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Assessment of Soil Fertility under Different Cropping Systems Practiced By Korku Tribes of Melghat Region, Maharashtra State, India

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ABSTRACT

A detailed soil fertility survey was carried out at tribal areas of Chikhaldhara tahsil of Amravati district, Maharashtra during the kharif season of 2016. In the present investigation, forty-two representative soil samples were collected from fields of Korku tribes practicing different cropping systems to analyze soil fertility status for increasing crop production and recommending optimal fertilizer doses. The soils of the experimental sites were neutral in reaction, low in electrical conductivity, and low to medium in organic carbon. Soils were non-calcareous with low to medium calcium carbonate content. Micronutrients like Fe, Mn, and Cu were sufficient, whereas widespread Zn deficiency was observed. Nutritionally, available phosphorus was low, while available nitrogen, potassium, and sulphur (mean 9.52 kg ha^{-1}) fell under the low to medium category. Low sulphur and nutrient variations are attributed to runoff and leaching from upper topography due to high rainfall. Physical parameters like hydraulic conductivity, available water capacity, and soil moisture showed an inverse relationship with bulk density. Single cropping systems maintained soil fertility better than double cropping systems. Therefore, conjunctive application of organic amendments (FYM/compost) and inorganic fertilizers according to land capability is recommended for sustainable soil health and crop yields.

Introduction

Soil fertility stands as the fundamental determinant of agricultural productivity and sustainable land management. Intensive and continuous cropping systems without adequate, balanced nutrient replenishment inevitably lead to multi-nutrient deficiencies. Periodically monitoring physical, chemical, and biological soil properties is therefore essential to optimize costly fertilizer inputs, maximize economic returns, and mitigate long-term environmental degradation (1-4). This challenge is highly pronounced in India, where the food grain demand requires maximizing agricultural output per unit area while preserving the core health of vastly diverse soil orders. Among these, Inceptisols and Entisols represent major soil orders developed under varied topography and climates. Prior research indicates these basaltic-derived soils are generally neutral to alkaline in reaction (pH 7.01 to 8.77), normal in electrical conductivity (EC), low-to-medium in organic carbon (OC), and heavily prone to low nitrogen (N) and phosphorus (P) availability due to rapid losses or chemical fixation (5-7).

The Melghat region, situated across the northern Satpura mountain range in the Amravati district of Maharashtra, covers an ecologically vital landscape. Located between 21°07' N to 21°45' N latitudes and 77°11'50" E to 77°72' E longitudes, it features an undulating topography with high seasonal rainfall averaging 1540 mm annually (8-10). Geologically, the area is dominated by Deccan Trap basalt, exhibiting varying stages of weathering—from hard, compact columnar basalt structures to softer, earthy brown weathered rock. This weathering yields three distinct soil types across the landscape: boulder-type soils along steep slopes, lateritic loams on hilltops/plateaus (prominent around Chikhaldhara), and fertile yet poorly drained clay soils in depressions.

The region is predominantly inhabited by the Korku tribe, an indigenous scheduled tribe making up over 80% of the local population. Historically dependent on forest produce, the Korku communities transitioned toward settled, rainfed agriculture after acquiring permanent land rights in 1973. Most families operate as small or marginal landholders, managing plots under 5 acres. Traditional cultivation focused on subsistence crops like jowar, kutki, and kodo, but has modernly diversified into soybean, pigeonpea (tur), cotton, chickpea (gram), and high-value horticultural options like strawberry. In light of these criteria, the present investigation entitled 'Assessment of soil fertility under different cropping systems practiced by Korku tribes of Melghat region, Maharashtra State' was conducted to evaluate the physical-chemical properties, map macro/micronutrient positions, and formulate sustainable recommendations.

Materials and Methods

The investigation was carried out during the year 2015–2016 at Chikhaldhara tahsil, located within the Melghat region of Maharashtra, India. The area lies between 21°13' and 21°21' N and 77°43' and 77°72' E. The local climate is sub-tropical with an annual rainfall of 1469.4 mm (2016 data). Forty-two (42) representative surface soil samples (0–20 cm depth) were collected from fields operated by Korku tribal farmers spanning 10 distinct villages. Coordinates and elevation indices were established via handheld GPS units (Table 1).

Results and Discussion

Classification based on operational field units revealed that 57.14% of the selected tribal cultivators operate within marginal to small categories (0 to 2 ha), while 42.86% manage semi-medium to medium holdings. Limited irrigation capabilities restrict 54.76% of farmers to a single rainfed kharif crop, whereas 45.24% exploit surface wells, canals, or streams to manage intensive double cropping. The local soil profiles showed a clear inverse relationship: bulk density is inversely proportional to available water capacity.

Mean bulk density was 1.30 Mg m^{-3}, spanning from a low baseline in Hirdamal (1.21 Mg m^{-3}) to severe compaction profiles in Dharamdoh (1.39 Mg m^{-3}). Correspondingly, Hirdamal showed the highest moisture buffer capacity (14.18% AWC), while structural compaction in Dharamdoh lowered AWC to 9.62%.

In conclusion, the field investigation concludes that the agricultural soils cultivated by the Korku tribes in Chikhaldara tahsil are predominantly neutral in reaction (mean pH 6.76), non-saline (mean EC 0.22 dSm^{-1}), and low-to-medium in organic carbon (mean 4.67 g kg^{-1}). The structural physics of these mountain soils exhibits a significant inverse relationship between bulk density and available water capacity (AWC). Highly significant 'Z' test values validate that these soils face severe fertility constraints, characterized by widespread deficiencies in available nitrogen (mean 176.93 kg ha^{-1}), available phosphorus (mean 8.18 kg ha^{-1}), and available sulphur (mean 9.58 mg kg^{-1}). Among micronutrients, DTPA-extractable Fe, Mn, and Cu are highly sufficient, whereas zinc deficiency (mean 0.34 mg kg^{-1}) is critically widespread across the tahsil. Furthermore, intensive double-cropping systems show accelerated nutrient depletion compared to traditional single-cropping fields.

Key Recommendations:

• Escalate mineral fertilizer input by 25% over current recommended doses to compensate for low macro and secondary nutrient status.

Table.1 GPS Coordinates and Elevation Data of Target Sampling Villages

Sr. No.	Name of Village	Latitude (North)	Longitude (East)	Altitude (m)	Samples
1	Hirdamal	21°38.183'	77°31.566'	604	4
2	Telkhar	21°19.173'	77°20.322'	582	2
3	Aadao	21°25.690'	77°05.861'	424	5
4	Badnapur	21°21.186'	77°22.317'	550	3
5	Makhala	21°31.981'	77°22.912'	948	2
6	Savarya	21°25.982'	77°01.992'	387	6
7	Churni	21°37.508'	77°30.956'	771	3
8	Chunkhadi	21°34.486'	77°25.068'	759	5
9	Beriteki	21°26.360'	77°00.310'	379	7
10	Dharamdoh	21°18.269'	77°18.319'	522	5

Table.2 Standard Lab Assays and References Adopted

Component	Operational Method Applied	Standard Source Reference
Soil Reaction (pH)	Potentiometric validation (1:2.5 soil-water matrix)	Jackson (1973)
Electrical Cond. (EC)	Conductometric assessment (1:2.5 supernatant liquid)	Jackson (1973)
Organic Carbon (OC)	Walkley and Black wet oxidation chromic acid titration	Jackson (1973)
Calcium Carbonate	Rapid acid neutralization titration method	Piper (1966)
Available Nitrogen (N)	Alkaline permanganate ($KMnO_4$) distillation method	Subbiah & Asija (1956)
Available Phosphorus (P)	Olsen's reagent extraction (0.5M $NaHCO_3$, pH 8.5)	Watanabe & Olsen (1965)
Available Potassium (K)	Neutral normal ammonium acetate (1N NH_4OAc) extraction	Jackson (1973)
Available Sulphur (S)	Turbidimetric assessment using barium chloride	Piper (1966)
Micronutrients (Fe, Mn, Zn, Cu)	DTPA extraction via Atomic Absorption Spectrophotometer	Lindsay & Norvell (1978)

Table.3 Soil Analytical Fluctuations across Cropping Intensities

Cropping Context	BD (Mg m^{-3})	AWC (%)	pH	EC (dSm^{-1})	OC (g kg^{-1})	$CaCO_3$ (%)
Single Cropping System	1.30	11.66	6.69	0.22	4.99	2.54
Double Cropping System	1.31	11.61	6.84	0.24	4.77	2.19

Table.4 Nutrient Status Variations as a Function of Cropping Pressure

Management Context	N (kg ha^{-1})	P (kg ha^{-1})	K (kg ha^{-1})	S (mg kg^{-1})	Fe (mg kg^{-1})	Mn (mg kg^{-1})	Zn (mg kg^{-1})	Cu (mg kg^{-1})
Single Cropping	191.37	8.93	174.62	10.40	4.50	13.02	0.41	2.39
Double Cropping	178.08	8.15	164.25	9.59	4.77	11.94	0.29	2.49

Table.5 Cumulative Soil Fertility Metrics and Statistical Validation (n=42)

Parameter	Minimum	Maximum	Mean	Low %	Med %	High %	Z-Test
pH (1:2.5)	6.12	7.98	6.76	31%	57%	12%	8.47**
EC (dSm^{-1})	0.12	0.35	0.22	100%	—	—	0.02
OC (g kg^{-1})	3.13	7.91	4.67	30%	70%	—	7.21**
CaCO3 (%)	1.62	4.00	2.27	84%	16%	—	53.24**
Available N (kg ha^{-1})	150.53	238.34	176.93	100%	—	—	11.31**
Available P (kg ha^{-1})	7.00	10.84	8.18	100%	—	—	65.80**
Available K (kg ha^{-1})	108.56	295.68	162.21	49%	39%	12%	37.94**
Available S (mg kg^{-1})	5.72	20.79	9.58	60%	40%	—	9.77**
Available Fe (mg kg^{-1})	2.11	9.71	4.41	43%	57%	—	100.58**
Available Mn (mg kg^{-1})	4.90	19.04	11.96	—	—	100%	35.94**
Available Zn (mg kg^{-1})	0.09	0.66	0.34	81%	19%	—	16.63**
Available Cu (mg kg^{-1})	1.20	2.70	2.32	—	—	100%	39.20**

• Apply Zinc Sulphate ($ZnSO_4$) @ 25 kg ha^{-1} to correct widespread crop zinc deficiency constraints.

• Adopt Integrated Nutrient Management (INM) using farmyard manure (FYM) or compost to reduce bulk density matrices and elevate water holding buffers.

• Implement contour bundling and vegetative cross-barriers to check topsoil leaching caused by high rains on Satpura slopes.

Author Contributions

R. R. Kove: Investigation, formal analysis, writing—original draft. S. M. Bhoyar: Validation, methodology, writing—reviewing. P. W. Deshmukh:—Formal analysis, writing—review and editing. R. P. Mane: Investigation, writing—reviewing.

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethical Approval Not applicable.

Consent to Participate Not applicable.

Consent to Publish Not applicable.

Conflict of Interest The authors declare no competing interests.

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