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Climate Resilient Livelihoods with Minor Millets in Mandla

Livelihood Opportunities for Vulnerable Communities in Mandla, Madhya Pradesh

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As at
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Supporting Millet Value Chain to Promote Climate Resilient Livelihood Opportunities for Vulnerable Communities in Mandla, Madhya Pradesh

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List of Acronyms

ASA	Action for Social Advancement
FPC	Farmer Producer Company
GI	Geographic Indication
IMD	India Meteorological Department
JNKVV	Jawaharlal Nehru Krishi Vishwavidyalaya
KVK	Krishi Vigyan Kendra
MBCFPCL	Madhya Bharat Consortium of Farmer Producers Company Limited
MCA	Ministry of Corporate Affairs
MK	Mann–Kendall
MPI	Multidimensional Poverty Index
MP SAPCC	Madhya Pradesh State Action Plan for Climate Change
NABARD	National Bank for Agriculture and Rural Development
NRLM	National Rural Livelihoods Mission
NTFP	Non-Timber Forest Produce
PC	Producer Company
PDS	Public Distribution System
PTG	Primitive Tribal Groups
SFAC	Small Farmers Agri-Business Consortium
ST	Scheduled Tribes

Background

Minor millets are central to traditional rainfed farming systems of marginalized and poor communities living in India's backward rainfed tracts, including the Scheduled Tribes and Scheduled Castes. They have an important place in the food system and culture of Gond and Baiga communities in eastern Madhya Pradesh. Of the six minor millets grown in India, the most important that is grown in Eastern Madhya Pradesh is the Kodo millet, i.e., Paspalum iscrobiculatum, and the little millet, known locally as Kutki, i.e., Panicum sumatrense/Panicum miliare. Kodo and Kutki are indigenous to Mandla and nearby districts. Kodo and Kutki are two different millet varieties belonging to the same family of minor millet crops. Both are drought-tolerant with a long shelf-life. Local farmers say that it can be stored for 100 years and will still be suitable for consumption. It could survive and grow in conditions where the soil is of marginal quality (locally known as Barra lands) with very thin top-soil. Interestingly, as per the traditional farmers, it does not require too much soil depth to grow and virtually does not need a lot of moisture from the land. The traditional varieties that they have been growing do not require good land quality to grow Kodo-Kutki minor millets. Its benefits far-outweighs the kind of land where it usually grows.

Minor millets are highly nutritious as they contain high amounts of proteins, fibre, vitamins like B-complex, vitamins including niacin, thiamine and riboflavin and vitamin E and the essential sulphur-containing amino acid methionine, lecithin. They are rich in minerals like iron, magnesium, calcium and potassium. It helps to effectively manage lifestyle diseases like obesity, diabetes, hypertension, stroke, anaemia and some kinds of cancer[1]. Traditionally minor millets, which occupied a definite space in the poor's daily diet, have vanished from their food basket. This is due to the green revolution and the public distribution system (as pushed by the Government), which intensively promoted carbohydrate rich food rice and wheat, which has led to nutritional deficiencies and adversely affected the country's traditional cropping system.

Millets are not only richer in nutrients than staple grains but also resilient to climate change impacts. They can also be cultivated in drought-prone areas in many arid parts of the country as they require much less water. Besides, "those who traditionally used to consume millets have moved away from it. Unfortunately, most Kodo-Kutki areas are now under paddy, maize, and other horticulture crops. Though farmers in tribal areas of Mandla continue to grow millets," says Shri Jagatram Chicham, President of the Van Samiti, Semikul Village, Mandla.

Mandla emerged on the developmental sector radar with prominence around 2010-11 when multiple non-profit organizations launched their operations focusing on farm & non-farm interventions and collectivization through Farmer Producer Companies (FPCs).

Development agencies working on food security and climate adaptation are promoting Kodo-Kutki as climate-resilient crops.

A few FPCs promoted by them have focused on Kodo-Kutki. Emerging indications show that consumer demand for minor millets is growing in more urbanized centers like Delhi, Mumbai, Bangalore, Chennai, and Tamil Nadu, Maharashtra and Gujarat due to increasing awareness and value of health, nutrition, eco-consciousness, and going back to roots concepts.

[1] https://www.dhan.org/developmentmatters/docs/2014/Development-Matters-February-2014.pdf

Objective and Scope of the Study

This study's overall objective is to map existing processes, benefits, and constraints within the millet value chain and the vulnerabilities posed by climate change and suggest informed measures to build the resilience of minor millets and its cultivators to the impending impacts of climate change. The district administration, community-based organizations, private sector entities, and other stakeholders such as NABARD and GIZ can take these measures for replication, scaling up and enhancing the value share of small and marginal farmers in the process.

This study is an analytical assessment of the millet value chain with the following scope:

- Screening for Climate Vulnerability of the Mandla Agricultural Region and exploring additional adaptation opportunities in the context of millets with FPCs.
- Identification of adaptation opportunities in the millet cultivating regions in Mandla shall provide an understanding of additional adaptation measures that would make millet a viable business model in the local agricultural economy and climate-proof millet value chain.
- Identification of bottlenecks in creating an incentive for millet production by FPCs and local farmers would give an insight into the possible strategies to address these bottlenecks and incentivize millet cultivation in Mandla.
- Exploring possible solutions and financing opportunities for climate adaptation and up-scaling of FPC activities.
- Analysis of various processes and activities carried out at each stage in the value chain, including production, trading, storage, transportation, processing, and value addition, to identify blockages and their causes.

Mandla Ecology & Physiography

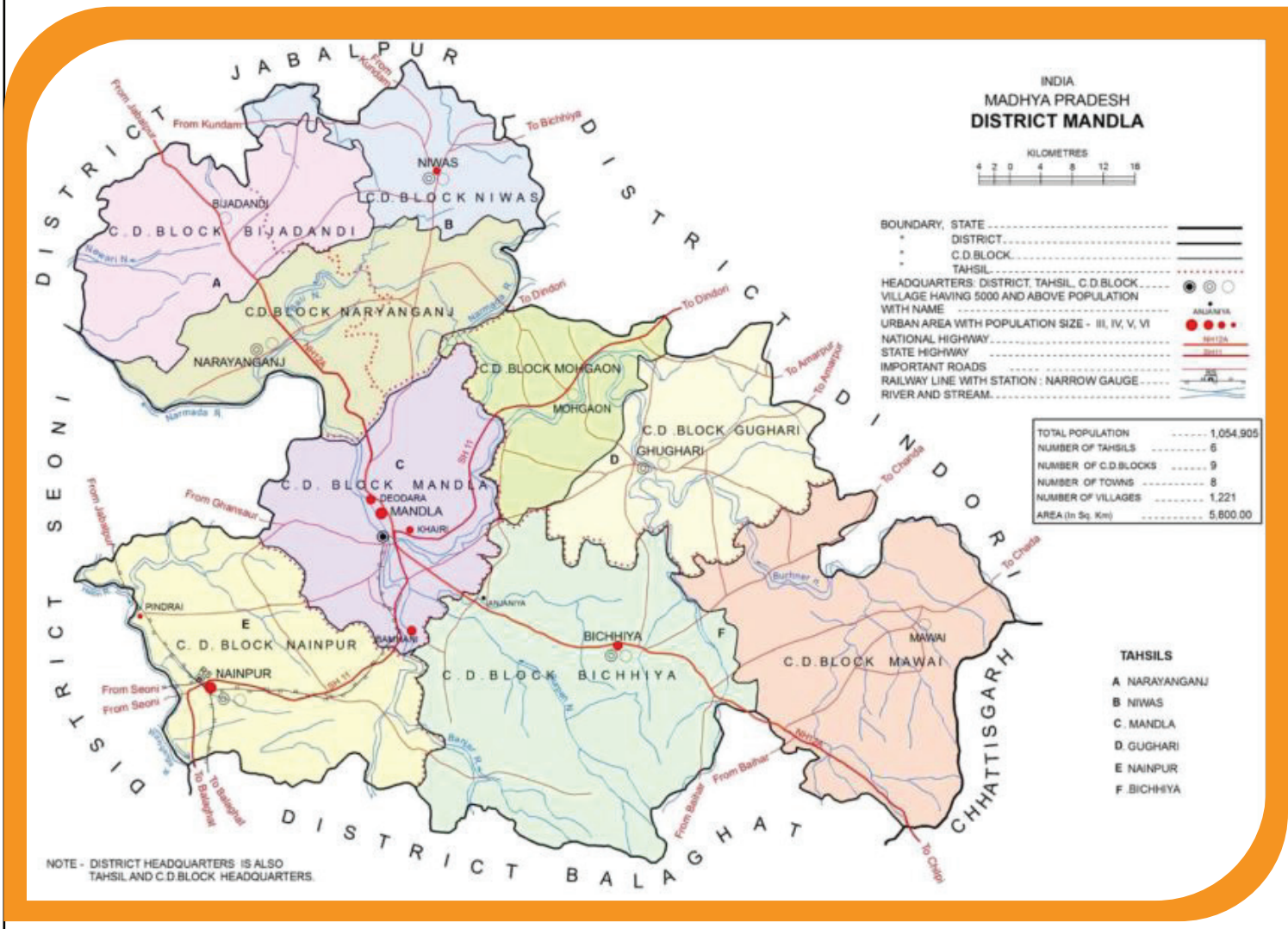
Mandla district consists of a rugged, high table-land in the eastern part of the Satpura hills, important being Maikal ranges, which forms a watershed between western and eastern India and divides the eastern region of the district into several undulating plains. Numerous small valleys and table-lands intersected by seasonal streams and rivers with table-lands at hilltops locally known as Dadar, are prominent topographic features of Mandla. The undulating topography of the Satpura ranges produces matrices of hillocks and plateaus with a table of grasslands. Many of Narmada's tributaries, such as Gaur, Balai, Banjar, Burhar, Kharmer, Kikara, and Matiyari, originate in the dense forests of Mandla.

As per the 'Soils of the World', the soils of Mandla are categorized as brown earth. In the local nomenclature, the soil is divided into four classes – Kabar or Kanhar, Morand or Mund, Sahara, and Barra. Of these four, Barra is of crucial importance to this scoping assessment.

Barra is the most ubiquitous type of soil in Mandla. Barra is a broad term covering red or yellow varieties and inferior qualities of black soil. It may be described as a red gravel or murram soil, often extraordinarily stony or with underlying rock within 8 to 12 inches. Large expanses of red Barra are found on Dadar – the flat tops of hills. These soils mostly support grasslands with few trees. They are not suitable for paddy but support crops with less water requirement like maize, oilseeds such as rapeseed, niger seeds, minor millet crops such as Kodo and Kutki. The topography, soil, and geology of the area are such that it does not hold water for long durations, causing water scarcity in the summer season. The irrigation facilities are poor and limited to areas adjoining dams and canals, predominantly in the Haveli and Pathar regions. For domestic purposes, people use water from rivers, streams, and small traditional wells.

The groundwater recharge is determined by geography, rainfall, lithology, and drainage density in an area. Most of the Mandla district is occupied by the Deccan Trap, which inhibits water percolation. The drainage density is also higher, which does not permit water to stay for longer durations, causing rainwater to flow away in the river and streams. In the area adjoining rivers and streams, groundwater is derived in fractures, while water scarcity is common on the hills (Dadar). Groundwater can be obtained from the murram formed after weathering of the trap zone. During and after the monsoon, water is available in the wells before drying up in summer.

Mandla District Map



Gond and Baiga Communities

Mandla district is a part of Mahakaushal, a region home to the 'Gond', and Primitive Tribal Groups (PTGs) and 'Baiga' communities. According to the Census of India 2011, 57.9% of the district's total population consists of scheduled tribes. 87.7% of the district population lives in rural areas, and about 28% of the household income is earned through the collection and sale of forest produce. The Gond community is rural and depends on the forest-agriculture interface, but they also practice settled agriculture. The Baiga community is also a forest-dependent community where bamboo collection, basket weaving, and NTFP collection are the primary livelihood sources. Baigas traditionally practiced Bewar, shifting cultivation practice, but slowly many have taken up plow cultivation.

In the Bewar practice, crop diversity is considerably high due to mixed cultivation, traditional varieties of crops, and customary cultivation practices. A Bewar consists of two to three acres of thick forest, often on a steep slope. Around May, all wood is cut down and burnt in situ and the ashes spread over the surface; at the onset of rains, Kodo, Kutki, baiganitur, or sweet potatoes are sown in the ashes. Provided the rains continue late enough, a plot of this kind supports crops until the fourth year, before a fresh Bewar is initiated.

Agriculture is mostly rain-fed. A district average of 9% of the total areas under cultivation is irrigated. Of the two cropping seasons, Kharif (commonly called Siari) is of great relevance in terms of area and growing principal cereal and millet crops. In the past, high crop diversity was prevalent in Mandla. There are paddy varieties that are endemic to the region, signifying the local genetic diversity. The largest grown single crop has traditionally occupied minor millets, Kodo and Kutki, a staple food of the tribal[2] population. While rice is the most extensively cropped, wheat is also grown in fertile portions of the district. Besides, other crops are maize, red gram, lentil, niger, and mustard.

The Gond and Baiga communities in Mandla have been consuming millets for generations. Still, many have adapted to rice consumption because of subsidized rates and rice preference by the younger generation. Besides, millet processing is complicated, says Smt Sushila Watti, a millet farmer and a member of the Board of Directors of the Narmada Self-Reliant Farmers Producer Company, Mandla. Women like Watti spend hours dehusking the millet with musar/musal, a traditional wooden pounding instrument, or Jaata. Nevertheless, women have begun growing Kodo-Kutki as they become aware of its water efficiency, nutritious value, and a sense of pride in reviving minor millets as part of indigenous food culture.

Methodology of the Study

To study the millet value chain, we covered the minor millet growing district of Mandla in Madhya Pradesh. Mandla and Dindori districts fall under the Agro Climatic Zone (NARP) North Hill Zone of Chhattisgarh (MP-3). Mandla district located in eastern Madhya Pradesh is occupied by the Narmada basin consisting of the north-eastern part of the Son sub-basin and south-western (Wainganga sub-basin) and south-eastern extent (Seonath sub-basin) of the Godavari basin. The fieldwork was carried out in one phase in January 2021. The COVID-19 pandemic imposed restrictions on people's gathering, which affected our study. Given an opportunity, we would like to conduct a second visit to analyze the issues that surfaced during the first round strategically.

[2] Farmers recollect their ancestors' guidelines to save Kodo-Kutki for the lean agricultural periods/persistent drought seasons and its friendly soil system approach. Before paddy cultivation took deep roots as the primary crop, this area was not associated with paddy. Tribal households used to grow minor millets, ragi, horse grams, etc. Kodo-Kutki fixes nitrogen in the soil, grows on infertile lands, requires little or almost no significant inputs, and is pocket-friendly to the farmers. They are conducive to the climate and do not contribute to the drivers of climate-related impacts, which can cause any difficulty for the value chain in Mandla.

We undertook the following interconnected steps to carry out the study:

1. Data collection and research;
2. Identification of climatic risks and impact;
3. Analysis of opportunities and constraints;
4. Recommendations for future action.

The fieldwork's core objective was to understand the dynamics of minor millet cultivation in Mandla as perceived by farmers, wholesalers, arhtiyas[3], processors - to identify challenges, contradictions, and opportunities. The primary survey, Key Informant Interviews, and Focus Group Discussions were carried out on the field in Mandla, where questionnaires were administered across the district in Mandla. Due to the COVID-19 pandemic, it wasn't easy to congregate and hold meetings everywhere. Besides, we collected secondary data on poverty and rainfall to understand climate variability in Mandla.

Table 1: Below mentioned is the list of stakeholders that were interviewed across the study area.

Instruments	Stakeholders
Meeting and Focused Group Discussions	• Reliance Foundation Team Members • Board of Directors and CEO of Narmada Self-Reliant Producers Company Limited • FPC CEOs and Promoting Organizations: (1) Mandla Tribal Farmer Producer Company (Mandla TFPC), promoted by ASA (2) Maheshmati Tribal Farmer Producer Company Ltd (Maheshmati TFPC), promoted by ASA (3) Kanha Krishi Vanopaj Producer Company Limited (Kanha KVPC), promoted by NRLM
Key Informant Interviews	• Mandla Mandi Trader • Village-based Arthiyas • ATMA agriculture expert
Semi-structured Interviews	• Cultivators • Shopkeepers and Grocery stores

[3] The arthiya isn't a trader holding title to the grain bought from a farmer. They merely facilitate the transaction between a farmer and actual buyer, who may be a private trader, a processor, an exporter, or a government agency like the Food Corporation of India (FCI). Their role and position is more akin to a broker.

Poverty Analysis of Eastern Madhya Pradesh

The Multidimensional Poverty Index (MPI) identifies multiple deprivations at the household and individual level in health, education, and standard of living. It uses microdata from household surveys. Each person in a given household is classified as poor or non-poor depending on the weighted number of deprivations his or her household, and thus, he or she experiences. These data are then aggregated into the national measure of poverty.

The MPI reflects both the incidence of multidimensional deprivation (education, nutrition, health, child mortality, access to fuel, sanitation, electricity, drinking water, housing, and assets). Therefore, a headcount of those in multidimensional poverty and its intensity (the average deprivation score experienced by poor people) has been computed. It can create a comprehensive picture of people living in poverty and ascertain the incidence of poverty. It permits comparisons across countries, regions, and the world and within countries by ethnic group, urban or rural location, and other key household and community characteristics.
The MPI offers a valuable complement to income-based poverty measures.

The table below reports the Multidimensional Poverty Index and its two components - the Headcount Ratio and the Intensity of Deprivation among the five districts in eastern Madhya Pradesh.

Table 2: Multidimensional poverty of the districts

District	People undernourished	Headcount ratio: Population in multidimensional poverty (H)	Intensity of deprivation among the poor (A)	Multidimensional Poverty Index (MPI = H*A)	Rank in the state among 51 districts	Rank in the country among 640 districts
	% Population	% Population	Average % of weighted deprivations	Range 0 to 1	Rank 1 being poorest, 51 being the least poor	Rank 1 being poorest, 640 being the least poor
Dindori	46.1	61.2	45.4	0.278	4	38
Mandla	40.5	54.6	45.2	0.247	8	65

According to the Multidimensional Poverty Index in Dindori and Mandla's districts, where millets are produced at large, almost half of the population is under poverty. The headcount ratio of poverty is highest in Dindori at 61.2% of the population, followed by Mandla at 54.6%. The average weighted deprivations (education, nutrition, and standard of living) is ~ 45% in the districts.

The Multidimensional Poverty Index in the country is 0.121, whereas it is almost double in all the districts. We analysed the districts' rankings inside the state (Rank 1 means the poorest and 51st the least poor). There are 51 districts in the state and 640 districts in the country measured for the rankings. Dindori (0.278) stands at 4th in the state and 38th in the country, signifying the absolute poverty that exists in the district. Mandla (0.247) is ranked 8th in the state and 65th in the country. As seen in the table, the number of poor people is very high, with 55% in Mandla and 62% in Dindori.

Millets in Mandla and Climate Change

The topographical feature of Mandla cannot support water-intensive agriculture. Yet, it is also the origin point of several rivers and provides opportunities to develop irrigation facilities suitable for agriculture. Mandla is located in the flood plain of the Narmada river and the Satpura Mountain range's topographical landscape. The area mainly features a plateau. Minor millets are generally suitable for dry and marginal lands[4]. Minor millets have been grown under rain-fed conditions by tribal farmers in Mandla and adjacent districts. They are drought-tolerant crops and survive in conditions where the soil is of marginal quality. They have low water requirements and early maturation, which helps them escape drought. Their grains have high fibre content, good protein quality, mineral composition, and nutraceutical values. It has traditionally been associated with the poor as their crop; the economically better-off class does not consume minor millet much. Historically, due to its accessibility to the poor, Kodo-Kutki has played an essential role in providing nourishment to people across different income categories. Now, it is widely considered for supporting climate adaptation of rainfed farming systems. Kodo-Kutki is effectively under the category of super-cereals.

Madhya Pradesh has a stagnant production of hardy species of pulses, oilseeds such as alsi, millets such as ragi, and minor millets such as Kodo-Kutki grown without fertilizers in eastern Madhya Pradesh. These crops are important to maintain food security in the state and the district as they can be grown even in water stress and high-temperature conditions. The nutritional content of the millet exceeds that of both rice and wheat. They are a rich source of protein and fibre. With 66.6% carbohydrates and 353 kcal per 100g, these millets can tackle malnutrition and stunting among children efficiently. Farmers and cultivators have awareness and traditional knowledge of the importance of the Kodo-Kutki in their food basket, why their ancestors continued growing and relying on minor millet. It has become difficult to grow them. But, from a local consumption perspective, a major challenge has been dehusking. Dehusking Kodo millet is a tough task as they contain seven inedible layers that need to be removed before consumption. Rice and wheat's easy availability through the Public Distribution System (PDS) has contributed to a shift in food consumption patterns in millet producing regions. More research inputs on technology from the scientific research stations and linkages with the market are required to improve their productivity.

Climate Trend and Variability Analysis

Climate change has been proved by the changing weather patterns, warming of the oceans and atmosphere, variations in the water cycles, sea-level rise, melting of the glaciers, and decreasing snow and ice cover on the earth poles and the third pole, i.e., the Himalayas. India is a peninsular country with a majority of the population dependent on the agriculture and allied sectors. Agri-allied sectors are highly susceptible to climate variability; amid this, the temperature and rainfall directly distress the farm production (Thornton PK, 2014). Moreover, it has indirectly increased soil erosion, decreased water supplies, groundwater level, and irrigation.

A higher rainfall variability, less diversified agriculture, and increased droughts and floods directly bear on food production and supply. Change in rainfall and increase in temperature would remarkably affect the Indian agriculture and allied sectors. In light of these observations, we aimed to study the trend of annual and seasonal rainfall and temperature variability in Mandla over the period of 1991 to 2020.

Climate variability, such as temperature and rainfall pattern, is examined in this study. Data was obtained from NASA from the year 1991 to 2020. The rainfall and temperature data are expressed in millimetres and degree Celsius, respectively.

[4] Besides, Kodo-Kutki requires a certain soil depth and moisture content (Neither too much soil nor too little). Therefore, it is primarily grown on lands which are known as Barra land. Any farmer with access to barra land grows Kodo-Kutki. The sowing season only starts after paddy transplantation to the field. The usual time period to show Kodu-Kutki is around August 10th and is sown via the broadcasting system.

Time Period for Data Analysis

Millets are grown as a Kharif crop in Madhya Pradesh. They are typically sown from June to July and harvested between September to October.

In this study, temperature and rainfall data have been analyzed for the entire year. However, special emphasis has been given to the monsoon season (June- September) as it is the growing season for millets. For climate data analysis year-round temperature and rainfall data were grouped into different seasons as per the India Meteorological Department's seasonal definitions (IMD). The rainfall intensities as defined by the IMD were also used for further analysis of the rainfall data.

Methodology for Trend Analysis

Test for Anomaly, Percentage Change

Changes were calculated as a percentage change over 30 years in annual and seasonal rainfall.

1.1. Mann–Kendall (MK) Test

The MK trend test is a non-parametric test used to identify a time series trend and determine whether a time series data has a monotonic upward or downward trend. This test has low sensitivity to abrupt breaks due to inhomogeneous time series. The non-parametric MK test is commonly used to detect monotonic trends in a series of climate data. In this test, the null hypothesis (H0) states that there is no trend in the series, and the data which come from an independent population are identically distributed. The alternative hypothesis (Ha) indicates that the data follow a monotonic trend. This test's significance is that it does not require the data to be normally distributed since the test is non-parametric (distribution-free test). Further, the test has low sensitivity to abrupt breaks due to inhomogeneous time series.

Consider the time series $x_1, x_2, x_3, \ldots$ Xn represents n data points.

The MK test statistic (S) is calculated as follows: (Mann, 1945; Kendall 1975; de la Casa and Nasello, 2010; Taxak et al., 2014; Pohlert 2020; Zaiontz 2020)

$$S = \sum_{i=1}^{n-1} \sum_{j=i+1}^{n} sgn\left(x_j - x_i\right) \qquad \text{.....(1)}$$

Where,

where, xj are the sequential data values, n is the length of the data set and

$$sgn(y) = \{1..if\,(y > 0)\ 0..if\,(y = 0)\ -1..if\,(y < 0) \qquad \text{.....(2)}$$

when $n \geq 8$, the statistic S is approximately normally distributed with the mean $E(S)=0$ and variance as

$$V(S) = \frac{n(n-1)(2n+5) - \sum_{i=1}^{m} t_i\left(t_i - 1\right)\left(2t_i + 5\right)}{18} \qquad \text{.....(3)}$$

where, m is the number of tied groups and t_i is the size of the ith tied group. The standardised test statistic Z is computed by

$$Z_{MK} = \{\frac{S-1}{\sqrt{Var(S)}}\ when\ S > 0\ 0 \ldots\ when\ S = 0\ \frac{S+1}{\sqrt{Var(S)}}\ when\ S < 0 \qquad \text{.....(4)}$$

The statistic S is closely related to Kendall's Tau as given by:

$$\tau = SD \qquad \text{..... (5)}$$

where

$$D = \left[\frac{1}{2}n(n-1) - \frac{1}{2}\sum_{j=1}^{p} tj(tj-1)\right]^{\frac{1}{2}}\left[\frac{1}{2}n(n-1)\right]^{\frac{1}{2}} \qquad \text{..... (6)}$$

where p is the number of the tied groups in the data set and tj is the number of data points in the jth tied group.

1.2. Slope of the trend, Theil-Sen Estimator

Theil–Sen estimator, also known as Sen's slope estimator (Sen 1968), is a non-parametric test used to identify a trend in a series and the slope of the trend. The Theil-Sen line is a non-parametric alternative to the parametric ordinary least squares regression line.

The slope of n pairs of data points was estimated using the Theil–Sen's estimator (Theil, 1950; Sen, 1968) is calculated as;

$$Q_i = \frac{(x_j - x_k)}{(j-k)} \; for\ i = 1, \ldots N \qquad \ldots\ldots\ldots (7)$$

where, x_j and x_k are data values at times *j* and *k*, *(j>k)* respectively. The median of these *N* values of Q_i is Sen's estimator of slope. If there is only one data in each time period, then

$$Sen's\ estimator = \{Q_{(N+1)/2}\ if\ N\ is\ odd \left(\frac{1}{2}\right)(Q_{N/2} + Q_{(N+2)/2})\ \ if\ N\ is\ even \qquad \ldots\ldots\ldots (8)$$

1.3. Test for jump/shift detection, Pettitt Test

Climatic data are not homogenous in nature due to the influence of various natural and anthropogenic forcings. Therefore, it is imperative to observe breakpoints in meteorological time series. These inhomogeneities in climate time-series data are detected using various statistical tools such as Student's, Mann-Whitney, Buish-and-R, Pettit, and SNHT. Studies have shown that Pettitt's and Buishand-R's tests are more reliable than the other tests. The study did Pettitt's test to detect the most probable change year in the annual and monsoonal rainfall series for Mandla.

Pettitt's test for change-point detection is a non-parametric test after Pettitt (1979) that detects a significant change in the mean of a time series when the change's exact time is unknown. According to Pettitt's test, if x_1, x_2, x_3, …x_n is a series of observed data which has a change point at t in such a way that x_1, x_2 …, Xt has a distribution function F1(x) which is different from the distribution function $F_2(x)$ of the second part of the series $x_t + 1$, $x_t + 2$, $x_t + 3$ …, x_n. The non-parametric test statistics Ut for this test may be described as follows:

The Null hypothesis (H0) no change is tested against the alternate hypothesis (Ha) change.

$$U_t = \sum_{i=1}^{t} \sum_{j=t+1}^{n} sign(x_t - x_j) \qquad \ldots\ldots\ldots (9)$$

$$sign(x_t - x_j) = \{1,\ if\ (x_i - x_j) > 0\ 0,\ if\ (x_i - x_j) = 0\ -1,\ if\ (x_i - x_j) < 0 \qquad \ldots\ldots\ldots (10)$$

The test statistic *K* and the confidence level (*ρ*) for the sample length (*n*) may be described as:

$$K = Max|U_t| \qquad \ldots\ldots\ldots (11)$$

$$\rho = exp\left(\frac{-K}{n^2+n^2}\right) \qquad \ldots\ldots\ldots (12)$$

When ρ is smaller than the specific confidence level, the null hypothesis is rejected. The approximate significance probability (p) for a change-point is defined as given below:

$$p=1-\rho \qquad \ldots\ldots\ldots (13)$$

1.4. Wilcoxon-Mann-Whitney U-Test

The Wilcoxon-Mann-Whitney U-test investigates whether two series, of length m and n, are from the same population. The series may again be split samples from a single series or series from paired instruments on the same site.

Based on Pettitt's test, where a significant change point exists, the series is segmented at the location of the change point into two subseries. The 'Wilcoxon-Mann-Whitney U-test' is used to compare the means of these two sub-series. It is a non-parametric test, and the data sets need not follow a normal distribution and is quite useful for the present study.

Results

1. Test for anomaly in time series climate data

1.1. Rainfall Anomaly in Mandla

The time series analysis (1991-2020) for rainfall in Mandla shows the prevalence of drought only for three years during the 30 years time period. This shows that Mandla is not a drought-prone region, nor is meteorological drought an area of concern. However, tests for anomaly for monsoon rainfall (Figure 1) and annual rainfall (Figure 2) suggest high variability in the year-to-year rainfall. For instance, in the year 2012, the monsoon rainfall was 1295.7 mm, but in the following year, it increased to 1695.33 mm, whilst the year after that (2014), Mandla received 952.03 mm of rainfall during the monsoon. This variability may not be indicative of the existence of drought, but such annual variability in the rainfall may be detrimental for the crop productivity. Further studies can be conducted to examine the optimum rainfall for the millet varieties grown in Mandla.

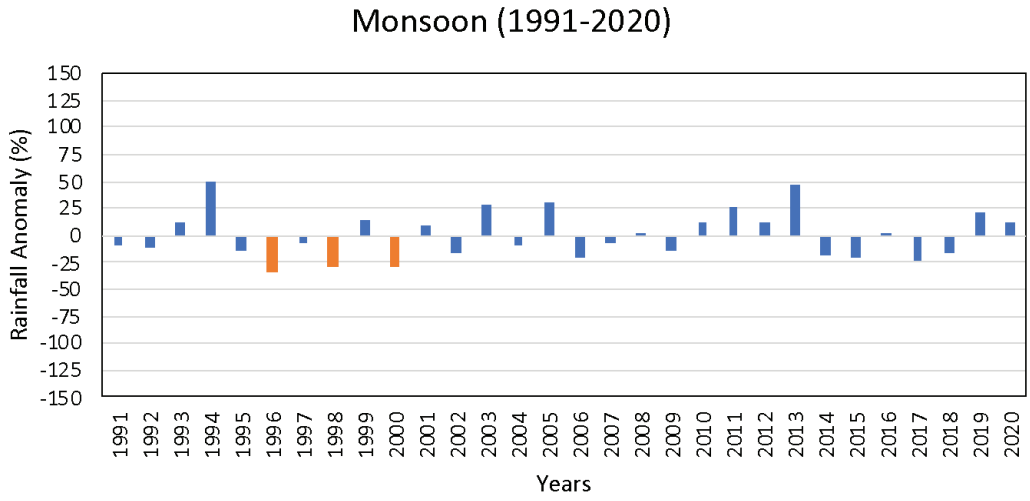


Figure 1: Monsoon rainfall anomaly in Mandla during the period 1991 to 2020. Monsoon months are as per the IMD, June to September. Orange bars indicate Moderate seasonal drought years.

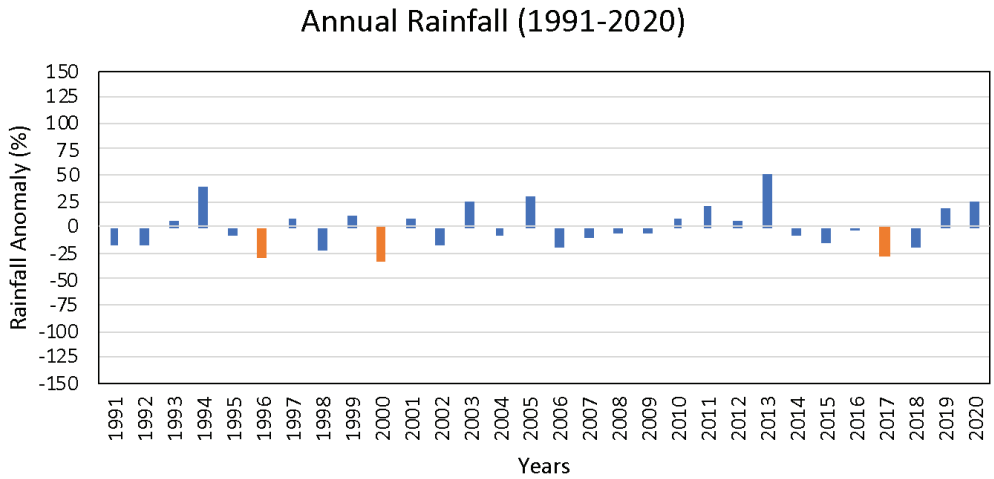


Figure 2: Annual rainfall anomaly in Mandla during the period 1991 to 2020. Orange bars indicate Moderate drought years.

During the monsoon season, the temperature profile, which is also the millet growing season, shows temperatures in Mandla are within the optimum growing temperature for millets (Figure 3). However, temperature anomaly mapping for the same time-series data also suggests high variability in the year-to-year temperature pattern for all four seasons (Figure 4).

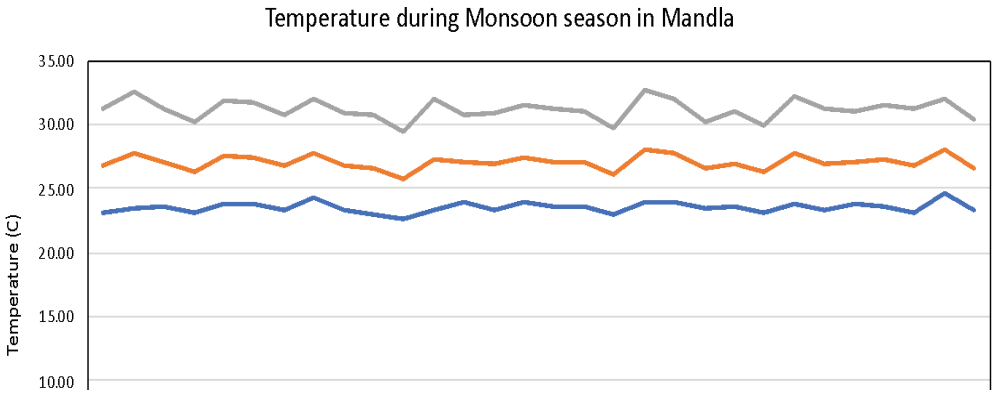


Figure 3: Temperature during the monsoon season (millet growing period) in Mandla during the study period 1991 to 2020.

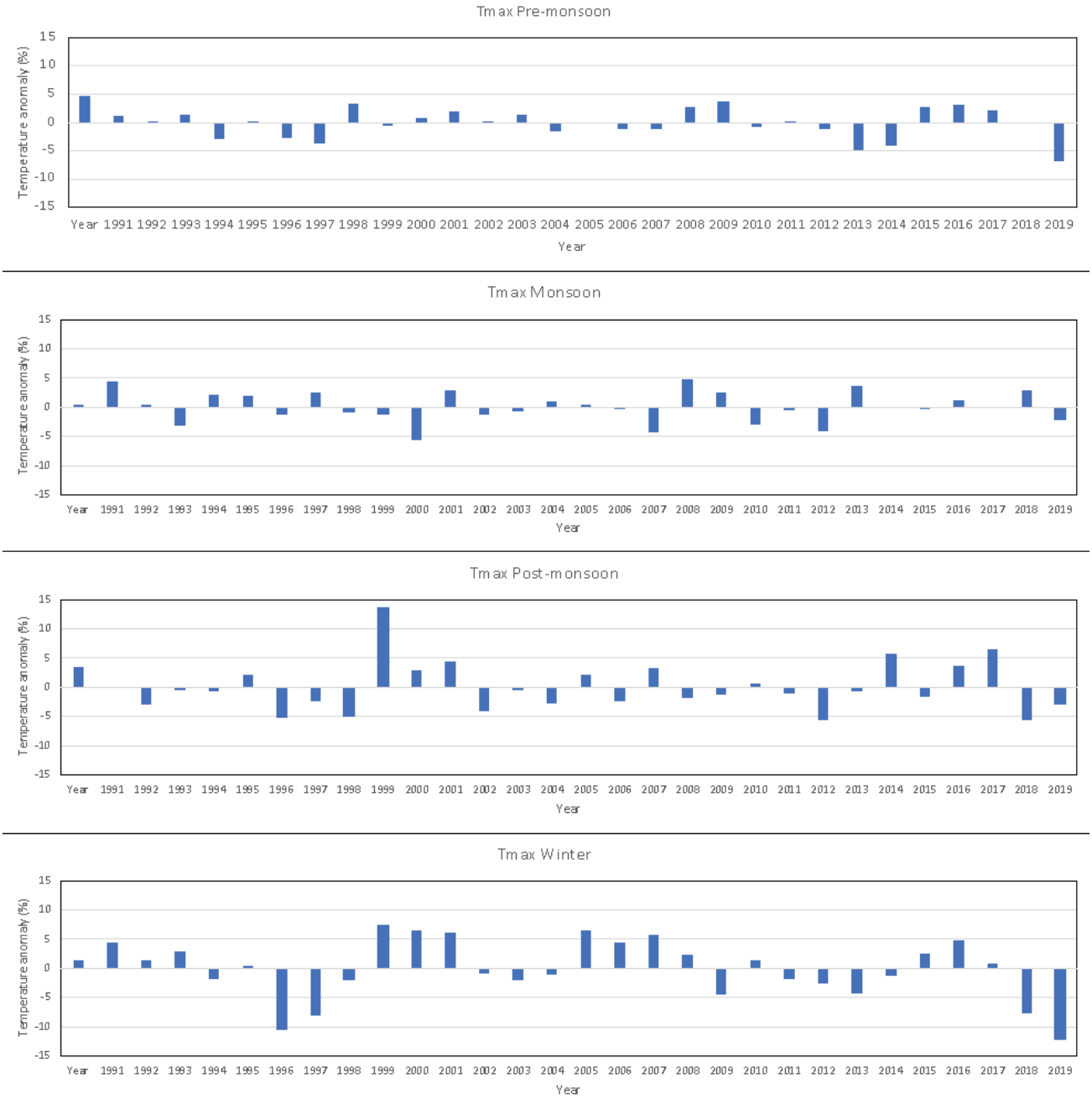


Figure 4: Temperature Anomaly for Tmax in Mandla.

There are no significant changes in the number of days for each of the rainfall intensities (Figure 5), suggesting no change in the region's rainfall intensities. Most of the rainfall (>~90%) in Mandla occurs during the four monsoon months (Figure 6); the remaining 8 months are relatively dry, receiving minimal rain.

Figure 5: Rainfall intensities during the four seasons in Mandla.

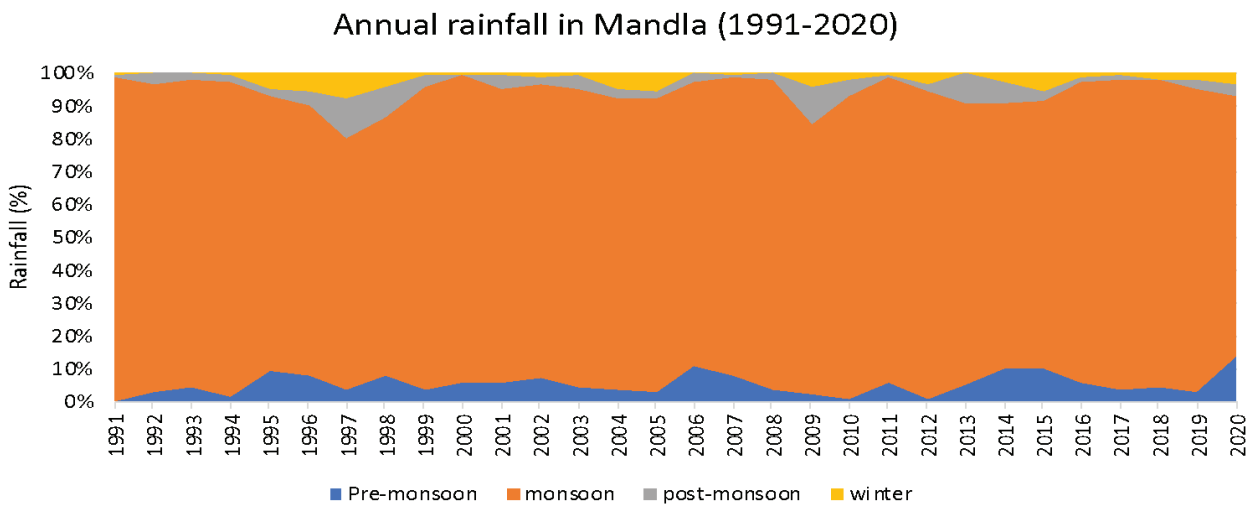


Figure 6: Share of rainfall during the four seasons in Mandla.

2. Trend analysis

2.1 Rainfall trend – Mann Kendall test, Sen's slope, Pettitt's test

There is no significant change in rainfall in all four seasons, significant at a 5% confidence level (Table 2). However, monsoon rainfall shows an increasing trend (although not significant) while the other three seasons show a decline in the rainfall. The increase in monsoon rainfall may lead to increased surface run-offs and subsequently lead to flooding in the low-lying areas and compacting the soil. On the other hand, decreasing rainfall trends in the other three seasons may lead to dry conditions and droughts in the region. Although there seems to be an absence of major meteorological droughts in the region (Figure 2), there could be a high risk of agricultural and hydrological droughts during the three seasons. Both 2003 and 2005 are El Nino years, while an early part of 2012 was La Nina year[5].

Table 2: Trend analysis of time series rainfall data during different seasons in Mandla.

Climate variable	Mann Kendall's trend test					Pettitt's test (most probable break year)	Trend
	P-value (two sided)	Var (s)	Kendall's tau	Sen's slope Q	z		
RF (pre-monsoon)	0.118	3461.67	-0.2	-0.33	-1.57	13 (2003)	Negative
RF (monsoon)	0.359	3461.67	0.118	0.22	0.918	22 (2012)	Positive
RF (post-monsoon)	0.733	3461.67	-0.045	-0.1	-0.340	15 (2005)	Negative
RF (winter)	0.830	3461.67	-0.030	-0.091	-0.214	15 (2005)	Negative

[5] https://origin.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostu/ONI_v5.php)

2.2 Temperature trend – Mann Kendall test

Table 3: Trend analysis of time series temperature data during different months in Mandla.

Climate variable	Mann Kendall's trend test					Pettitt's test (most probable break year)	Trend
	P-value (two sided)	Var (s)	Kendall's tau	Sen's slope Q	z		
T_{max} Jan	0.318	3141.67	-0.131	-0.036	-0.999	19 (2009)	Negative
T_{max} Feb	0.432	3141.67	-0.103	-0.022	-0.785	3 (1993)	Negative
T_{max} Mar	0.087	3141.67	-0.223	-0.058	-1.713	22 (2012)	Negative
T_{max} Apr	0.971	3141.67	-0.007	-0.001	-0.036	7 (1997)	Negative
T_{max} May	0.886	3141.67	-0.021	-0.010	-0.143	4 (1994)	Negative
T_{max} Jun	0.886	3141.67	-0.021	-0.005	-0.143	8 (1998)	Negative
T_{max} Jul	0.284	3141.67	-0.14	-0.024	-1.07	9 (1999)	Negative
T_{max} Aug	0.225	3141.67	0.159	0.014	1.213	7 (1997)	Positive
T_{max} Sep	0.412	3141.67	0.108	0.012	0.821	9 (1999)	Positive
T_{max} Oct	0.772	3141.67	0.039	0.007	0.285	24 (2014)	Positive
T_{max} Nov	0.748	3141.67	-0.044	-0.014	-0.321	28 (2018)	Negative
T_{max} Dec	0.402	3141.67	-0.108	-0.029	-0.821	18 (2008)	Negative

Table 4: Trend analysis of time series temperature data during different seasons in Mandla.

Climate variable	Mann Kendall's trend test					Pettitt's test (most probable break year)
	P-value (two sided)	Var (s)	Kendall's tau	Sen's slope Q	z	
Pre-monsoon						
T_{max}	0.412	3141.67	-0.108	-0.081	-0.821	4 (1994)
T_{min}	0.353	3141.67	0.122	0.021	0.928	10 (2000)
T_{avg}	0.915	3141.67	-0.016	-0.001	-0.107	25 (2015)
Monsoon						
T_{max}	0.971	3141.67	-0.007	-0.010	-0.036	8 (1998)
T_{min}	0.318	3141.67	0.131	0.007	0.999	12 (2002)
T_{avg}	0.91475	3141.67	-0.016	-0.001	-0.107	25 (2015)
Post-monsoon						
T_{max}	0.914	3141.67	-0.016	-0.004	-0.107	28 (2018)
T_{min}	0.108	3141.67	0.209	0.022	1.606	6 (1996)
T_{avg}	0.971	3141.67	0.007	0.002	0.036	23 (2012)
Winter						
T_{max}	0.175	3141.67	-0.177	-0.083	-1.356	19 (2009)
T_{min}	0.943	3141.67	-0.011	-0.0714	-0.001	19 (2009)
T_{avg}	0.475	3141.67	-0.09	-0.014	-0.714	19 (2009)

2.3 Test for homogeneity

Table 5: Test for homogeneity to identify breakpoints in the time series temperature data during different seasons in Mandla.

Climate variable	Pettitt's test (most probable break year)	Wilcoxon, Mann-Whitney p-value (Two-tailed)	
Temperature			
Pre-monsoon			
T_{max}	4	0.122	
T_{min}	10	0.097	
T_{avg}	25	0.586	
Monsoon			
T_{max}	8	0.415	
T_{min}	12	0.186	
T_{avg}	25	0.795	
Post-monsoon			
T_{max}	28	0.463	
T_{min}	6	0.038	
T_{avg}	23	0.427	
Winter			
T_{max}	19	0.079	
T_{min}	19	0.446	
T_{avg}	19	0.111	
Rainfall			
Pre-monsoon	13 (2003)	0.775	0.050
Monsoon	22 (2012)	0.719	0.050
Post-monsoon	15 (2005)	0.990	0.050
Winter	15 (2005)	0.690	0.050

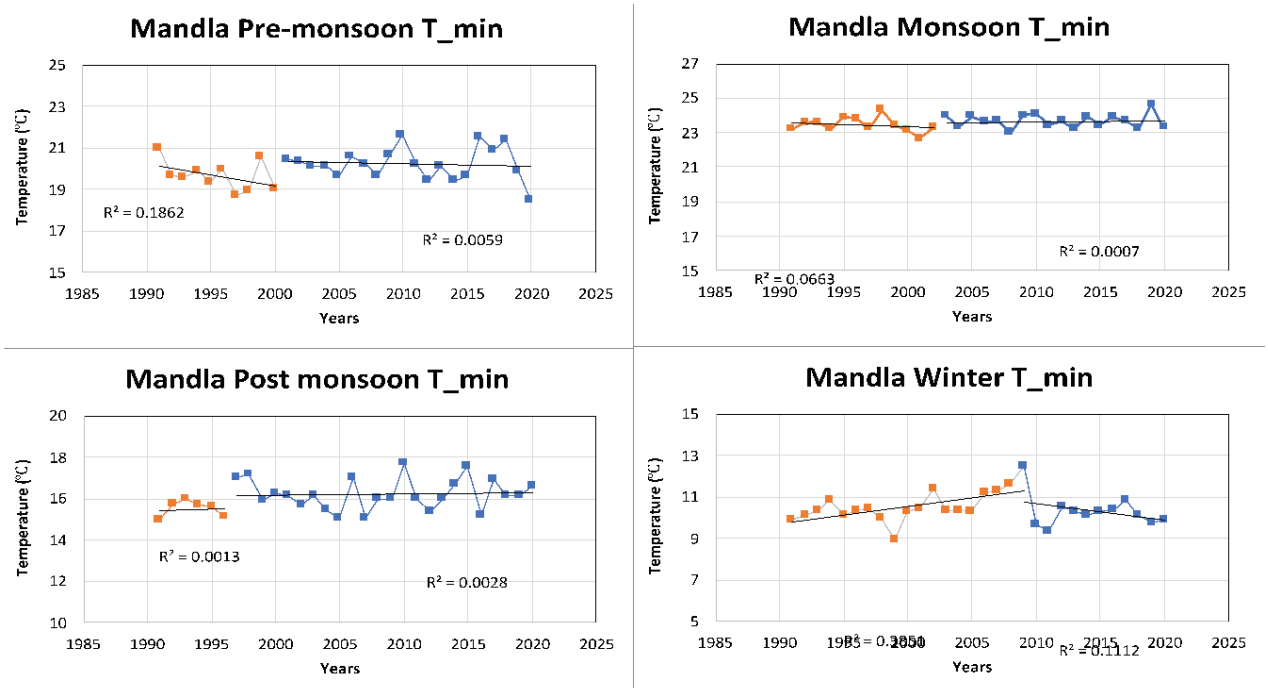


Figure 7: Wilconsin-Mann-Whitney test for homogeneity of time series minimum temperature during the four seasons in Mandla. The series changes at breakpoints.

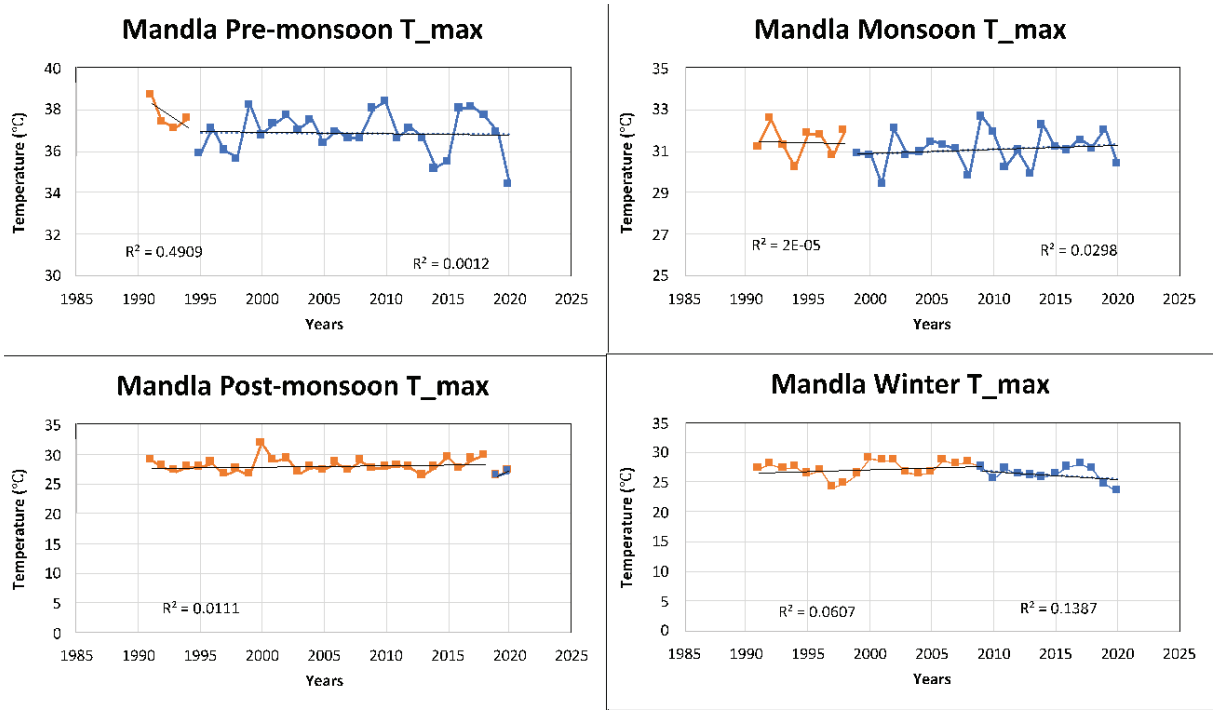


Figure 8: Wilconsin-Mann-Whitney test for homogeneity of time series maximum temperature during the four seasons in Mandla. The series changes at breakpoints.

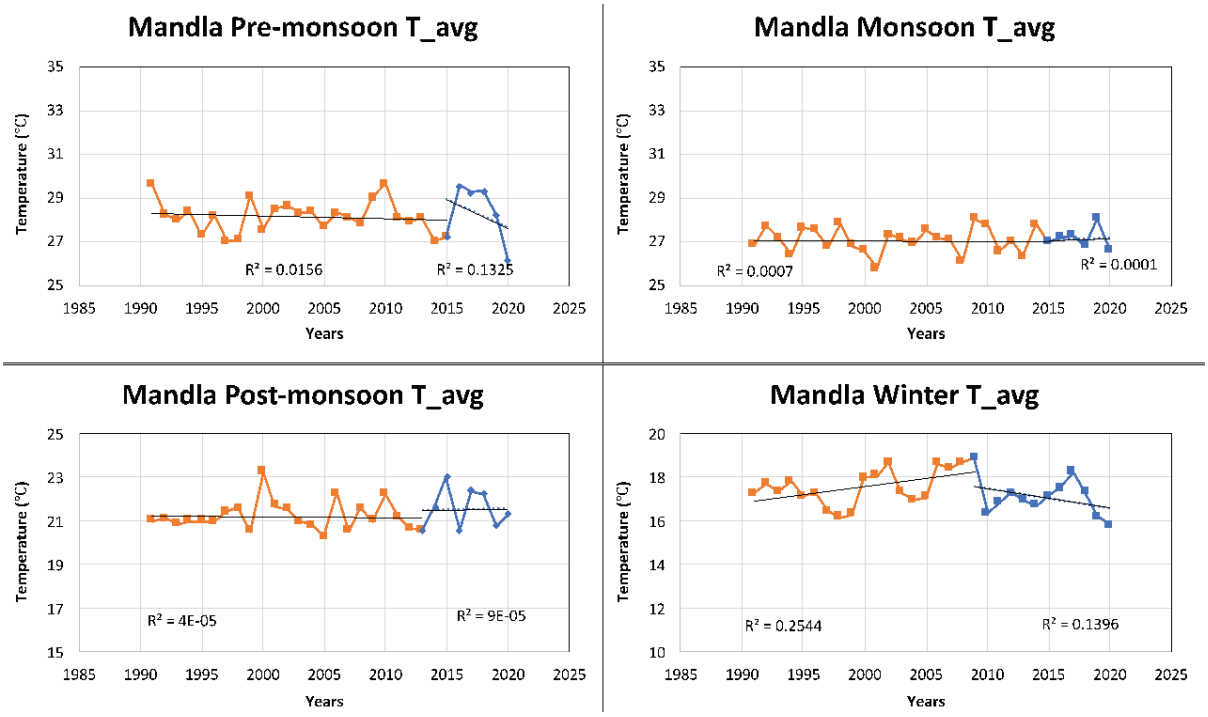


Figure 9: Wilconsin-Mann-Whitney test for homogeneity of time series average temperature during the four seasons in Mandla. The series changes at breakpoints.

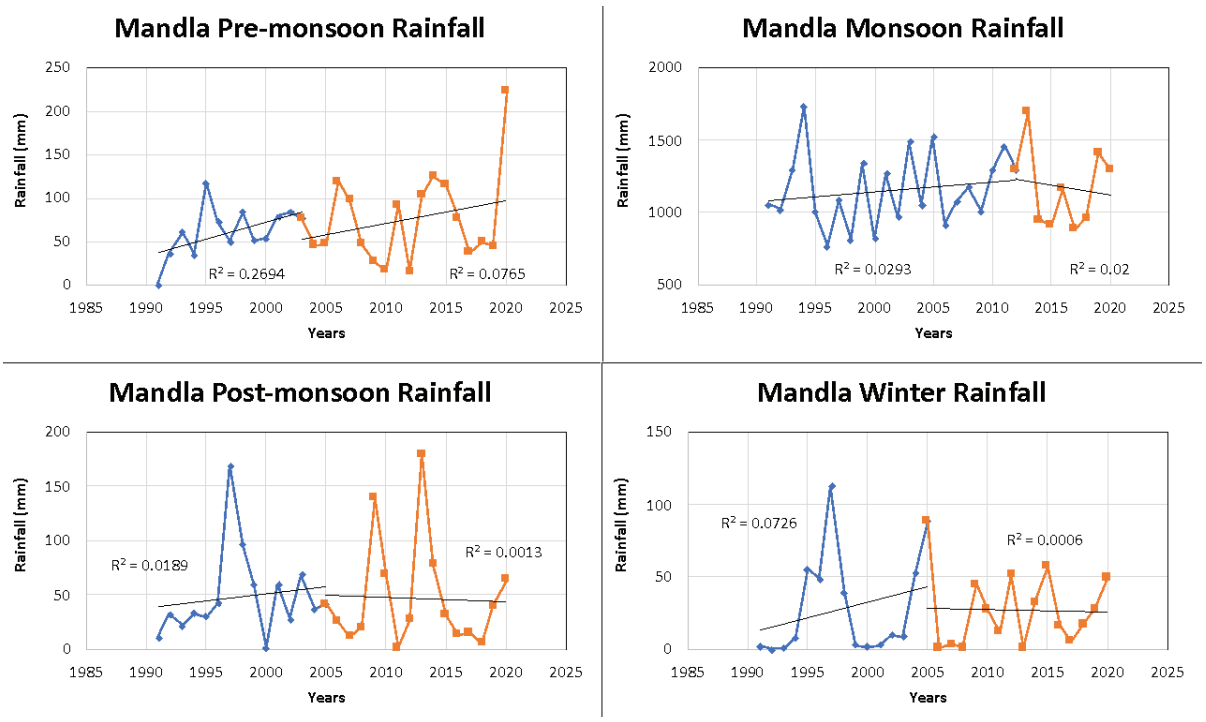


Figure 10: Wilconsin-Mann-Whitney test for homogeneity of time series maximum rainfall during the four seasons in Mandla. The series changes at breakpoints.

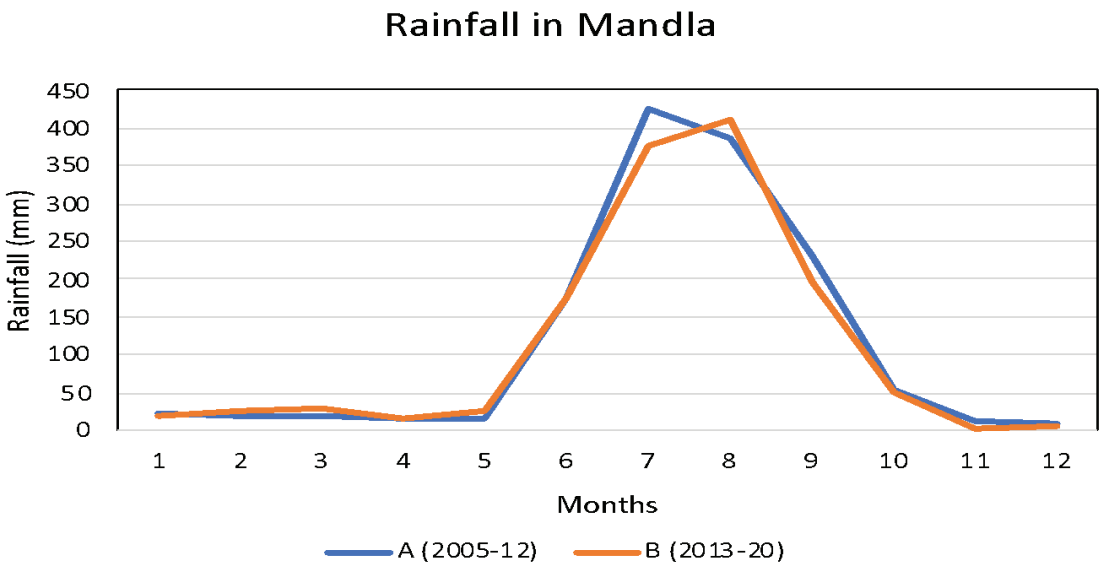


Figure 11: Rainfall seasonality in Mandla. Pettit's test show a breakpoint in 2012. Rainfall data split into two to show the seasonality variation between the two time periods.

Inference: Not much difference in rainfall. However, the peak monsoon rainfall has changed from June/July in the first period to Aug/Sept in the second period.

Climate Risks Faced by Farmer Producer Companies in Mandla

Current observations of climate in the Mandla district indicate a gradual increase in temperatures across all seasons and a decrease in rainfall during the monsoon period with erratic and uneven spatial and temporal rainfall distribution. This observation has been confirmed by the farmers and Board Members of the FPC Narmada Self-Reliant Farmers Producers Company Limited. Our conversation with stakeholders and farmers mentioned a reduction in the rainy season months. From a four-month season, now it has reduced to a two-month rainy season cycle only. Monsoon's onset has shifted from June to the first fortnight of July, which has affected the cropping sequence and sowing time. However, the farmers can't relate any such changes to the climate change phenomenon. Awareness concerning climate change-global warming is significantly less among the communities.

Rainfall variability, increase in temperature & increasing occurrence of drought conditions: Climate projections indicate an increase in temperatures by 2050s and an uneven distribution of rainfall across the state, with a perceptible decrease in rainfall during the winter period and almost no change in the rain during monsoon concerning the current climate. Rainfall variability could result in delays in sowing, loss of seeds, favourable conditions for pests, fungi, other microorganisms, production losses, poor quality harvests, loss of storage, and many other adverse impacts. Also, the shifting of the monsoon is expected to affect the cropping sequence and sowing time. The frequency and intensity of droughts and heavy rainfall events concerning the current situation are likely to increase further (MP SAPCC, 2012). These predicted changes could lead to cropping centers' spatial and temporal shifts and crop productivity decline. Also, as the evapotranspiration rate increases with an increase in temperature, it will deplete the different soil types' moisture retention capacity and threaten agriculture.

Depletion of groundwater tables: On the other hand, an increase in rainfall intensity is likely to lead to faster run-off causing higher soil erosion in the ravine areas with little or no scope of groundwater recharge in the alluvial

plains. It will cause further depletion in the groundwater tables. The status of soil health and its fertility is likely to deteriorate further with an increase in soil erosion and higher temperatures, causing stored carbon to be released from the soil.

Lack of storage infrastructure and humidity factor: Unavailability of post-harvest storage facilities at the district level and local area cause damage to the Kodo-Kutki.

Lack of information: Farmers do not have adequate information on weather variability and predictions.

Identification of Adaptation Opportunities in Millets Value Chain

Currently, organizations do not focus on the adaptation opportunities in the Millet's Value Chain. Though the FPCs are engaged in advocating for the cultivation of Kodo-Kutki, they have realized that the minor millets will not be the panacea to raise the income level for the tribal households. Therefore, FPCs were found to focus on diversification of the cereals production and procurement. The study found that among various FPCs working in Mandla, Kanha FPC has developed product portfolios and is engaged in preparing cookies, traditional sweets/mithai made of Kodo-Kutki, millets namkin sev, Kutki rice, and Kodo rice. However, due to lack of capital, their product marketing has not taken off.

Identification of Interventions for Climate-Proofing of Millet Value Chains

Targeting those most vulnerable to climate risk is the stepping stone for climate-proofing. In the Millet Value Chain in Mandla and the nearby district, the producers are at maximum risk. Other stages of the value chains, such as procurement, transportation, processing, and packaging, are at minimal risks. Over the last five years, cultivators have realized a shift in monsoons and changes in the rainfall patterns. Earlier rainfall was for four months, from July to September. But over the years, there is a delay in monsoon and shortening of monsoon duration. Similarly, the rainy days are decreasing, and the rainfall is constrained between July and August.

This shift in monsoon augurs very well for the cultivation of minor millet; Kodo is sown in the last week of July and Kutki during August's first ten days. A few of the interventions that are available for climate-proofing of the Millet Value Chain in Mandla and nearby districts are:

- Mandla has a good set of FPCs promoted by various NGOs and Foundations working in different blocks of the district. We found a positive understanding and a collaborative spirit among them. This understanding needs to be leveraged to expand the current area under Kodo-Kutki and popularise scientific cultivation practices among the cultivators.

- Quality seed is one of the major constraints in Kodo-Kutki area expansion. Promoting organizations may take up seed production programs in collaboration with KVK Mandla & Millet Research Station at Dindori.

- Mandla has nine functional FPCs in the area, with a diverse crop portfolio. A few FPCs may focus only on millets for standardization of pre- and post-harvest operations through institutionalized support and interest-free funds.

- A niche market in the form of multi-grain flour and biscuits has emerged and is fast expanding. Promoting institutions may explore a partnership with leading fast-moving consumer goods (FMCG) companies for bulk productions and millet-based product development.

- Besides, suppose an appropriate investment is made in institutions and infrastructural development at the district level (storage facilities, state-of-the-art millet processing unit, value addition, and brand development). In that case, it can generate widespread and lasting benefits for the producers.

- Kodo-Kutki are rich in nutrients; the Government of Madhya Pradesh may introduce millet-based meals in the Anganwadi/School mid-day meal programme.
- Climate Smart Agriculture investments can incentivize the poor farmers to increase or maintain their crop diversity to reduce rice sensitivity to rainfall variability.

FPC Assessment

Farmers in the FPCs are aware of the importance of minor millet as a climate-resilient crop. They are highly suitable for dry and marginal lands, a common feature in the Mandla district. Both Kodo-Kutki have low water requirements and early maturation, which helps them escape drought. Their grains have high fiber content, good protein quality, mineral composition, and nutraceutical values. These millets can increase the resilience of the smallholder farmers, but they will not be sufficient. Millet cultivation and consumption does not fulfill the need and desire of a farmer's household. They have to grow other crops, which quickly move into the market and be easily consumed at home. Also, households cultivating Kodo-Kutki use the crop for quick cash dispensation in times of necessity or emergency. When a household needs quick cash, they carry out five kilograms or ten kilograms to the nearby haat and sell it to the retailer.

FPCs are working with cultivators to improve the availability and use of better quality millet seeds. Local farmers produce the seed, which is purchased by the farmer producer company and marketed locally through their storefronts. In addition to seed, the primary focus is on the aggregation of millet grain through the FPCs to reduce the number of intermediaries between the farmers and the wholesale mandi trader to achieve a better price through a bulk sale.

The study team interacted with four promoting organizations and four FPCs in Mandla. The Board of Directors of the FPCs agreed that they are willing to invest time and resources in climate adaptation for climate-proofing provided that they receive investment and grant support. Since the FPCs are not profitable and do not have sufficient capital, they are not willing to infuse cash towards climate adaptation.

The Narmada FPC has created some assets in remote areas—for instance, an office and godown facility together on land donated by the community. A few FPCs have set up an installation of cleaning and grading machines. But we found that most of these asset creations in remote areas have been due to the facility of loans on high-interest rates (18-24 percent) from non-banking financial companies or micro-finance companies. Such high rates of interest for asset creation are neither of any help to small or marginal farmers nor can they be sustainable in the long run. Therefore, despite understanding the context of climate change and the necessity of climate-proofing, they want to postpone it until assistance in the form of interest-free loans or grants is provided. Additional details about the Narmada FPC are in Annexure IV.

Value Chain Assessment

The study's findings identify general value chain issues, such as lack of information, the need to empower farmers, reduce adapting rice cropping systems, varieties innovations, and market imperfections, as well as climate-specific challenges for millet, such as the cropping period, increasing pests, and shifts in temperature and rainfall.

[6] Newly married women-folk avoid engaging in tiring dehusking efforts and cook Kodo-Kutki, which does not taste as relishing as rice. Respondents mentioned that the consumption pattern and practice of cooking Kodo-Kutki in the household has drastically been disappearing. They can't hold anyone responsible for it but pointed out that women don't want to engage in drudgery work with the ease of life impacting every aspect of our daily lives. With the increasing availability of rice, it is easier to cook and eat. So, here we see a drastic shift in dietary patterns in the hinterlands.

Key Actors and Stakeholders involved in Kodo-Kutki

1) Cultivators and their households
2) Farmer Producer Companies and their Promoter Organizations
3) Board of Directors and the shareholders of the FPC
4) Agriculture department represented by the District Agriculture Officer
5) Agriculture Technology Management Agency (ATMA), Krishi Vigyan Kendra, Mandla, and ICAR
6) Retailers and wholesalers
7) Processing Mill Entrepreneurs and other social enterprises
8) APMC (Regulated Market)
9) Nashik, Bhopal, Jabalpur, Mandla and Dindori markets and value chain actors
10) Other non-governmental organizations

Table 6: Sowing to Market Activity Costing Breakdown

Stages	Particular	KODO	KUTKI
Seed			
	Seed (in One Acre)	9 Kgs	6 Kgs
	Price of Seed[7] (Mostly previous year retail seeds)	₹22 / Kg	₹30/Kg
a	Seed Cost for One Acre	₹198 (₹22 x 9)	₹180 (₹30 x 6)
Jutai – Pre-harvest tillage			
	Number of days required for pre-harvest tillage processes	6 days	6 days
	Number of laborer required for one acre	2	2
	One labour cost per day	₹150	₹150
	Two labour costs per day	₹300	₹300
b	Total Pre-harvesting Labour Cost[8,9]	₹1,800 (₹300 x 6)	₹ 1,800 (₹300 x 6)
Katai – Standing Crop Harvest			
	Number of days required for Harvesting of one acre crop harvest	5 days	5 days
	Number of laborer required for one acre	2	2
	One labour cost per day	₹150	₹150
	Two labour costs per day	₹300	₹300
c	Total Harvesting Labour Cost	₹ 1,500 (₹300 x 5)	₹ 1,500 (₹300 x 5)
Thrashing			
	No of days required	2 days	2 days
	No. of Labour required	2	2
	One labour cost per day	₹ 200	₹ 200
	Two labour costs per day	₹ 400	₹ 400
d	Total Thrashing Cost	₹ 800 (₹400 x 2)	₹ 800 (₹400 x 2)

[7] Promoting institutions are making efforts towards better quality seed production and dissemination among the cultivators. But, largely, farmers use the seeds from the preceding harvest.

[8] If a farmer wishes to use a tractor for the pre-harvest activity of leveling, sowing, etc.—a tractor charges at the rate of ₹300 per day.

[9] Cultivators aim to use their own labor or of the family members. However, this is changing now as many tend to migrate to urban centers for additional income. Therefore, cultivators request other farmers to support each other in their fields. However, this is an important cost, and to derive the most approximate unit economics of production, we have included it as a cost.

	Selling Price	₹2,000/quintal	₹2,800/quintal
	Gross Sale Price	₹5,000 (₹ 2,000 x 2.5)	₹7,000 (₹ 2,800 x 2.5)
	Profit per acre	₹5,000 – ₹ 4,298 = ₹701	₹7,000 – ₹4,280 = ₹2,720
Four Major Agricultural Markets/Mandi's in Mandla and adjacent district			
1. Mandla Mandi (in town)		2. Ghansaur Mandi (in adjacent Seoni district)	
3. Nainpur		4. Bichhiya	

Approx. 200 trucks of minor millet are supplied from Mandla (~5,000 tonnes) to Nashik alone. Another value-chain study conducted by MSSRF, ASA, and Biodiversity in 2018, estimated it to be ~18,000 tonnes (Mandla and Dindori combined). About 20 to 25 trucks of minor millet are supplied to Anand in Gujarat. Mandla Millets are increasingly facing competition from Chhattisgarh and Odisha in the Nashik market.

Mapping of the Minor Millet Value Chain and Marketing Channels

Channel	Actors	Present market share (%)
1	Producers > Rural Agents/Arethias > Traders @Mandla > Nashik Big Miller's > Direct Sales/Company Sales/Own Brands > Consumers	40
2	Producers > FPC > Traders @Mandla > Nashik Big Millers > Direct Sales/Company Sales/Own Brands > Consumers	20
3	Producers > FPC > Traders @Mandla > Nashik Big Millers > Direct Sales/Company Sales/Own Brands > Consumers	20
4	Producers > Household Storage > Rural Haats/Local Markets > Small Aggregators > Minor Processing Units > Consumers	10
5	Producers > Minor Processing Units/local Miller > Consumers/Big stores or big retailers in Jabalpur or Bhopal	5
6	Producers > FPC > Social Enterprise > (Minor Processing Units) > Consumers/Big stores or big retailers in Jabalpur or Bhopal	5

Bottlenecks for FPCs and Vulnerabilities in Stages of the Value Chain

Farmer Producer Companies face multiple challenges and bottlenecks to collectivize and then develop market linkages to maximize profit and create value for their shareholders. According to a study by NABCONS (2011), "poor skills of professionals associated with the FPCs, lack of vision and direction from Board of Directors, operational problems like low equity base due to low share value (share capital ranged from 0.1 to 0.5 million across FPCs), inability to attract capital or credit from outside" are the significant challenges. Our study came up with the same assessment that the FPCs still operate at a fundamental economic scale. The FPC is as good as its farmers and the region where it is operational. However, some promoting agencies had routed grants to the FPCs or managed credit through joint ventures. A few FPCs had managed to obtain loans (investment and working capital), poor marketing and value addition expertise; and no or inadequate business plans led to many FPCs' failure. Despite attempts by the FPCs, their work still seems to be of collectivization even though they have attempted tirelessly to diversify their portfolio in order to commercialize, find markets and consumers. Still, they end up selling off to wholesale traders. They have limited success in breaking into the Nashik market directly.

FPCs face multiple challenges in Mandla as far as cultivation and production of Kodo-Kutki are concerned. Some of the challenges are not directly related to climate change. Other circumstances currently seem to be more concerning for the FPCs with their participation in the millet value chain than the impact of climate change. Additional impairing factors include inadequate investment in product development and commercialization and the persisting perception of low social status associated with their consumption. Lack of knowledge on ways to use small millets in the daily diet is widespread despite the great array of dishes that can be made. The poor availability of millet foodstuffs in local markets, coupled with high prices for their products, also limits their popularization. Our discussions led to the following findings:

Production Bottlenecks:

1) Farmers have small-size landholdings, and they have to choose between growing what they can easily sell and consume rather than growing a climate-resilient crop. The preference for crop sowing by the farmers is (a) Paddy (b) Maize (c) Kodo-Kutki. Cultivators now tend to focus their limited time and land on growing paddy and maize, but under increasingly drought-prone conditions, they recognize that millets are more reliable[10].

2) Lack of improved variety of seed for Kutki has been mentioned as a major reason for its decline, especially for the white Kutki variety (sabhat) that can withstand drought. Also, farmers harvest the crop early as the grains turn yellow, resulting in high moisture and fungal infection.

3) Kodo-Kutki cereals' production area has declined more than 50% in the state in the last 20 years as livelihoods have shifted toward wage labor and purchase of subsidized grains of rice and wheat [11]. With the ever-increasing irrigation facility[12] and access to water sources through the MGNREGS, cultivators are clearly on the side of growing paddy as their main crop[13], or the levelled land is converted for cereals/vegetables.

4) Reduction in production of minor millets: in traditional agriculture, crop diversity is higher in the crops of minor millets like Kodo-Kutki. Mixed cropping is practiced to fulfill a household's food needs. But in recent years, the area under these crops has depleted due to the market economy and changing food habits.

    a. Area under cultivation went down to 3.09 lakh hectares from 11.97 lakh hectares
    b. Production declined to 1.25 lakh tonnes from 2.92 lakh tonnes though productivity increased from 243 to 408 kg/ha.

[10] Because of their accessibility to the poor, they can play an essential role in providing nourishment to people across all income categories and supporting climate adaptation of rainfed farming systems.
[11] http://www.nuscommunity.org/initiatives/ifad-eu-ccafs-nus/kodo-and-kutki-millets-in-madhya-pradesh/
[12] If there is a water supply provision (dug well/ canal) near the agricultural fields, the field is no longer allocated to Kodo and Kutki.
As the facilities for irrigation are improving, the FPC has seen a shift towards paddy cultivation, and many who have been in millet cultivation readily switch to paddy.
[13] https://pib.gov.in/newsite/PrintRelease.aspx?relid=186206

c. Productivity level of 408 kg/ha is very low compared to other competing cereals (upland paddy/gora dhan) that could be grown in the same piece of land having a productivity of 1,000 kg/ha.

5) Increased use of hybrid seeds and lack of varieties in Kodo-Kutki: the increased use of hybrid varieties, especially paddy, has impacted local crop diversity. Many government programs, schemes, and subsidies focus on promoting hybrid seeds and increasing land under hybrid paddy. Several local varieties of paddy face the threat of extinction.

6) Recently, millet crops have received national and international attention as traditional gluten-free super-foods. India's proposal to observe an International Year of Millets in 2023 has been approved by the Food and Agriculture Organization (FAO). This renewed perception enhances the millet's potential to be an economic investment for smallholder farmers and insurance against monsoonal failure in the country's millet hotspots. Minor millet stakeholders can best utilize the dedicated year to highlight its genetic diversity, earmark investment and government funds to the minor millet production hotspots like Mandla and Dindori, and scientific research to develop new varieties with better yields.

Consumption Bottlenecks:

1) A shift in dietary patterns: Kodo-Kutki is no more on the priority list of food items at home. Kids and household members have developed a taste for rice and prefer to consume rice as the staple diet. Besides, the younger generation in these tribal hinterlands do not consider it tasty for consumption and usually avoid eating it. Again, it is hard work to process and cook. Dehusking is a significant challenge, and grain sizes are too small, making the process of household consumption also extremely labourious and hence undesirable by family members. Daily consumption is limited, and slowly it has moved out of the food basket of tribal households, who used to be its primary producers and consumers.

2) In the rural areas of Mandla (and Dindori), Kodo and Kutki have a vital subsistence role for tribal households, who prefer them equally or more than rice. They consume Kodo and Kutki mainly as rice and kheer (a kind of porridge). But, dehusking Kodo-Kutki at the household level is difficult — the grain has seven inedible layers that need to be removed before consumption. Therefore people are losing motivation and interest in its consumption.

3) Locally, consumers are aware of minor millets but prefer paddy rice because of its availability, taste, ease of processing, and lower prices. Kodo-Kutki does not feature in the food basket of the economically mobile class. In the words of a farmer, 'yeh ek chahtwala khadya padarth nahi hai gharo me' (it is not an aspirational food item in homes).

4) Consumers in the Tier 1 cities of Bhopal, Indore, and Jabalpur are largely unaware of Kodo-Kutki millet as rice and wheat have captured the staple crop's food basket. It is not a fast-moving item in Tier 1 cities and small towns. However, there are indications that consumer demand for minor millets is expected to grow in more urbanized metropolitan centers of Delhi-NCR, Mumbai, Bengaluru, and Chennai, Hyderabad due to growing awareness and value of health and nutrition. But availability in metro cities and experimentation in the kitchen is a challenge.

5) There is a growing awareness amongst consumers in metropolitan areas regarding multi-grain products. Still, there is low awareness of minor millets, their nutritive value, and ecological benefits. Government, social enterprises, food start-ups, and non-profit organizations need to promote these cereals, positioning them as high nutrition, gluten-free food items.

6) Promoting organizations, agriculture and food processing departments should explore the potential of producing local fast food prepared by the minor millets to encourage adaptation and interest among people. In local food joints or highway dhabas in Mandla or Jabalpur or even at the Kanha National Park, which attracts a significant flow of national and international tourists and nature lovers, no restaurants could be found that served meals made of Kodo or Kutki millets or promoting them as locally produced

7) Another major problem highlighted by the respondents has been that Kodo millet's consumption is often found to cause intoxication and poisoning. According to the cultivators and respondents in the FGDs, toxicity in Kodo arises from poor storage conditions (causing fungus growth), and subsequent processing can cause health ailments.

Harvest & Post-harvest Challenges:

1) Kodo-Kutki harvesting is a time-taking process. Thrashing and dehusking are equally challenging and time-intensive processes. In households, the burden falls on the women.

2) Some households use the traditional home-based storage facilities, which are susceptible to moisture and fungus attacks, further degrading its quality. It also increases the chances of toxicity and hinders better price realization for the farmer. Many farmers mentioned a lack of enough space to store Kodo-Kutki, and they sell to the intermediaries immediately after the harvest at low prices.

3) The challenges in processing small millets are plenty, i) variations in raw materials and ii) low shelf life of the processed minor millet rice and grits due to pest infestation and rancidity. The grains of different minor millet crops vary in shape, nature of grain surface, hardness, husk-grain bonding, and expected rice recovery.

4) There are no post-harvest practices like drying and farmers follow cleaning. The FPCs claim that they are engaged in primary cleaning, grading, and colour sorting, giving farmers a share in the value-added price. But the study did not find sufficient evidence of any value addition at the farm gate or in the subsequent stages of the value chain. The bulk of the produce is procured by the wholesale traders in Mandla or Dindori district and then transported off to Nashik in Maharashtra or Anand in Gujarat.

Market-based Bottlenecks:

1) The Kodo-Kutki Millet hotspots of Madhya Pradesh are located in the tribal hinterland. It is highly rural and distant from the urban metropolitan centers of the country. The relative underdevelopment of these regions compared to many other parts of the country or even within Madhya Pradesh is startling. Some of the reasons include poor roads, lack of public transportation, lack of access to markets, access to the latest technologies, knowledge, and infrastructure.

2) Lack of Market Opportunities: minor millet markets are currently monopolised. A cartel of private millers based in Nashik settles the price of the crop. This system puts the FPCs and cultivators without any bargaining power. Since these traders in Nashik have established business relationships with the wholesale mandi traders in Mandla and Dindori districts, the local FPCs have not succeeded in making any breakthroughs in direct selling to the Nashik market. It is a fact that trading is easier between trustworthy people belonging to the same social fraternity.

3) Together in Mandla and Dindori districts, there are three to four milling units. The main dehuller station in Mandla buys Kodo and Kutki for ₹20-25/kg and sells the cleaned rice for ₹90/kg. However, the quality of processed Kodo-Kutki rice is sub-standard and not equal to the quality that the end markets would like to have.

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[15] Nashik Millers have invested huge capital for infrastructure and procurement, but their returns are also time-consuming. Further, they have to absorb the risk of price variation, delayed receipt of payments from the retailers, and losses due to such other factors have to be accommodated in the price spread. Besides, absorbing the risks on stones, other foreign materials, weight loss on drying and polishing. They have to incur the difference in price variation, transportation charges, and storage charges as the crop is season bound.

4) The bulk of the farmers' millet yield is consumed domestically. Still, around 50% of farmers end up selling part of their production to local retailers, the local markets (shandy), neighbours, or FPCs.

5) Kodo-Kutki are largely transported to Nashik in Maharashtra. Nashik is the major aggregation point for minor millets in India. Millets from as far as Odisha arrive in the Nashik market.

   a. The transportation price of Kodo and Kutki to Nashik is ₹3-4/kg. In Nashik, there are 21 mills producing bhagar, but only one label specifies the products content. Bhagar products in Nashik are sold for ₹90-95/kg. With the increase in fuel prices, the transportation cost is expected to rise further.

6) Price-discovery for the minor millets is totally dependent on the Nashik traders: Big traders/Millers located at Nashik apprise price information to Mandi traders, based on that local price is fixed daily during the season.

7) The lack of a modern processing facility in Mandla is a major obstacle. Post-production processing facilities are not available at the farm gate. There is no value addition at the district level large enough to attract investors or consumers. However, this offers a significant opportunity for investors. Mandla-Dindori districts are minor millet hot-spots. It is also closely located to the other minor millet-producing regions of Chhattisgarh and Odisha, which transport a significant amount of minor millets to the Nashik market.

8) NGOs and government programs are working with cultivators to shorten the value chain. E.g., FPCs promoted by ASA have engaged in aggregating grains and selling cleaned and graded grains in bulk. Other initiatives existing in the area include Kanha Krishi Vanopaj Producer Company and Tejaswini Rural Women Empowerment Programme. But they lack the high-grade polished quality to attract bulk consumers, and scale is not sufficient to attract agri-companies or big retail marts to start direct procurement in Mandla.

9) Another challenge at the processing stage is the low output of Kodo-Kutki post-processing. 100 kgs of Kodo-Kutki delivers only 30 kgs of output to the Millers, which they sell on the market. Without the right supply-chain and support of sufficient working capital to take the risk and explore the marketing options in other states and well-developed markets, an investor in Mandla may not have an incentive to invest in a state-of-the-art processing plant.

Infrastructural Bottlenecks:

1) Mandla interior hamlets are connected with the road to Mandla town and other nearby local market hubs, but the transportation facilities are limited and usually end up being expensive for the cultivators.

2) Small processing plants are procured from Salem. However, the product's quality and finish are not up to the mark, with a high percentage of broken grains which are considered low quality. There is a need for midsize to large capacity processing plants that can lower the loss percentage, provide higher shelf life and keep the final output quality and look of the finished product standardized.

3) Mandla is in imminent need of a state-of-the-art processing plant having different facilities like destoner-cum-grader with aspirator, dehuller and pulveriser, semolina machine, flakes-making-machine, etc. The type of machines and investment would depend on the required capacity and types of product to be manufactured. It varies from ₹2 lakh to ₹70 lakh per unit. Details given in Annexure-3.

4) Existing Kodo-Kutki processing steps need to be studied and standardized. ICRISAT Hyderabad and CFTRI, Mysore and DHAN foundation may be explored for further solutions and ideas.

[16] The low output from the crop is due to the inherent quality of the crop.

Economic Bottlenecks:

1) Access to credit is a major challenge for farmers. Banks do not provide credit to poor farmers, and NBFCs charge high-interest rates.

2) Lack of Working Capital: working capital is insufficient and its capacity to raise further capital is minimal.

3) FPCs in Mandla prefer funds in the form of grant-in-aid. The balance sheet is not strong where financing institutions will lend to them. Therefore, it is necessary that FPC access institutions like SFAC or NABARD for support.

Staff-based Bottlenecks:

1) FPCs have limited staff on their direct payroll. The business performance is not such that it can afford human resources. Therefore, major support is currently provided by the promoting institutions' staff in managing the operations, logistics, and additional support. Staff directly associated with the FPC do not have significant exposure that empowers them to engage with other value chain players at an equal footing.

2) Technically qualified people to manage and run medium-size or large-scale processing plants are limited. Currently, this does not affect much of the work of the FPCs. However, if any FPC plans to set up a robust processing facility, they may need to hire people from outside.

Environmental Bottlenecks:

1) Pest issues: problems with ants cutting the panicles have been observed in Kodo plants, whereas, for Kutki, the major pest has been burrowing worms.

2) Respondents mentioned that an invasive species (Lantana Camara) has been growing into the lands suitable for Kodo and Kutki.

3) Kodo crops are susceptible to fungal infestation as a result of poor post-harvest drying practices. Therefore, training farmers in proper post-harvest practices for Kodo is needed to avoid fungus development.

4) Access to information helps farmers make appropriate decisions in adopting sustainable and climate-resilient agriculture practices. Though they have received timely information from the promoting organizations, the challenge is that information flow is distorted as organizations phase out from certain areas.

5) Kodo-Kutki Identity in the Market: Bhagar is a well-known Maharashtra-based millet. Kodo-Kutki procured from eastern Madhya Pradesh is mixed with millets produced in Maharashtra and rebranded as Bhagar. Bhagar is consumed by Hinduism's followers primarily during the period from Ganeshotsav until Navaratri, where Hindus and others keep vrath (fasting). And they consume Bhagar as they complete the vrath. As per practices and beliefs in Hinduism, devotees observing a fast (vratis and vratiharins) do not eat rice/wheat, and preference is given to crops that have not been ploughed and almost grow naturally without human interventions.

[17] The low output from the crop is due to the inherent quality of the crop.

Therefore, in some parts of the country, Bhagar and sabudana (made out of Cassava) are consumed during fasts. Besides, Bhagar is a usual dietary choice by them as it is largely cultivated without fertilizer or pesticide. 60% of the Maharashtrian population observe such fasts, keeping the Kodo and Kutki millet active. Growing demand has been observed in Andhra Pradesh and Tamil Nadu, where the consumers are more interested in healthier millet-based dosa and idli. This market is good for the minor millets, but in the process, Kodo-Kutki are losing their identity. Efforts need to be made for the GI certification of Kodo and Kutki.

Identification of Opportunities at Various Stages of the Value Chain

1) Research, Development, Demonstration and Product Diversification: data collection and regular sharing of input prices across minor millet hot-spots and global minor millet prices to enable better benchmarking and price comparison.

2) Branding and organic certification: Mandla's Kodo-Kutki requires branding. With its near 100% organic production, the promoting organization and FPCs can approach organic certification authorities.

3) Incentives can be provided through favorable MSP and direct district-based procurement systems (inclusion of millets in PDS) by the state government.

4) Ensuring better price, processing (especially post-harvest and storage, with local level processing units), and marketing.

5) Upstream marketing and processing facilities of Nashik and Anand need to be deeply researched to understand the end-market and best practices for replication in Mandla.

6) De-hulling has been considered a challenge for farmers. If de-hulling services are available in the vicinity, which can reduce the drudgery and provide processed Kodo-Kutki rice, households may hold on to the consumption habits. Infused with regular awareness sessions and promotion about its nutritious and health benefits (through food melas dedicated to locally produced crops and cuisines), it has the potential to be part of the local food basket.

7) Production stage: As Kodo-Kutki requires less water than paddy, it is a viable option for the Mandla and Dindori landscape, prone to dry spells and erratic rainfall. Promoting organizations should bring the experience of millet production from more advanced states to Mandla and Dindori districts to enhance the production and new product development with a special aim to reach young farmers.

8) Intercropping with pulses can improve the productivity of the Kodo-Kutki. Funding support to the farmers for better technology adoption and extensification.

9) Mainstream climate change across the policies, plans, programs, and projects of the Minor Millets Promotion Plan.

10) Economically, the crop is viable for small and marginal farmers provided they have better price realization and access to processing plants in Mandla. Setting up processing plants in Mandla would expand market opportunities and better price discovery for the producers.

[17] In 2019, the government of Madhya Pradesh has applied for GI certification of 'Kodo and Kutki', the high-nutrition varieties of millets mostly grown by local tribal households.

a. Modern Processing Facilities: set up processing units (grader, dehuller, and destoner). It will likely give farmers an impetus to cultivate the nutritious grain that is plagued by low produce, difficult processing methods, information asymmetry, and weak markets.

   i. Potential of robust price arbitrage is available in the case of Mandla. Geographically, Mandla is located in eastern central India's heart with access to millet producing Odisha and Chhattisgarh regions. Producers and traders transport the produce from these two states to Nashik, increasing their costs and producing less profit. A modern processing facility in Mandla can attract and tap into these two states' markets to begin with.

   ii. Machine specifications: Annexure III

Financing Opportunities for Climate Adaptation and Up-Scaling of 'FPCs' Millet Business Model

FPCs have managed to do limited business primarily focused on procurement only. Member-share capital is the only source of equity. FPCs are restricted in their ability to be competitive in a market where other players are not fully regulated/transparent in operations. Price volatility in agricultural commodities is high and managed by the Nashik market. Price recoveries are not so fast and holding is fraught with downside risks.

1. Social Investors/ Funding/ Grants
2. Risk-taking capability profit payoffs
3. Under One District-One Identity, Kodo-Kutki has been identified for Mandla and efforts should be made to bring it to the world level.
4. Horticulture and Food Processing Department, Govt. of Madhya Pradesh to make the state a forerunner in the field of horticulture and to promote agro-based industries in the state.
5. Favourable taxations and other financial instruments to enable additional entities to enter the market as processors to make Mandla a Minor Millet Processing Hub in the region.

Recommendations

Value chain intervention requires investment in market access, tech introduction, agro-advisory services, and most importantly, post-production processing facilities in Mandla. An attempt has been made by Kanha Krishi Vanopaj Producer Company Ltd., Bichhiya, to set up a processing plant but the unit is stuck in bureaucratic perplexity. To create an equal market for Kodo-Kutki, the study makes the following recommendations:

1) Kodo-Kutki are grown in inferior land having low moisture retention and low soil quality. The productivity is low because it is grown in this kind of land. However better agronomic practices coupled with land improvement could improve productivity, ultimately the crop responds to basic factors of production. Similarly, potential partnerships with agencies in other minor millet hot-spots in Uttarakhand, Tamil Nadu, and Gujarat [18] would be crucial.

[18] P. Anbukkani, S.J. Balaji and M.L. Nithyashree. Production and consumption of minor millets in India - A structural break analysis. Ann. Agric. Res. New Series Vol. 38(4):1-8(2017)

The eastern Madhya Pradesh region has research institutions such as Minor Millet Centre at Dindori, Mandla KVK, Dindori KVK and JNKVV-Jabalpur which are working in this line and scope exists to work together. Promoting institutions need to tie-up with them to conduct research and developing and dissemination of improved seed varieties.

2) The need of hulling

Hulling is the process of removing the outer hull/husk from the grains, which are not human edible. It is a vital process for obtaining grain-rice and for further processing of grains for consumption. Small millets other than finger millet are well protected in glume encasements, hence the conversion of their grain to rice involve hulling. Traditionally, small millets were hulled manually by women in the production regions using pestle and mortar and/or wooden/stone grinders, as there is little to no local processing infrastructure in the villages. This process involves significant drudgery and time. Due to this reason, the consumption of small millets has drastically declined in the production regions

The major challenges in processing of small millets are

1) The small size of the grains.
2) Variations in the raw materials due to variation in varieties, cultivation practices and microclimate, across production regions, years and crops.
3) Low shelf life of the processed rice and grits due to pest infestation and rancidity. Most of the small millet processing work that was done manually earlier can now be done by using equipment.

The process of hulling includes

Pre-hulling

1) Separation of Materials Other Than Grains (MOTG) namely, straw, small sticks, dust, sand, mud,
2) pebbles and weed seeds from the grains as much as possible before hulling.
3) Segregaton of unfilled grains from the grains as much as possible before hulling.
4) Segregation of filled grains into different size and weight fractions before hulling, as hulling of same size/weight grains is more effective.

Post-hulling

1) Segregation of unhulled grains from the hulled fractions (grain, rice and grits).
2) Segregation of sand particles and dust from rice and grits.
3) Segregation of rice and grits to use them separately.

For ensuring quality output, the following machines are needed in the process line: i) Grader/Shaker with aspirator, ii) Destoner and iii) Huller. Choosing the right set of equipment is critical for optimising the investment and for effective operation.

Description of requirement	Village/Community scale	Small scale enterprise	Medium scale enterprise
1. Capacity	50 kg/hr	100 kg/hr	500 -1000 kg/hr
2. Manpower	2 persons	2 to 10 persons depending on the volume of operations	15 to 30 persons depending on the volume of operations
3. Infrastructure	200 sq ft floor area	- 1200 sq ft floor area - Godown to stock 2 to 4 tonnes of materials	- 5000 to 10000 sq ft floor area - Godown to stock 10-20 tonnes of materials - Pick-up vehicle - Open yard for drying, sorting and cleaning grains - A small office room
4. Equipment	Decided based on locally grown small millet crops	Decided based on actual small millet crops to be processed	Decided based on actual small millet crops to be processed
4.1 Suggested basic equipment	- Destoner- 1 - Grader- 1 with aspirator - Huller- 1	- Destoner- 1 to 2 - Grader- 1 to 2 - Huller- 1 to 2	- Destoner- 4 to 8 - Grader- 4 to 8 - Huller- 2 to 4 - Pulveriser- 1 - Semolina making machine- 1 - Elevators
4.2 Additional equipment		Pulveriser- 1	Polisher- 1
4.3 Investment required (approx)	Rs. 4 lakhs	Rs.5 to 10 lakhs	Rs.50 to 100 lakhs
5. Accessories	- Weighing scale- 100 kg - Weighing scale- 50 gm to 5 kg - Air blower	- Weighing scale- 100 kg - Weighing scale- 50 gm to 5 kg - Packing & sealing machines - both gunny & polythene - Air blower	- Weighing scale- 100 kg - Weighing scale- 50 gm to 5 kg - Packing & sealing machines - both gunny & polythene - Hydraulic trolley - Air blower
6. Power requirement	Single or 3 phase; 5	3 phase; 10 to 20 HP	3 phase; 30 to 50 HP

3) FPC Board Members and senior functionaries should be provided training in established institutions such as ICRISAT, Indian Institute of Millet Research, The Central Research Institute for Dryland Agriculture, and National Institute of Agricultural Extension Management (MANAGE) among others. The training program can focus on the following:

a. Importance of Millets to address malnutrition and achieve Nutritional and Fodder Security
b. Major pest and Crop Protection Technologies in Millets
c. Millets Value Chain Development – A perspective
d. Digital Agriculture to Reach Unreached
e. Hands on Training on Primary processing of Millets
f. Training on Secondary Processing of Millets
g. Marketing Linkages in Millets
h. Understanding the food processing technologies
i. Importance of packaging of food products
j. Practical session on labeling, branding and commercialization of Millets Value Added Products

4) Mandla is suitably located to tap into the market of Odisha, Chhattisgarh, Andhra Pradesh, and Madhya Pradesh leading to creation of significant price arbitrage to motivate farmers to produce more minor millets.

Annexure I: List of Respondents/Key Informants

#	Organization	Interviewee	Designation	Date	Location
1	Reliance Foundation	Shri Dinesh Yadav	Team Leader	22.02.2021	Office, Mandla Town
2		Shri Ishwar Singh	Assistant Project Manager – Institution Building		Office, Mandla Town
3		Shri Bubulal Kishoria	Assistant Project Manager – Water Security		Office, Mandla Town
4		Shri Bharat Kumar	Assistant Project Manager – FPO & Market Linkages (Livelihoods)		Office, Mandla Town
5	Gram Van Samiti	Shri Jagatram Chicham	President, Gram Van Samiti		Semikul Village, Post -Baddhar, Tehsil Mandla
6	Mandla Tribal Farmer Producer Co. Ltd.[19]	Shri Yogendra Chaukikar	Livelihoods	23.01.2021	ASHA office, Mandla Town
7		Shri Sharam Mishra	Area Manager – ASHA Lead		ASHA office, Mandla Town
8	Narmada Self-Reliant Farmer Producer Company Ltd.[20]	Shri Balsingh Kusram	Board of Director	23.01.2021	FPC Office Village Kuteli, Post – Baddhar, Tehsil Mandla
9		Shri Ramcharan Ueeke	Board of Director		
10		Shri Ashok Kumar Yadav	Godown/Store-in-Charge		
11		Shri Chand Dubey	Chief Executive Officer		
12	Foundation for Ecological Security	Satya Shubham Das	Team Lead	25.01.2021	FES Project Office, Mandla Town
13		Pradyumna Acharya			
14	Kanha Krishi Vanopaj Producers Co. Ltd., Bichiyaa, Mandla	Ranjeet Kachhwaha	CEO	25.01.2021	Mandla FPO Office
15	Mssrs Kanhaiya Lal Kailash Kumar Rawat	Kanhaiya Lal Kailash Kumar Rawat	Proprietor/Trader	25.01.2021	Mandla Mandi
16	Ratan Enterprises & Flour Mill[21]	Ratan Lal	Local Miller	26.01.2021	Mandla Town

[19] Promoted by Action for Social Advancement (ASA).
[20] Promoted by Reliance Foundation.
[21] A local miller running a micro-enterprise in Mandla town.

Annexure II: Indicators for Assessing FPC Formation Process and Functioning[22]

CRITERIA	INDICATORS
1. Characteristics	• Size: Is the size good enough to be economically viable and socially cohesive • Not dominated by politically / economically powerful members • Poor and women are included (if mandated)
2. Identity & structure	FPC has a proper work place and compliant to statutory and business requirements • Majority members know the purpose of forming FPC and can give an account of ' 'FPC's activities including finances • Single member per household representation norm used
3. Leadership	• Leadership roles change, fixed tenure • Leaders have been elected by the members • Adherence to the procedure while conducting election of the Office Bearers and Executives
4. Functioning	FPC has a set of rules (bye laws) which has been discussed and agreed and sanctions for rule breakers • Regular BOD meeting and AGM takes place with significant attendance • The majority of members (X%) contribute to BOD / AGM discussion and decision making • Up-to-date maintenance of records, books of accounts, statutory and internal audit, etc.
5. Independence (in proportional to the age of the PC)	• Meetings of BOD / AGM regularly take place in the absence of Promoting Institution or with diminishing support • Records are maintained without or with little support from the Promoting Institution • Decisions are taken independent of the Promoting Institution
6. Resource mobilization	• FPC raises fund to carry out business • Overheads expenditure met with the own resources • Reserve funds • Mobilization of specialized skills, information, resources etc. through public and private sector linkages
7. Resource management	• Business plan and its implementation • FPC has shown ability to negotiate with the various stakeholders • FPC effectively oversees/manages the work of Executives working as salaried persons • Budget control
8. Skill acquisition & use	• Office Bearers and Executives have attended training programs (including specialized training) • Utilisation of acquired skills to identify and solve operational problems
9. Distribution of benefits	• Equitable distribution of benefits (dividends and services) • Mechanism of benefits sharing developed and adhered to

Annexure III: Millet Processing Machines:

1) Village/Community Level: Space 200 square feet floor area. Destoner-cum-Grader with Aspirator and a Dehuller. It may cost around ₹2 lakhs. Its capacity is around 50kg/hour, and two-person can easily operate it. It can work in a single phase.

2) Small Scale Level: Space 1,200 square feet floor area. Destoner, Grader, and Dehuller 2 numbers each is required. Its capacity is around 100 kg/hour. It may cost around ₹4-5 lakhs.

3) Medium Scale Level: This enterprise's capacity maybe around 500-1,000 kg/hour. 5,000 to 10,000 square feet is required with godowns to stock raw materials up to 10-20 tonnes. Destoner and Grader of 4 to 8 numbers, Dehuller 2 to 4 machines. For value addition, we can keep Pulveriser, Semolina Machine, Flakes Making Machine. It cost maybe around ₹20-30 lakhs.

4) Large Scale Level: Most of the large-scale enterprises are found in Nashik. It may cost around ₹60-70 lakhs.

Annexure IV: Narmada Self Reliant Farmers Producer Company Limited

Narmada Self Reliant Farmers Producer Company Limited[23] is a non-government company incorporated on 25 Jan 2011. It's a private unlisted company and is classified as a 'company limited by shares'. The company's authorized capital stands at 35 lakhs and has 63.477% paid-up capital, i.e., ₹22,21,700 lakhs. Narmada Self Reliant Farmers Producer Company Limited's last annual general meet (AGM) happened on 30 Sep 2019. The company last updated its financials on 31 Mar 2019 as per the Ministry of Corporate Affairs (MCA). The FPC is majorly in Agriculture and Allied Activities business for the last ten years and company operations are active. Currently, Narmada FPC has 4,731 members.

The FPC is also a member of Madhya Bharat Consortium of Farmer Producers company limited (MBCFPCL). MBCFPCL is a state-level conglomerate of Farmer Producer companies. It was established in September 2014 to create umbrella support to members, particularly on the market, financial linkages, brand development, value-adding, agri-extension, insurance, and leverage & transfer the benefits of the economy of scale. Narmada FPC has issued shareholdings at par to its members. Earlier FPC issued six shares to one member at the rate of ₹100.

According to the SFAC guidelines, now only three shares are issued to one member at the rate of 100. According to the board of directors, CEO, and members, the size of FPC affects its performance and efficiency, and the team views it as a challenge. Mandla is a sparsely populated area with its undulating features; villages are spread out far, and there is no public transportation connecting them at regular intervals. The low economic status of the associated farmer members hinders regular interaction and proves to be cost-intensive. FPC has grown the membership and expanded the footprints but, it is all happening at bootstrapping mode. FPC business will achieve Rs One Crore in this financial year (2020-21) through input and output marketing, but the company is nowhere near a profit-making benchmark.

[22] The table has acted as the reference tool during the FPC assessment.

[23] Narmada Self Reliant Farmers Producer Company Limited's Corporate Identification Number is (CIN) U01407M P2011PTC025251

Mandla is known for producing crops that is generally viewed as organically produced because of the very low use of fertilizers and pesticides in general (Fertilizers consumption average 38 kgs against national average of 165.8 Kgs per hectare-Year 2016). This sentiment definitely provides opportunity to various market players to hedge highly on the Mandal & Dindori Kodo-Kutki. Therefore, FPCs are engaged in the procurement of diverse crops such as patla dhaan, Sujata & Sharbati wheat varieties. The procured produce is sold as organic to various actors in the value chain[24]. Efforts have been made to penetrate the Nashik Market but have had limited success.

Narmada FPC challenges are the same as those of other FPCs in Mandla. Collectivising thousands of farmers in diverse socio-economic rural areas of Mandla is an arduous task that FPC has achieved. The FPC has emerged as an interface between small and marginal farmers and the external market in their current operating area. However, socio-economic problems like poverty, low literacy rate, lack of access to resources, PTGs situation, and the district's backward legacy are some of the significant weaknesses.

Currently, the company has a cap-ex of Rs. 30 lakhs. The last financial year turnover was Rs. 70 lakhs. In the current financial year, i.e., the year 2020-21, the annual turnover has been Rs. 93 lakhs (till January 2021).
The organizational leadership, i.e., BoD and CEO, is in unison responding to the climate change and adopting adaptation measures. Their only limitation is concerning the lack of capital and training associated with the climate change adaptations.

[24] Actors such as wholesale traders in Mandla and nearby Mandis, Mandla Organic social enterprise, and the Nashik Millers

Table 7: Services/functions[25] provided by the Narmada FPC

#	Broad categories of services	Services/Functions	Yes/ No	Remarks	Scale (1 to 5[26])
1	Production services	Input supply (good quality seeds, improved agronomic practices, information	Yes	Primarily indigenous seed varieties are in use. Provision of quality seed is a challenge.	3
2		Production activities			
3	Marketing services	Grading & sorting	Yes		2
		Processing	No		0
		Market information	Yes		2
		Branding	No		0
		Certification	Yes		3
		Transport and storage	Yes		
4	Financial services	Savings	Yes		0
		Loans, and other forms of credit	No		0
		Financial Management	No		0
5	Technology and educational services	Extension Services	No		0
		Research	No		0
		Certification of groups	No		3
		Organizational skills	Yes		3
		Training & information sharing	Yes		3
6	Welfare services	Health	Yes		3
		Safety nets	Yes		3
		Drinking water	Yes		3
		Community development	Yes		3
7	Linkages and coordination	Creating linkages	Yes		3
		Coordination with various actors	Yes		3
8	Representations and Policy advocacy	Defense of group	Yes		3
		Political and administrative representations	No		0
		Advocacy at different level	No		0

[25] Table adapted from Trebbin A and Markus H. 2012 Farmers' producer companies in India: a new concept for collective action? Environment and Planning 44: 412–27. https://doi.org/10.1068%2Fa44143

[26] Scale 5 being very good, 4 being good, 3 being Satisfactory, 2 being poor, and 1 being ultra-poor.

Table 8: Post Incorporation Compliances

Compliance Items	Yes/No	Remarks
First meeting of the board of directors of the company	Yes	
Auditor Appointed	Yes	
Bankers Appointed and Bank account opened	Yes	
Printing of share certificate	Yes	
Publication of name of Company	Yes	
Common seal	Yes	
Maintenance of Statutory Registers ("the Registers")	Yes	
Does your Producer Company undertake an internal audit of its accounts?	Yes	
What is the frequency of such audits?	Quarterly	
Who does the internal audit?	Reliance Foundation Accounts Team	
Producer Company prepares a balance sheet and profit and loss of accounts?	Yes	
What are the records / books /registers that your Producer Company maintains?		
Do you file calendar of returns to be filed by the FPCs?	Yes	
Obtained certificate of registration under various acts to begin business		
Permanent Account Number (PAN)	Yes	
Tax Deduction and Collection Account Number TAN	Yes	
Registration for Shop License	No	
Registration under GSTN	Yes	
Service Tax Registration		

Role of Promoting Organization

The Narmada FPC has been functional and supported by Reliance Foundation, which has focused on the IB-CB component to create a resilient FPC for the future. Due to the challenges associated with the production, Reliance Foundation focused on the diversification[27] of crop types so that smallholder farmers can build a better crop portfolio and thereby food and income security. The study found that the institution building by the Reliance Foundation has focused on social and economic well-being. A tremendous effort has been built towards community institutional development, orientation together with steps towards economic development.

Competitors

Mandla has more than thirteen registered FPCs[28]. FPCs of Mandla compete with each other. Some of the FPCs are as follows:

1. Narmada Self Reliant Farmers Producer Company Limited (Narmada SRFPC), promoted by Reliance Foundation.
2. Kahnha Krishi Vanopaj Producer Company Limited (Kanha KVPC), promoted by NRLM
3. Mandla Tribal Farmer Producer Company (Mandla TFPC), promoted by ASA
4. Maheshmati Tribal Farmer Producer Company Ltd (Maheshmati TFPC), promoted by ASA

[27] As total dependence on the Kodo-Kutki isn't viable for smallholder farmers, that too when a significant percentage of the population involved belong to the ST category.

[28] http://sfacindia.com/PDFs/List-of-FPO%20ident fied-by-SFAC/List%20of%20FPOs%20in%20the%20State%20of%20Madhya%20Pradesh.pdf?var=9958908.25855

5. Bal Ganga Farmer Producer Company Limited, promoted by Centre for Advanced Research & Development (CARD)
6. Sankatmukta Kissan Producer Company Limited, promoted by Centre for Advanced Research & Development (CARD)
7. Narayanganj Krishak Producer Company Limited, promoted by Gramin Vikas Trust (GVT)
8. Shri Ganesh Kisan Producer Company Limited, promoted by National Institute of Women Child & Youth Dev (NIWCYD)
9. Sahastradhara Farmer Producer Company Limited, promoted by National Institute of Women Child & Youth Dev (NIWCYD)

The Narmada FPC was registered in 2011. In 2021, it celebrated its ten years in operations. Farmers are attached to the company, and it was observed that the procurement process is robust. It has built a warehouse cum office with a land grant from the community. It showcases that the FPC and its promoting organization have done good work in community reach, community awareness, and focus on the participation of different community members in the Board of Directors. Besides, Reliance Foundation has focused on the Farmer Producer Company orientation and developed a long-term perspective.

This strategy provided the newly created FPCs an opportunity to flourish, pilot, and implement their program strategies and showcase different results. Also, it minimized and eliminated the friction situations among the beneficiaries and the staff and field workers. More so, it puts them on the path to complement each other work and at least speak in one voice at the district level if the need arises to do so.

Despite these, now, as the focus is more on the marketing, large-scale procurement, and selling of the product to get the best price for the shareholders, we can observe a high competition level. Besides, these the wholesaler themselves tries to access either directly or their rural agents. Moreover, the FPCs have not directly managed to venture into the Nashik Market, the most important market to decide the future and present Kodo-Kutki rates down the value chain. The study did not foresee any important economic factors that will affect the FPC's product or services being affected by any major natural calamity leading to the failure of agriculture.

Procurement through APMCs are limited in Mandla. FPCs prefer to sell the procured product to the wholesalers Mandi Trader. Madhya Pradesh has done remarkably well in recent years in the agriculture sector with state government keen on promoting marketing and selling of the produce to other markets. Nevertheless, Kodo and Kutki products were not easily found in Mandla or nearby towns. Minor Millets in the form of Bhagar food was found in grocery shops and outlets with retail prices ranging between ₹120-130/kg (wholesale rate ₹85-90/kg).

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