Biological Forum – An International Journal **15(10): 1224-1227(2023)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Effect of IFS on Soil Physical, Chemical and Biological Properties of Soil

Sharanabasava[1*], Irappa N. Nagaral[2], I. Balakrishna Reddy[3], Abhishek Belli M.[4] and Ramesh[2]
[1]M.Sc. (Agri.), Department of Soil Science and Agricultural Chemistry, UAS, Raichur (Karnataka), India.
[2]Ph.D. Scholar, Department of Soil Science and Agricultural Chemistry, UAS, Raichur (Karnataka), India.
[3]Assistant Professor, Department of Agricultural Microbiology,
College of Agriculture, Hagari, UAS, Raichur (Karnataka), India.
[4]Ph.D. Scholar, Department of Crop Physiology, UAS, Raichur (Karnataka), India.

(Corresponding author: Sharanabasava)*
(Received: 23 August 2023; Revised: 24 September 2023; Accepted: 05 October 2023; Published: 15 October 2023)
(Published by Research Trend)

ABSTRACT: This article reviews the effects of various integrated forming systems on soil processes such as evaporation, infiltration, run-off, and soil loss, as well as physical properties such as bulk density, porosity, aeration, soil moisture, soil aggregation, and water retention and transmission properties. The chemical and biological features of soil include the total microbial population and the availability of major, secondary, and micronutrients. The goal is to improve crop growth and crop yield. We suggest that adopting the appropriate IFS models will significantly improve the physical, chemical, and biological properties of the soil, reduce the cost of cultivation, and increase crop yield.

Keywords: IFS Models, Biological Properties, Chemical properties, Physical properties.

INTRODUCTION

Understanding the physical characteristics of soil is crucial for determining and enhancing soil health and achieving the highest possible productivity for any given soil or climate. The geographical and temporal variability of soil greatly influences its physical characteristics in the field. Improved methods of managing this heterogeneity are needed if big agricultural fields are to be adequately characterized from a physical perspective. There is an increasing awareness that physical circumstances, not plant nutritional status in the soil, determine yields. A significant decrease in the yield potential of rainfed areas can be attributed to various climatic and edaphic crop production constraints, including physical constraints related to soil, such as surface crusting and hardening, subsurface hard pan and compactness, high permeability, slow permeability, and extremes of consistency, soil water-related constraints, wind and water erosion, etc. This assumes that in order to increase crop yield, soil needs to be kept in a physical state that promotes healthy crop growth. Even when all other conditions are met, a crop's genetic yield potential cannot be reached unless the physical environment of the soil is kept at its ideal level.

Without a doubt, the yield potential of many crops can be greatly boosted if these soils are appropriately managed for excellent physical condition. Additional beneficial soil chemical characteristics for plant growth include nutrient absorption. The benefits of adopting soil physical management technologies, however, vary greatly depending on the intensity of rainfall, soil texture, and slope, in addition to the current crop or cropping system. These technologies are location-specific. We provide an overview of the management methods' effects on reducing the physical constraints imposed on the soil to increase agricultural yields in India's rain-fed regions.

Between 2010 and 2013, fieldwork was done in five distinct blocks: Khajuripada in the Kandhamal district; Dhenkanal Sadar and Odapada in the Dhenkanal district; Golamunda and Narla in the Kalahandi District of Odisha; and rain-fed medium land conditions in Khajuripada of the Kandhamal district. The purpose of the experiment was to compare how well the pond-based integrated farming system (IFS) model performed.

Impact on soil health

Physical properties: IFS models were developed in Kalahandi, Dhenkanal, and Kandhamal districts for medium-land scenarios. The texture of the soil was clay, sandy loam, and clay. Before the trial began, the bulk density of the soil ranged between 1.39 and 1.46 mg/m^3 in several clusters (Table 1). Following three years of testing, the soil's texture stayed the same as it had been before the experiment began. The bulk density decreased marginally, ranging from 1.36 to 1.42 mg/m^3 (Table 1). This was achieved by using tank silt and organic manure made from chicken dung, mushroom waste, rice straw, and onion leaves instead of chemical fertilizers. According to Jeyamangalam *et al.* (2012), adding more organic manure, such as tank silt, resulted in a drop in bulk density. A decrease in bulk density was a sign of improved physical characteristics of the soil and a favorable environment for crop growth.

Table 1: Physical properties of soil as influenced by IFS model.

Name of cluster	Sand (%)	Silt (%)	Clay (%)	Textural class	Bulk Density (mg/m^3)
Initial soil status					
Khajuripada	59.2	16.6	24.2	Sandy clay loam	1.46
Dhenkanal Sadar	36.2	33.8	30.0	Clay loam	1.42
Odapada	36.6	33.9	29.5	Clay loam	1.40
Golamunda	24.0	30.3	45.7	Clay	1.39
Narla	23.1	30.3	46.6	Clay	1.39
After end of experiment					
Khajuripada	58.3	17.1	24.6	Sandy clay loam	
Dhenkanal Sadar	35.7	34.6	29.7	Clay loam	1.40
Odapada	35.8	34.3	29.9	Clay loam	1.37
Golamunda	23.3	30.8	45.9	Clay	1.36
Narla	22.2	30.9	46.9	Clay	1.36

Table 2: Nutrient concentration in different residues and effluents and soil quality parameters as influenced by different cropping system.

Cropping system	pH	SOC	BD	N	P	K	B	Cu	Zn	Fe
Rice-Baby corn	5.53	0.94	1.31	129.5	13.9	99.5	1.38	5.53	11.7	49.4
Rice-Chili	5.57	0.87	1.33	117.8	11.1	89.3	1.46	5.54	12.2	50.5
Rice-Cowpea	5.73	1.20	1.26	142.8	14.5	112.8	1.45	5.87	11.6	51.2
Rice-Moong	5.68	1.16	1.24	154.6	16.2	119.2	1.45	6.21	11.3	50.4
Rice-fish-cowpea	5.85	1.26	1.23	164.9	16.9	130.4	1.46	6.34	12.2	51.2
SEM±	0.07	0.03	0.02	3.21	0.32	1.86	0.05	0.33	1.5	1.5
CD (P=0.05)	0.20	0.10	0.06	9.61	0.95	5.59	0.14	0.98	4.4	4.6

Note: SOC, soil organic carbon (%); BD, bulk density (kg/m^3); N, P, K: available nitrogen, phosphorus, potassium (kg/ha); Zn, Fe, Cu, Mn, B: zinc, iron, copper, manganese,(mg/g)

Soil quality (SQ): All of the measured indicators of soil quality were significantly impacted by cropping patterns (Table 2). Notable increases in soil pH, SOC, and accessible NPK: to better understand how the treatments in this study affected the SQ, we employed a non-linear, weighted, additive soil quality indexing approach. Different cropping systems had a substantial ($P<0.01$) impact on the SQ. With values of 0.91, 0.75, 0.69, 0.37, and 0.19, respectively, the SQI of the various cropping systems were in the following order: rice-fish-cowpea < rice-moong < rice-cowpea < rice-baby corn < rice-chili. Compared to the rice-chili system, the rice-fish-cowpea cropping system showed a 79% increase in SQI. The rice-fish-cowpea system's improved soil qualities could be the result of the fish's constant churning and movement of the soil as well as the poultry birds' input of feces to the pond (Nayak *et al.*, 2018).

The loading of organic materials (fish and poultry droppings) and the faster decomposition of organic wastes (root and leftover rice straw) in the integrated fields may be the cause of the rise in microbial activity and SOC. The SOC increased in every cropping system, with the exception of the rice-chili system, demonstrating the exhausting nature of the chili crop. In comparison to other cropping systems, the rice-fish-cowpea system has shown a considerable improvement in the soil carbon stock. It is mostly caused by the soil's lower BD and increased SOC. The rice-fish cultivation has significantly decreased the soil BD in addition to improving the SOC. Reduced soil temperatures, a sluggish rate of organic matter decomposition, the kind of land use practices, and the ongoing in situ root decay of cowpea and rice are some of the factors contributing to the enhanced soil carbon stock in the rice-fish-cowpea system (Manjunath *et al.*, 2018).

Table 3: Available soil N, P and K (kg/ha) and organic C (%) at the start and completion of the study under different farming system models.

Model	2003				2005				Increase %			
	N	P	K	O C	N	P	K	O C	N	P	K	OC
A	115	7.7	310	0.28	118	8.1	342	0.31	2.6	5.2	10.3	10.7
B	114	7.5	312	0.25	124	8.3	350	0.33	8.8	10.8	12.2	32.0
C	120	7.3	315	0.26	132	8.3	369	0.34	10.0	13.7	17.1	30.8
D	118	7.5	318	0.27	128	8.4	358	0.33	8.5	12.0	12.6	22.2
E	121	7.4	314	0.27	134	8.5	378	0.35	10.7	14.9	20.4	29.6
Mean	118	7.5	314	0.27	127	8.3	359	0.33	8.1	12.9	14.5	25.1

According to the study, accessible N, Zn, B, and Fe are the primary indicators of soil quality (SQ) on the humid tropical west coast of India. These indicators have a significant impact on the functions of the soil as well as the general health of the soil.

Solaiappan *et al*. (2007) examined different farming system models such as (A)Conventional cropping, (B) Crop+ poultry(20) + goat (4), (C) Crop + poultry(20) + goat (4) + dairy (1), (D) Crop + poultry(20) + goat (4) + sheep (6) and (E) Crop + poultry (20) + goat (4) + sheep (6) + dairy (1) and found IFS model (E) recorded maximum organic carbon (0.35%), available soil N (134 kg / ha), soil P (8.5 kg/ha) and soil K (378 kg/ha) at the end of study (Table 3).

IFS contributes significantly to the enhancement of soil health by raising the soil's nutritional content. Enhancements in the physical qualities of the soil and the supply of N, P, K, and other mineral nutrients are two advantages of using livestock manure in crop development. Applying livestock manure to the soil raises its organic matter content, which enhances cation exchange capacity, water infiltration, and water-holding capacity. According to Brouwer and Powell (1995), manure and urine have the ability to elevate pH levels, hasten the breakdown of organic matter, and increase termite activity.

Analyzing a variety of soil parameters in order to compare the IFS and CFS, it was discovered that whereas the salt buildup in the CFS resulted in alkalinity, the IFS plot had reached pH neutrality, presumably as a result of heavy organic input application. In IFS, there has been a growing tendency in the number of bacteria, actinomycetes, and fungi, as well as the concentration of organic carbon. In actuality, each of these values represents a sign of healthy soil (Table 4).

Table 4: Data on Soil pH and Organic carbon (%) at eight observation points between 1998 and 2002 in the IFS and two conventional farms.

Year	Soil pH			Organic Carbon (%)		
	IFS	CFS I	CFS II	IFS	CFS I	CFS II
Nov 98	7.80	7.60	7.92	0.54	0.65	0.60
Apr 99	7.50.	7.84	8.26	0.52	0.41	0.42
Nov 99	7.69	7.89	7.95	0.93	0.71	0.58
Feb 00	7.82	7.95	7.21	0.65	0.50	0.50
Nov 00	7.68	8.13	8.19	0.93	0.75	0.89
Apr 01	7.68	8.28	8.31	0.65	0.50	0.50
Nov 01	7.80	7.80	7.80	1.04	0.62	0.85
Apr 02	7.00	7.40	7.50	1.18	0.54	0.59

Table 5: Soil biological properties as influenced by different cropping system.

Cropping system	DHA	PHT	Urease	CS
Rice-Baby corn	169.8	267.5	2.8	18.5
Rice-Chili	112.0	322.2	1.9	17.3
Rice-Cowpea	222.8	341.0	2.9	22.7
Rice-Moong	220.5	363.4	3.2	21.5
Rice-fish-cowpea	267.2	418.0	4.1	23.2
SEM±	6.5	9.6	0.1	0.67
CD (P=0.05)	19.6	28.9	0.3	2.00

DHA, dehydrogenase activity (mg TPF/h/g); PHT, Phosphatase (µg/g/h); CS, Carbon stock, (Mg C/ha).

Standard techniques were also used to test the soil microbiological parameters, including phosphatase (PHT), urease activity, basal soil respiration (BSR), dehydrogenase activity (DHA), and microbial biomass carbon (MBC). Using established protocols, farmyard manure (FYM), cow shed waste, and dairy effluents were regularly analyzed. Using a variety of physical, chemical, and biological soil parameters, a non-linear programming technique was used to create the soil quality index.

Carbon stock: At a soil depth of 0 to 15 cm, five replications of the soil sample were taken from various agricultural systems. Using a core sampler, the BD and SOC of the soil samples were assessed. Using the following formula, the carbon stock (Mg C/ha) from 0 to 15 cm of soil depth was calculated.

Carbon stock (Mg C/ha) – SOC (%) × BD (Mg/m^3) × Soil depth (cm)

Biological properties: The population of heterotropic bacteria, actinomycetes and azotobacter varied from 33 to 65, 34 to 72 and 24 to 41 CFU × 10^4 g soil, respectively (Table 6). The fungi population ranged from 33 to 58 CFU × 10^3 g soil in different locations. Actinomycetes, Azotobacter, and heterotrophic bacteria all showed population increases over the beginning levels (Table 6).

The addition of organic matter to the soil, which encouraged the growth and multiplication of these bacteria, was the cause of the population's rise over time. The population of fungus decreased in comparison to the starting values, which was caused by a rise in soil pH that impeded fungal growth. According to Rousk *et al.* (2009), there is a negative link between bacterial and fungal development in the pH range of 4.5 to 8.3. Bacterial growth was encouraged by neutral or slightly alkaline circumstances, while fungal growth was favored by acid pH. In IFS, there was a rising tendency in both the number of bacteria and actinomycetes as well as the content of organic carbon. Good soil health was indicated by each of these measures (Walia and Kaur 2013).

Table 6: Population of heterotrophic bacteria, actinomycetes and free-living N fixer *Azotobacter* (CFU × 10^4 g soil) and fungi (CFU × 10^3 g soil) in soil as influenced by IFS model.

Name of cluster	Heterotrophic bacteria	Actinomycetes	*Azotobacter*	Fungi
Khajuripada	33	34	24	58
D. Sadar	42	34	33	39
Odapada	65	66	31	38
Golamunda	63	71	41	33
Narla	63	72	29	38
After end of experiment				
Khajuripada	53	42	36	29
D. Sadar	72	56	49	32
Odapada	103	112	55	23
Golamunda	86	103	49	28
Narla	79	78	46	34

CONCLUSIONS

It can be concluded that IFS is also an eco-friendly approach in which the waste of one enterprise becomes the input of another, thus making efficient use of resources. It helps in improving the health of the soil, such as its physical, chemical, and biological properties, increases water use efficiency, and maintains water quality. This system minimizes the use of harmful chemical fertilizers, weed killers, and pesticides, thus safeguarding the environment from their adverse effects.

Acknowledgement. I am thankful to all authors for supporting and writing the quality review paper, and a special thanks to Sridhara M. R. sir for helping.

Conflict of Interest. Authors have declared that no completing interests exist.

REFERENCES

Brouwer, J. and Powell, J. M. (1995). Soil aspects of nutrient cycling in a manure experiment in Niger. In: Powell, J. M., Fernandez-Rivera, S., Williams, T. O. and Renard, C. (Eds.) livestock sustainable nutrient cycling in mixed farming systems of sub-Saharan Africa. Vol II.

Jeyamangalam, F., Annadurai, B. and Arunachalam, N. (2012). Effect of tank silt as organic amendment on physical properties of tehir soil using groundnut. *Journal of Soils and Crops*, *22*(1), 10-14.

Manjunath, B. L., Paramesh, V., Mahajan, G. R., Reddy, K. V., Das, B. and Singh, N. P. (2018). A five years study on the selection of rice-based cropping systems in Goa, for west coast region of India. *Journal of environmental biology*, *39*, 393–399.

Nayak, P. K., Nayak, A. K., Panda, B. B., Lal, B., Gautam, P., Poonam, A., Shahid, M., Tripathi, R., Kumar, U. and Mohapatra, S. D. (2018). Ecological mechanism and diversity in rice based integrated farming system. *Eco*logical Indicators, *91*, 359-75.

Rousk, J., Brookes, P. C., & Bååth, E. (2009). Contrasting soil pH effects on fungal and bacterial growth suggest functional redundancy in carbon mineralization. *Applied and environmental microbiology*, *75*(6), 1589-1596.

Solaiappan, U., Subramanian, V. and Maruthi, G. R. (2007). Selection of suitable integrated farming system model for rain-fed semi-arid vertic inceptisols in Tamil Nadu. *Indian Journal of Agronomy, 52*(3), 194-197.

Walia, S. S. and Kaur, N. (2013). Integrated farming system an ecofriendly approach for sustainable agricultural environment: A review. *Greener Journal* of *Agronomy*, *Forestry and Horticulture, 1*(1), 1-11.

How to cite this article: Sharanabasava, Irappa N. Nagaral, I. Balakrishna Reddy, Abhishek Belli M. and Ramesh (2023). Effect of IFS on Soil Physical, Chemical and Biological Properties of Soil. *Biological Forum – An International Journal, 15*(10): 1224-1227.