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RESEARCH PAPER

Comparative studies on soil fertility status of natural farming and farmers practice in northern dry zone of Karnataka

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Abstract: Soil fertility is important as it directly influence the productivity and overall health of the soil.This research was conducted to study soil fertility status in <5,5-10 and 10-15 years under natural farming and farmers practice at 0-20 cm soil depth in three natural farming clusters of Belagavi district in northern dry zone of Karnataka during 2022-23.This study revealed that natural farming had a positive effect on soil fertility. Soil pH and EC decreased in natural farming (8.29 to 8.08, 0.47 to 0.41 dS/m), where as it increased in farmers practice from 8.35 to 8.49 (pH),0.49 to0.51 dS/m(EC) and CEC increased from 54.94 to 75.91 c mol(p+)/kg in natural farming but decreased from 50.47 to 42.82 c mol (p+)/kg in farmers practice. Organic carbon increased in natural farming from 7.11 to 9.63 g/kg but it decreased from 6.12 to 4.24 g/kg in farmers practice over the years. Available macronutrients and DTPA-extractable micronutrients increased in natural farming but significantly decreased in farmers practice over the years. Overall, natural farming showed improvements in soil fertility while farmers practices resulted in decline in soil fertility over the years.

Key words: Available nutrients, Natural farming, Organic carbon, PH

Introduction

Over the past century, agriculture has shifted significantly from organic methods, which dominated before the 1940s, to more intensive practices to meet the demands of growing population. The consistent yields of traditional organic farming were insufficient, prompting the adoption of modern techniques to enhance efficiency, reduce costs and increase crop production. This transition aimed to ensure food security and improve farmers livelihoods. In India, the shift from organic to conventional farming has burdened farmers with debt due to rising production costs, volatile market pricesand expensive inputs. The excessive use of chemical fertilizers and pesticides has degraded soil health, reduced soil organic matter and harming its physical, chemical and biological properties (Montgomery, 2018).

Understanding the influence of natural farming versus conventional practices on soil fertility is crucial for enhancing soil health, sustainability and crop productivity. It helps identify practices that improve nutrient cycling, organic matter content and soil resilience. This knowledge guides farmers and policymakers in adopting sustainable agriculture for long-term environmental and economic benefits. In recent years, natural farming has gained prominence as an alternative to conventional methods. Natural farming emphasizes the use of locally available organic inputs, minimal soil disturbance and enhancement of soil biological activity. It promotes practices such as crop rotation, cover croppingand the use of organic manures and biofertilizers, aiming to improve soil structure, increase organic matter contentand restore the natural balance of soil ecosystems (Freibauer *et al.,* 2004).

The Northern Dry Zone of Karnataka, with its varied soil types, including black soils rich in clay and red soils with lower fertility, presents a unique case for studying the influence of farming practices on soil fertility. The comparison between natural farming and farmers' conventional practices offers insights into the long-term impacts on soil health. This study aims to evaluate the effects of natural farming versus conventional farming practices on soil fertility in selected regions of the Northern Dry Zone of Karnataka. By analysing key indicators of soil quality, this research seeks to contribute to the understanding of sustainable agricultural practices and provide recommendations for enhancing soil health in this challenging Agro-Climatic Zone.

Material and methods

The farmers were categorized into three groups who are practicing natural farming for <5 years (A series), 5-10 years (B series), 10-15 years (C series) and in each category of farmers practicing natural farming,20 farmers were selected and the soil samples were collected. Similarly adjacent corresponding farmer were selected who were practicing conventional farming. Categories of farmers practicing natural farming in 3 different clusters of Zone 3 of Karnataka (Table 1) was selected from base line survey done in the Project "Comparative Evaluation of NF systems for enhancing the lively hood of farm families" during 2018-19 to 2022-23. These farmers selected are also beneficiaries of the project "CM Natural farming" of Zone 3.

Soil pH was measured using a glass electrode pH meter after stirring for 30 minutes at 25°C, following the method by Sparks (1996). EC was determined in the supernatant solution using a conductivity meter, expressed in dS/m. Free $CaCO_3$ was estimated using the rapid acid titration method described by Piper (2002). OC content was determined by Walkley and Black method, as per Sparks (1996). Available nitrogen was measured

Table 1. Categories of farmers practicing natural farming in 3 different clusters

<5 years			5-10 years			10-15 years		
	Cluster	Years		Cluster	Years		Cluster	Years
A_1	Shegunasi	3.0	B_1	Shegunasi	7.0	C_1	Shegunasi	11.0
A_2	Shegunasi	4.0	B_2	Shegunasi	5.0	C_2	Shegunasi	12.5
A_3	Shegunasi	2.0	B_3	Shegunasi	6.0	C_3	Shegunasi	13.0
A_4	Shegunasi	2.0	B_4	Shegunasi	5.0	C_4	Shegunasi	10.5
A_5	Shegunasi	3.0	B_5	Shegunasi	6.0	C_5	Shegunasi	13.0
A_6	Shegunasi	2.5	B_6	Shegunasi	8.0	C_6	Shegunasi	10.5
A_7	Shegunasi	4.0	B_7	Shegunasi	7.0	C_7	Shegunasi	11.0
A_8	Shegunasi	2.0	B_8	Shegunasi	6.0	C_8	Shegunasi	13.0
A_9	Shegunasi	3.0	B_9	Shegunasi	7.5	C_9	Shegunasi	14.5
A_{10}	Shegunasi	3.5	B_{10}	Shegunasi	7.5	C_{10}	Shegunasi	15.0
A_{11}	Shegunasi	4.5	B_{11}	Naganur	8.0	C_{11}	Harugeri	14.0
A_{12}	Naganur	1.5	B_{12}	Naganur	9.0	C_{12}	Harugeri	11.5
A_{13}	Naganur	4.0	B_{13}	Naganur	9.5	C_{13}	Harugeri	12.0
A_{14}	Naganur	3.0	B_{14}	Naganur	6.0	C_{14}	Harugeri	10.0
A_{15}	Naganur	4.0	B_{15}	Naganur	5.5	C_{15}	Harugeri	14.5
A_{16}	Harugeri	3.5	B_{16}	Naganur	8.0	C_{16}	Harugeri	12.0
A_{17}	Harugeri	4.0	B_{17}	Harugeri	6.0	C_{17}	Harugeri	13.5
A_{18}	Harugeri	2.5	B_{18}	Harugeri	5.0	C_{18}	Naganur	14.0
A_{19}	Harugeri	3.5	B_{19}	Harugeri	6.5	C_{19}	Naganur	13.5
A_{20}	Harugeri	2.5	B_{20}	Harugeri	9.0	C_{20}	Naganur	11.5

using the Alkaline permanganate oxidation method (Sharawat and Burford, 1982). Available phosphorus was extracted using Olsen's method and estimated spectrophotometrically. Available potassium was extracted using neutral normal ammonium acetateand K content was determined using a flame photometer. Available sulphur was extracted with 0.15% $CaCl_2 \cdot 2H_2O$ andmeasured turbidimetrically using a spectrophotometer, according to Jackson (1973).DTPA-extractable micronutrients are measured by Atomic Absorption Spectrophotometer as described by Lindsay and Norwell (1978).

Results and discussion

The data (Table 2) shows that soil pH decreased over time in natural farming from 8.30 to 8.09, while it increased in farmers practices, from 8.35 to 8.49 across <5, 5-10 and 10-15 years of farming. Natural farming consistently had significantly lower pH values compared to farmers practices in all time categories. Significant differences in soil pH were observed within each farming method over the different years. Soil pH decreased over time under natural farming due to the continuous addition and microbial decomposition of OC, which released organic acids, while in farmers practice, pH increased as chemical use reduced OM and its decomposition. The most significant pH reduction was observed in 10-15 years of natural farming (Panghate *et al.,*2020).

The data (Table 3) showed that electrical conductivity (EC) decreased over time under natural farming, from 0.46 to 0.43 dS/m, while it slightly increased in farmers practices from 0.49 to 0.51 dS/macross<5, 5-10 and 10-15 years of farming. EC values were significantly lower in natural farming compared to farmers practices, though the differences among years within each practice were not significant.EC was lower under natural farming compared to farmer practice across <5, 5-10 and 10-15 years, with the highest EC seen in 10-15 years under farmers' practice due to synthetic fertilizers and intensive farming. Natural farming showed significantly lower EC in 10-15 years, due to buildup of organic matter, improved soil structure and increased microbial activity (Geisseler and Scow, 2014).

Table 2. Influence of natural farming and farmers practice on soil pH (<5 ,5-10 and 10-15 years)

SL.No	pH (1:2.5)					
	<5 years		5-10 years		10-15 years	
	NF	FP	NF	FP	NF	FP
1	8.25	8.28	8.22	8.32	8.09	8.31
2	8.23	8.30	8.11	8.35	8.21	8.41
3	8.33	8.42	8.29	8.42	8.04	8.55
4	8.23	8.46	8.35	8.44	8.02	8.45
5	8.25	8.31	8.18	8.27	8.03	8.46
6	8.34	8.37	8.16	8.53	8.14	8.52
7	8.31	8.28	8.15	8.39	8.12	8.48
8	8.29	8.46	8.25	8.37	8.03	8.55
9	8.29	8.33	8.19	8.53	8.19	8.40
10	8.31	8.35	8.15	8.40	7.98	8.45
11	8.16	8.25	8.21	8.48	8.16	8.58
12	8.45	8.48	8.28	8.42	8.14	8.42
13	8.28	8.35	8.10	8.46	8.07	8.52
14	8.30	8.35	8.31	8.47	8.23	8.45
15	8.35	8.45	8.30	8.47	8.13	8.49
16	8.28	8.35	8.28	8.40	8.14	8.42
17	8.35	8.42	8.29	8.50	8.04	8.61
18	8.32	8.40	8.25	8.43	8.10	8.50
19	8.35	8.27	8.32	8.49	8.00	8.66
20	8.22	8.32	8.13	8.42	8.01	8.59
Mean	8.30	8.35	8.23	8.43	8.09	8.49
Max	8.45	8.48	8.35	8.53	8.23	8.66
Min	8.16	8.25	8.10	8.27	7.98	8.31
S.D	0.06	0.07	0.08	0.07	0.07	0.08
C.V	0.75	0.84	0.93	0.80	0.91	0.99
For comparison between farming practices in different years						
t stat. values	4.51		10.21		13.62	
P=0.01	< 0.01		< 0.01		< 0.01	
Remarks	S		S		S	
For comparison between years						
	<5yr	5-10 yrs	5-10 yrs	10-15 yrs	<5yr	10-15yrs
Natural farming						
t stat. values	3.77		5.14		8.87	
P=0.01	<0.01		<0.01		< 0.01	
Remarks	S		S		S	
Farmers practice						
t stat. values	3.29		3.55		5.46	
P=0.01	<0.01		<0.01		< 0.01	
Remarks	S		S		S	

*NF- Natural farming, FP-Farmers practice, S- Significant, NS- Nonsignificant

The data (Table 4) showed that soil organic carbonwas significantly higher under natural farming compared to farmers practices across all periods, with OC increasing from 5.17 to 6.09 g/kg in natural farming and decreasing from 4.79 to 4.19 g/kg in farmers practices over 10-15 years. Natural farming consistently demonstrated higher OC values and significant increases over time, while farmers practices showed a decrease in OC.Soil organic carbon was consistently higher under natural farming compared to farmers practices across all time periods, with significant increases observed over 10-15 years due to

Table 3. Influence of natural farming and farmers practice on electrical conductivity (<5, 5-10 and 10-15 years)

SL.No	EC (dS/m)					
	<5 years		5-10 years		10-15 years	
	NF	FP	NF	FP	NF	FP
1	0.52	0.55	0.48	0.50	0.37	0.42
2	0.42	0.49	0.47	0.52	0.39	0.47
3	0.44	0.47	0.42	0.44	0.44	0.49
4	0.47	0.51	0.51	0.55	0.48	0.64
5	0.47	0.52	0.50	0.47	0.41	0.58
6	0.50	0.45	0.43	0.45	0.44	0.54
7	0.40	0.45	0.47	0.50	0.37	0.43
8	0.49	0.51	0.45	0.49	0.50	0.51
9	0.53	0.55	0.39	0.41	0.38	0.43
10	0.47	0.49	0.42	0.47	0.31	0.46
11	0.55	0.57	0.47	0.55	0.45	0.50
12	0.35	0.38	0.44	0.47	0.45	0.47
13	0.45	0.49	0.35	0.40	0.47	0.53
14	0.39	0.41	0.49	0.49	0.53	0.59
15	0.45	0.48	0.37	0.45	0.49	0.57
16	0.47	0.52	0.45	0.47	0.47	0.63
17	0.41	0.44	0.47	0.51	0.39	0.46
18	0.44	0.49	0.45	0.46	0.42	0.56
19	0.49	0.51	0.44	0.49	0.45	0.59
20	0.52	0.55	0.45	0.48	0.35	0.32
Mean	0.46	0.49	0.45	0.48	0.43	0.51
Max	0.55	0.57	0.51	0.55	0.53	0.64
Min	0.35	0.38	0.35	0.40	0.31	0.32
S.D	0.05	0.05	0.04	0.04	0.06	0.08
C.V	11.08	9.89	9.24	8.14	13.10	15.73
For comparison between farming practices in different years						
t stat. values	5.44		5.60		6.40	
P=0.01	< 0.01		< 0.01		< 0.01	
Remarks	S		S		S	
For comparison between years						
	<5yr	5-10yrs	5-10yrs	10-15yrs	<5yr	10-15 yrs
Natural farming						
t stat. values	0.89		0.83		1.49	
P=0.01	0.913		0.209		0.077	
Remarks	NS		NS		NS	
Farmers practice						
t stat. values	0.81		1.88		1.18	
P=0.01	0.215		0.037		0.127	
Remarks	NS		NS		NS	

*NF- Natural farming, FP-Farmers practice, S- Significant, NS- Nonsignificant

Table 4. Influence of natural farming and farmers practice on organic carbon (<5 ,5-10 and 10-15 years)

SL.No	OC (g/kg)					
	<5 years		5-10 years		10-15 years	
	NF	FP	NF	FP	NF	FP
1	5.30	5.00	5.60	4.60	6.00	4.40
2	4.80	4.50	5.30	4.00	6.20	3.70
3	5.30	5.00	5.70	4.00	5.40	4.00
4	5.40	5.10	5.10	4.20	5.90	4.60
5	5.10	4.40	5.50	3.90	6.00	4.00
6	4.90	4.60	5.60	4.20	6.50	4.30
7	5.20	4.70	5.40	4.30	6.10	3.80
8	5.40	4.70	5.60	4.70	5.60	4.20
9	5.10	4.80	5.80	4.10	6.30	4.40
10	5.00	4.60	5.30	4.40	6.70	4.10
11	5.70	5.30	5.50	4.50	6.60	4.20
12	4.60	4.30	5.30	4.70	5.90	4.60
13	5.20	4.90	6.00	5.20	6.30	4.00
14	5.50	5.20	5.70	4.80	5.30	4.20
15	5.30	5.00	5.60	4.90	6.30	4.10
16	4.70	4.20	5.30	4.70	6.20	3.90
17	5.40	5.00	5.40	4.90	6.50	4.50
18	4.90	4.50	5.70	5.00	6.00	4.60
19	5.20	4.90	5.90	5.20	5.70	3.80
20	5.30	5.00	5.60	4.70	6.20	4.39
Mean	5.17	4.79	5.55	4.55	6.09	4.19
Max	5.70	5.30	6.00	5.20	6.70	4.60
Min	4.60	4.20	5.10	3.90	5.30	3.70
S.D	0.28	0.31	0.23	0.40	0.38	0.28
C.V	5.41	6.37	4.07	8.75	6.22	6.70
For comparison between farming practices in different years						
t stat. values	12.86		11.57		17.91	
P=0.01	< 0.01		< 0.01		< 0.01	
Remarks	S		S		S	
For comparison between years						
	<5yr	5-10yrs	5-10yrs	10-15yrs	<5yr	10-15yrs
Natural farming						
t stat. values	5.17		4.81		7.90	
P=0.01	< 0.01		< 0.01		< 0.01	
Remarks	S		S		S	
Farmers practice						
t stat. values	2.11		3.45		6.66	
P=0.01	0.025		< 0.01		< 0.01	
Remarks	NS		S		S	

*NF- Natural farming, FP-Farmers practice, S- Significant, NS- Nonsignificant

continuous organic inputs, reduced tillage (Marriott and Wander, 2006) and due to more addition of soil organic matter (Vidyavathi *et al*., 2011). Conventional practices led to lower OC values due to factors such as heavy tillage and chemical fertilizer use, which degrade organic matter (Jenkinson and Rayner, 2006).

The data (Table 5) shows that CEC was consistently higher under natural farming compared to farmers practices across <5, 5-10 and 10-15 years, with mean values increasing from 54.94-75.91 c mol(p+)/kg in natural farming but decreased from 50.47-42.82 c mol(p+)/kg in farmers practice over time. CEC values increased in natural farming due to improved organic matter and soil structure enhancing nutrient retention (Liebig and Doran, 1999) but in farmers practice CEC values decreased over the years in farmers practice due to use of more chemical fertilizers, intensive tillage, monocropping and intensive irrigation.

The soil nutrient data in Table 6 highlights notable differences in nutrient availability between NF and FP fields over time. Available nitrogen (N) levels were consistently higher in NF fields, reaching up to 228.02 kg/ha in the 10-15 years category, whereas FP fields saw a marked decline in N (as low as 167.11 kg/ha in 10-15 years). This reduction is likely due to higher crop uptake and limited organic matter inputs, which was critical for N replenishment. Available phosphorus (P_2O_5) was also higher in NF fields, increasing with time to 27.58 kg/ha

Table 5. Influence of natural farming and farmers practice on Cation exchange capacity (<5, 5-10 and 10-15 years)

SL.No	CEC (c mol(p+)/kg)					
	<5 years		5-10 years		10-15 years	
	NF	FP	NF	FP	NF	FP
1	58.91	53.66	61.36	48.07	73.87	43.66
2	53.15	48.98	55.87	40.22	75.42	41.01
3	45.50	41.48	66.57	56.88	82.48	46.39
4	59.45	54.99	40.33	36.34	72.47	41.27
5	47.96	44.15	54.89	47.98	72.80	35.82
6	52.26	48.44	48.61	62.12	78.83	47.10
7	46.61	42.62	54.05	48.99	69.02	46.01
8	46.79	42.41	60.31	53.57	66.78	40.66
9	57.38	53.60	50.51	45.55	73.08	40.51
10	60.48	56.74	52.00	43.77	88.31	44.55
11	79.36	74.36	53.37	53.50	77.57	45.37
12	40.51	37.07	55.70	46.21	72.02	44.15
13	56.54	51.02	78.79	66.31	76.34	40.86
14	57.62	52.57	62.05	43.08	63.71	42.19
15	50.55	45.25	54.54	38.41	71.99	37.92
16	56.28	51.20	73.26	45.84	76.73	41.94
17	58.40	53.27	59.30	44.71	81.31	40.55
18	61.46	56.35	59.88	46.28	77.14	41.71
19	52.96	51.17	74.56	52.35	85.16	45.59
20	56.71	49.98	55.37	45.67	83.11	49.13
Mean	54.94	50.47	58.57	48.29	75.91	42.82
Max	79.36	74.36	78.79	66.31	88.31	49.13
Min	40.51	37.07	40.33	36.34	63.71	35.82
S.D	8.12	7.81	9.21	7.46	6.16	3.25
C.V	14.78	15.48	15.73	15.44	8.12	7.59
For comparison between farming practices in different years						
t stat. values		18.65	4.99		25.66	
P=0.01		< 0.01	< 0.01		< 0.01	
Remarks		S	S		S	
For comparison between years						
	< 5yr	5-10yrs	5-10yrs	10-15yrs	< 5yr	10-15yrs
Natural farming						
t stat. values		1.21	7.36		10.22	
P=0.01		0.1211	< 0.01		< 0.01	
Remarks		NS	S		S	
Farmers practice						
t stat. values		0.77	3.30		3.93	
P=0.01		0.226	< 0.01		< 0.01	
Remarks		NS	S		S	

*NF- Natural farming, FP-Farmers practice, S- Significant, NS- Nonsignificant

in the 10-15 year NF fields. The lower P_2O_5 levels in FP fields (minimum of 18.08 kg/ha in 10-15 years) could result from crop removal and minimal replenishment, especially in intensive farming systems (Duddigan *et al*., 2023). Available potassium (K_2O) levels showed a similar pattern, with NF fields exhibiting significantly higher values (up to 440.82 kg/ha in 10-15 years) compared to FP fields (285.64 kg/ha in the same period). The higher K_2O in NF fields may be attributed to reduced crop demand and natural accumulation over time, while FP fields experience depletion due to continuous crop uptake (Yadav *et al*., 2013). Available sulfur (S) also increased notably in NF fields, reaching 21.31 kg/ha over 10-15 years, while FP fields maintained lower levels (as low as 10.9 kg/ha), suggesting that

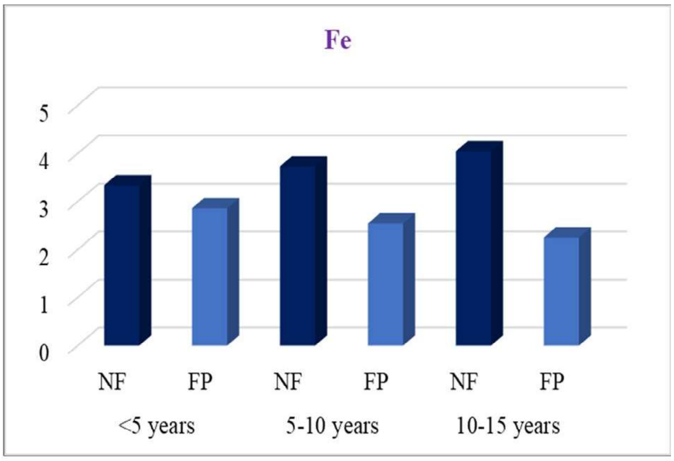

Fig 1. Influence of natural farming and farming practice on soil iron content

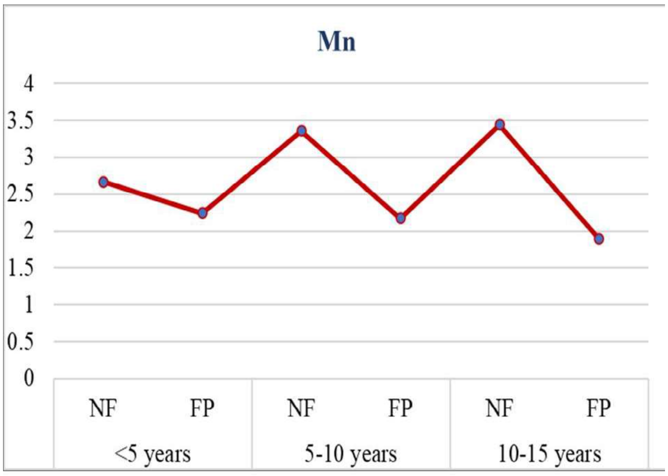

Fig 2. Influence of natural farming and farming practice on soil manganese content

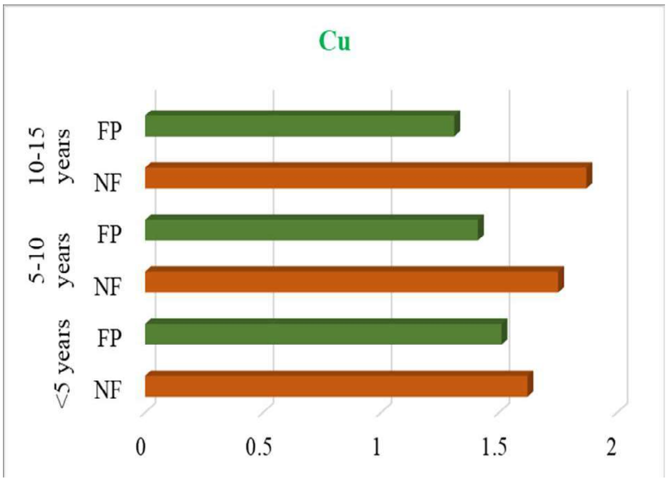

Fig 3. Influence of natural farming and farming practice on soil copper content

S may be lost through crop uptake without sufficient replenishment. These findings emphasize that NF fields retain better nutrient levels, likely due to reduced nutrient export and greater organic matter cycling. FP fields experience nutrient depletion over time, indicating the need for balanced nutrient management, such as organic amendments or periodic

Table 6. Descriptive statistics of soil available nutrients used for soil fertility analysis

Av. N (kg/ha)	Classes Practices	Farming	Mean	Maximum	Minimum	SD	CV
	<5 years	NF	214.09	220.91	207.63	3.81	1.78
		FP	176.02	182.76	162.00	5.69	3.23
	5-10 years	NF	222.82	226.50	220.15	1.91	0.86
		FP	175.4	182.11	165.00	4.59	2.62
	10-15 years	NF	228.02	231.70	225.35	1.91	0.84
		FP	167.11	179.18	125.10	15.19	9.09
Av. P2O5 (kg/ha)	<5 years	NF	22.1	25.48	19.50	1.76	7.96
		FP	20.41	22.76	15.90	1.54	7.57
	5-10 years	NF	23.03	25.38	18.90	1.59	6.91
		FP	19.22	22.28	16.48	1.66	8.63
	10-15 years	NF	27.58	28.80	25.80	0.87	3.16
		FP	18.08	19.30	16.30	0.87	4.82
Av. K2O (kg/ha)	<5 years	NF	305.12	315.98	288.90	8.21	2.69
		FP	273.7	284.68	263.78	6.79	2.48
	5-10 years	NF	374.11	395.60	343.50	14.21	3.80
		FP	264.85	311.29	242.88	17.46	6.59
	10-15 years	NF	440.82	466.90	392.50	22.94	5.20
		FP	285.64	293.90	278.41	5.2	2.03
Av. S (kg/ha)	<5 years	NF	12.13	13.66	1.51	0.47	3.91
		FP	11.69	12.18	11.19	0.41	3.48
	5-10 years	NF	15.52	20.06	12.09	2.40	15.46
		FP	11.40	12.62	10.49	0.60	5.27
	10-15 years	NF	21.31	27.27	15.79	3.99	18.71
		FP	10.90	12.16	10.07	0.59	5.39

*NF- Natural farming, FP-Farmers practice, S- Significant, NS- Nonsignificant

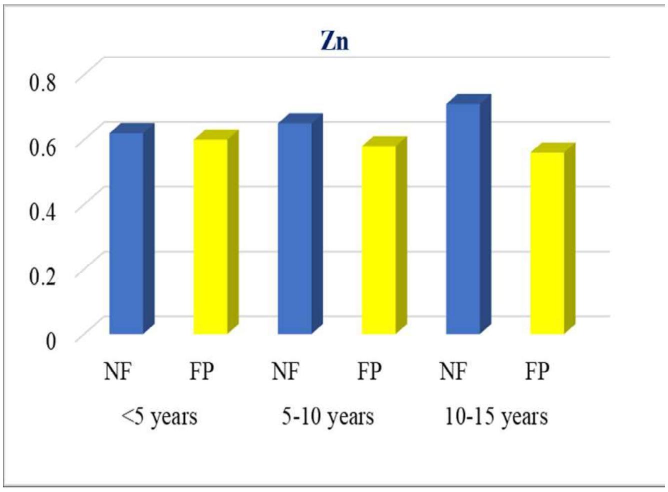

Fig 4. Influence of natural farming and farmers practice on soil zinc content

fertilization, to maintain soil fertility and support sustainable crop production.

The data (Fig 1 to 4)revealed that DTPA-extractable micronutrients were higher under natural farming compared to conventional practices across all periods. DTPA- extractable Fe increased from 3.34-4.05 mg/kg, Mn from 2.67-3.44 mg/kg, Cu from 1.62-1.87 mg/kg and Zn from 0.62-0.71 mg/kg. Inconventional farmers practice, available micronutrients decreased from 2.86-2.25 mg/kg (Fe), 2.24-1.89mg/kg (Mn), 1.51-1.31 mg/kg (Cu) and from 0.60-0.56 mg/kg (Zn). Natural farming showed higher values for available nutrients compared to farming practices over various periods. This improvement is attributed to the enhanced organic matter addition (Vidyavathi *et al*.,2011; Poojar *et al*., 2022) and reduced tillage in natural farming, which promotes nutrient release, reduces fixation and supports microbial activity (Munda *et al*., 2018). Conventional practices often lead to reduced nutrient availability due to increased fixation, diminished organic matter and soil degradation (Hinsinger, 2001; Hudson, 1994).

Conclusion

Natural farming outperformed conventional practices in maintaining soil health and fertility. Soil pH, EC andOC levels were significantly more favourable under natural farming with decrease in pH and EC andincrease in OC and CEC is due to continuous addition of organic matter and reduced tillage. Available nitrogen, phosphorus, potassium, sulphur and micronutrients like iron, manganese, copper and zinc were higher in natural farming, reflecting enhanced nutrient availability and microbial activity. Conventional practices led to increased soil pH and EC, decreased OCand lower nutrient levels due to reduced organic matter and intensified soil degradation.

This comparison highlights that natural farming fosters sustainable soil health through organic matter buildup and biological activity, supporting long-term resilience, while conventional methods show short-term improvements but require pH management and careful nutrient balancing to sustain productivity. Together, the benefits of organic inputs in promoting soil stability and nutrient cycling, while emphasizing the need for adaptive management in conventional systems to mitigate nutrient imbalances and maintain long-term soil health.

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