and engagement. After discussions, community members engage in resource mapping exercises, where village resources are mapped on paper - which helps villagers to visualize and understand the overarching view of availability, distribution and usage of natural resources. The local communities, including the youth, participate in a scoping walk through the landscape to assess the land's condition and its potential for improvement. Following this, community, technical experts and local leaders identify necessary interventions, which are prioritized based on immediate requirements of the community. To ensure transparency and consensus among all stakeholders, all decisions are made during Gram Sabha meetings. As last step, Program Execution Committee (PEC) is formed with at least 50% women, to oversee the implementation of the planned interventions. Figure 30 shows the governance process involved in the management of natural resources.

Financing mechanisms towards effective governance of land and natural resources

Financing, governance and management of common lands and natural resources is mainly done through MGNREGA. NRM (Natural Resource Management) activities encompass a wide range of practices aimed at

managing natural resources sustainably. These activities include efforts to manage land, water, soil, plants, and animals in a way that ensures their long-term sustainability and productivity.

Institutional structures responsible for promoting the adoption of the agroecological principles

Households, as an institution, play a crucial role in promoting biodiversity by using indigenous local seeds during the sowing season. In addition to using indigenous seeds, households strive to lower their farming input costs by recycling materials. This involves practices such as using compost made from animal manure, and crop residues to enrich the soil, instead of purchasing expensive chemical fertilizers. Recycling materials not only reduces the financial burden on farmers but also promotes sustainable farming practices by minimizing waste and enhancing soil fertility.

At the village level, cluster level federations (CLFs), Village Organizations (VOs), and self-help groups (SHGs) bring rural women together to participate in socio-economic, political, and cultural discussions. These groups plan activities to diversify their livelihood opportunities, such as practicing organic farming and poultry rearing.

At the Gram Panchayat level, government stakeholders, including the sarpanch, sachiv, and MGNREGA officials, are actively involved in managing land and natural resources. For instance, MGNREGA oversees initiatives like tree plantation, land development, and soil management. These activities are further supervised by block-level officials to ensure effective implementation.

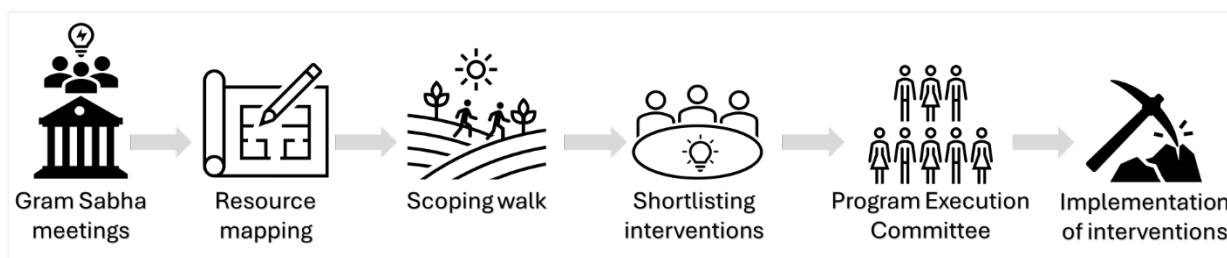


Figure 30 Village level natural resource governance process (Figure by: Sudharsan Malaiappan)

13. Participation

Existence of social organizations active in local management of food and agricultural systems

Key organizations driving the transition to agroecological practices are Foundation for Ecological Security (FES), Action for Social development (ASA), Professional Assistance for Development Action (PRADAN), BAIF Development Research Foundation, Tribal Knowledge networks, Agricultural extension services, local cooperatives, microfinance institutions, Farmer Producer organization (FPO's) and Self-Help Groups (SHG's).

Non-Governmental Organization (NGO's): In Mandla, FES, PRADAN and BAIF Development Research Foundation are some of the prominent NGO's working with tribal farmers to introduce agroecological practices such as natural farming, regenerative agriculture, natural resource management, agroforestry, livelihood improvement and biodiversity conservation.

Tribal Knowledge Networks: They document indigenous knowledge on agroforestry, medicinal plants, traditional farming system, local biodiversity, and promote sustainable natural resource management practices.

The State Agricultural Department supports the agroecology transition in Mandla by promoting climate-resilient practices such as organic farming, integrated pest management, and soil conservation techniques. It provides training and capacity-building programs for farmers to adopt sustainable methods, emphasising crop diversification and agroforestry. The department facilitates access to high-quality seeds, organic inputs, and subsidies for eco-friendly farming equipment. Partnerships with local cooperatives and farmer groups strengthen value chains and ensure fair market access for agroecological produce. Additionally, the department collaborates on water conservation projects, enhancing resource efficiency and resilience in farming systems.

Krishi Vigya Kendra (KVK), which is part of Indian Council of Agricultural Research (ICAR), conducts on-farm demonstration, farmer training programs and workshops, provides agricultural inputs and resource materials focussed on sustainable agriculture, climate resilient farming practices, etc.

The Department of Rural Development, through the National Rural Livelihoods Mission (NRLM), promotes agroecology in Mandla by organising rural poor households into SHGs and federations, fostering collective action for sustainable farming practices. By focusing on asset creation through local resources, NRLM aligns with the agroecological principles of economic diversification, synergy, and recycling, supporting diversified livelihoods through composting and repurposing agricultural by-products, building sustainable and resilient rural livelihoods.

Community led organizations: They play a pivotal role in driving agroecological transformation by empowering tribal communities to take collective action. In Mandla, several communities led organizations such as Joint Management Forest Committees (JFMC), Farmer Producer Organizations (FPO's), Self-Help Group (SHG's), Village Organizations (VO's) and Cluster level Federations (CLF) for sustainable promotion of agroecological practices.

Joint Management Forest Committees (JFMC) work with local communities for sustainable management of natural resources, agroforestry, protect biodiversity, and regulate the collection of Non-Timber Forest Products (NTFP's) such as Mahua (*Madhuca longifolia*) and Tendu (*Diospyros melanoxylon*).

Farmer Producer Organizations (FPO's) are formed by group of farmers who assists small farmers by providing access to markets, collective bargaining in procuring agricultural inputs, and other supports.

Self Help Groups (SHG's), Village Organizations (VO's) and Cluster Level Federations (CLF): These are grassroots groups, mostly led by women, with focus on income generation through sustainable agriculture practices.

Conclusion and Recommendations

The assessment of agroecological practices in Mandla reveals that while a diverse range of initiatives and practices already exist, they are largely fragmented and limited to small scales. These localized efforts, although impactful in certain contexts, have not yet achieved the systemic integration required for a broader agroecological transition. The lack of coordination, scalability, and adoption across the district leaves significant room for improvement in transforming Mandla's food systems into sustainable, resilient, and inclusive ones.

A comprehensive agroecological transition plan is essential to address the challenges of climate change, soil degradation, biodiversity loss, and economic vulnerability among smallholder farmers. Such a plan should build on existing practices while creating an enabling environment for scaling and sustaining agroecological innovations across the district. The assessment highlights the urgent need for more cohesive strategies that integrate ecological, economic, and social dimensions of farming in Mandla.

Recommendations

- Promote scaling of agroecological practices through the establishment of Agroecological Living Landscapes (ALLs) as multi-stakeholder platforms for co-designing and implementing innovative solutions.
- Foster **collaborations among local communities, NGOs, research institutions, and government bodies** to create synergies and enhance resource-sharing across the district.
- Strengthen **farmer networks and knowledge-sharing platforms** to disseminate successful practices and empower local communities through participatory approaches.
- Enhance **market access and value chains** for agroecological products to ensure economic viability for farmers, particularly smallholders.
- Integrate **capacity-building programs** targeting women, youth, and marginalized communities to drive equitable participation in the agroecological transition.
- Invest in **infrastructure and policy support** for water conservation, soil health management, and biodiversity restoration, aligned with agroecological principles.
- Encourage the adoption of **nature-based solutions** such as crop diversification, agroforestry, and renewable energy use to build resilience to climate variability.
- Develop **financial mechanisms and incentives** to support smallholder farmers in adopting and sustaining agroecological practices, including subsidies, loans, and insurance schemes.
- Conduct **multilocation trials and participatory research** to evaluate the scalability and adaptability of agroecological models across diverse agro-climatic zones.
- Prioritize the creation of **inclusive governance structures** that ensure community ownership, participation, and decision-making in agroecological planning and implementation.

By addressing these gaps and scaling up existing initiatives, Mandla can become a model for sustainable agroecological transformation, demonstrating how fragmented efforts can evolve into a cohesive and impactful strategy for resilient food systems.

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Annexures

Annexure 1: Information on recycling practices

Vermi compost, involves converting organic waste, including crop residues and biomass into nutrient-rich compost using earthworms. The process begins with setting up a composting tank in a suitable environment - shaded, humid, with proper drainage. Soil or sand, partially decomposed organic matter, and bio waste - are layered within the composting tank, which creates the optimal environment for the introduction of earthworms. This method simulates the natural behaviour of earthworms, which live in soil and feed on biomass. The resulting compost is rich in plant nutrients, vitamins, and growth-promoting substances, improving soil biodiversity and microbial communities, and thus boosting agricultural production. Each vermicompost pit contributes towards production of 200 to 300 kgs of vermicompost per annum.

Biochar preparation: Although a large proportion of Mandla district is under forests, these forests are heavily infested by invasive species, particularly *Lantana camara*, an exotic plant from South America. *Lantana camara* poses a significant threat to both commons and private uplands. FES, in partnership with tribal communities has undertaken measures to control *Lantana* and successfully restored 6000 hectares of land. The uprooted *Lantana* is used in the preparation of biochar, which is used for improving soil organic carbon in homesteads that were otherwise deficient. The process of producing biochar involves drying the removed *Lantana* plants and heating them in a drum with limited oxygen. Initially, the *Lantana* wood is burned with the drum open, allowing for complete combustion. Once the wood is fully ignited, the lid is closed, and the process continues overnight to create biochar.

Farmers practice two methods of biochar application (mixing biochar with Cow urine and mixing biochar with compost (saturating with cow dung) with a ratio of 1:1 and saturated for 5 days).

Crop residues: In addition to the above practices, crop residues are left on the field, during ploughing, get mixed with the soil and decomposes, and works as manure and increases the soil fertility. It contains useful recyclable components, such as nutrients, solids, energy and fiber that enhance the soil quality. Paddy straw, the residue left after harvesting rice, has versatile applications in agriculture. It can be used as an organic mulch to conserve soil moisture, regulate soil temperature, and suppress weed growth. Additionally, paddy straw serves as an excellent raw material for vermicompost production, contributing to the creation of nutrient-rich organic fertilizer.

Annexure 2: Information on input reduction practices

Farm Yard Manure (FYM): FYM is a nutrient-rich organic material composed of decomposed livestock dung and urine, along with straw and other bedding materials. It plays a crucial role in enhancing soil fertility by providing essential nutrients such as nitrogen, phosphorus, and potassium. FYM also improves soil structure, increases microbial activity, and enhances the soil's ability to retain moisture. Its application helps in nitrogen fixation, which is vital for the growth of crops. FYM reduces the dependency on synthetic fertilizers for nutrient management.

Mulching: Mulching involves covering the soil around the crop plants with protective layers, providing several agricultural benefits. Mulching is usually done using dry straw of cereals, millets, pulses, and even oilseed crops. Mulching significantly reduces the proliferation of weeds, reduces competition for nutrients, and leads to significant labour savings, estimated between 24 and 40 days per acre. These labour savings translate to substantial economic benefits, ranging from \$43 (INR 3600) to \$72 (INR 6000) per hectare, a considerable figure given local wage rate. As a result, mulching has been widely adopted, especially on homesteads.

Local seeds: Farmers use both hybrid seeds and local indigenous seed varieties, such as seeds of kodo, kutki, paddy, and few varieties of maize and paddy. Using local indigenous seeds not only preserves the genetic diversity

but also reduces the dependency on external inputs. They store these seeds in bamboo baskets or in a container made from mixture of paddy straw and soil at household level. They store the grains in such an environment that there is no passage of air which affects the seed quality. The farmers also get the good-quality seeds from Farmer Producer Companies (FPOs) at a cheaper rate. To further optimize resource usage, activities such as Direct Seeding of Rice (DSR) and System of Rice Intensification (SRI) are practiced reducing the quantity of seed required for paddy cultivation.

Farm mechanization: The traditional farm equipment's such as seed drills and ploughs, is still being used for various farm activities like ploughing, harvesting, sowing. However, farmers are increasingly shifting towards mechanization by renting heavy machineries to achieve higher return in lesser time.

Bio Resource Centers (BRC): Embracing the regenerative agriculture approach, women-led Bio-input Resource Centers (BRC) has been established in the district. These centers focus on the preparation of bio inputs such as bio fertilizers and biopesticides for nutrient and pest management. In addition, automated Bio Resource Centers have also been established in the blocks of Mohgaon and Bichhiya for improved composting techniques, which play a crucial role in converting organic waste into nutrient-rich soil stimulants while also reducing drudgery.

Rainwater harvesting: Harvested water, collected from rainfall or other sources, is a valuable resource for irrigation and other agricultural activities. It is used to irrigate crops, ensuring an adequate water supply during dry periods. Moreover, harvested water can be utilized for various household chores, reducing dependency on external water sources and promoting sustainable water management practices.

Annexure 3: Information on soil health practices

Mulching: Mulching involves covering the soil around the crop plants with a protective layer which helps to maintain soil moisture, is crucial for seed germination, reduces weed infestation, enhances water percolation, reduces irrigation water requirements, reduces soil compaction which can adversely affect the roots of crops, resulting in reduced growth and development of plants. Mulching also adds to soil temperature buffering and creates a controlled microclimate.

This practice though limited in extant, is timed with the patterns of the rainy season and the various phases of crop cultivation. For example, farmers plough their fields before the maize sowing season, which traditionally starts in the final week of June. This is often done using a pair of bullocks. Soon after sowing, a substantial layer of mulch is applied, three to four inches thick (7.5 to 10 cm), insulating the soil. This mulch typically consists of dry straw of cereals, millets, pulses, and even oilseed crops.

Organic compost: Farmers use organic compost, vermicompost, cow dung compost in the form of Farmyard manure (FYM) as alternatives to synthetic fertilizers. A few farmers also use biofertilizers and bioformulations such as *beejamrit*, *jivamrit*, *whapasa*, and biopesticides such as *neemastra*, *bhramastra*, *agniastra* for plant protection.

To reduce soil erosion, agroforestry is also a method used by farmers of Narayanganj block. They plant trees such as mahua, bamboo, sal on the boundaries of the agricultural land to retain the soil moisture and reduces erosion. Very few farmers also adopted efficient irrigation techniques such as drip and sprinkler irrigation, which reduces runoff and soil erosion.

Stone bunding

In Mandla, construction of stone bunds along the natural contour lines reduces soil erosion and increases agricultural potential. Bunds of various dimensions can be seen in fields specially in stone abundant area. In case the construction of the bunds done by technical team it follows precise dimensions i.e. one metre in width at the top, expanding to about 1.25 m at the base, with a height of 85 cm. It helps in slowing runoff, protect the crops from wind, curtail soil erosion and promote the gradual build-up of nutrient-rich enhanced soil.

Green manuring for improving soil health

Azolla is being promoted by CSOs and local institutions in agriculture field to control weeds, retain moisture in the soil and helps in nitrogen fixation. Azolla also helps in protecting crops against unusual dry weather and improves soil productivity. Farmers believe that Azolla has helped in reducing the labour cost for weeding as it does not allow weeds to grow in paddy field. This it reduces the drudgery of women and increases crop yield.

Silt Application as a soil health improvement practice.

Water bodies in command area are silted that limits storage capacity and in need of de-siltation. The excavated silts contain organic matter from decomposed flora and fauna, making the silt nutrient rich which can be used for improving soil health. Farmers apply the silt in the agriculture field to improve soil health and crop productivity. Silt application facilitates the growth of earthworms in crop fields. Earthworms play a crucial role in improving soil fertility, soil aeration and water infiltration, which are vital for healthy plant growth.

In Mandla, on an average, 2-3 ponds/tanks and a stream can be found in many of the villages. Traditionally these water bodies are used for daily ablutions, as drinking water for cattle and for other purposes such as local traditional festivals. The local communities maintained such ponds by de-silting them and the collected silt is applied on croplands. Presently these waterbodies are expected to be maintained by the village panchayat, the local governing body. This has led to poor maintenance and reduced the water holding capacity of the waterbodies.



Contact

Sudharsan Malaiappan, Research Officer, International Water Management Institute (IWM), New Delhi, India s.maliappan@cgiar.org

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