Natural, Organic, Biological, Ecological and Biodynamic Farming

Incorporates ICAR Recommended Syllabus

V.N. Tiwari; D.K. Gupta; S.R. Maloo; L.L. Somani

NATURAL, ORGANIC, BIOLOGICAL, ECOLOGICAL AND BIODYNAMIC FARMING

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PREFACE

Our nation has pursued the policies of intensive use of agro-chemicals in the last 30-40 years to meet the challenges of increasing the agricultural production. Level of consumption of agro-chemicals is sometimes held as yardstick of agricultural development. Use of agro-chemicals along with other technologies like improved hybrids/varieties and irrigation has indeed elevated out country to self-sufficiency in food production.

The indiscriminate use of fertilizers and plant-protection chemicals to increase the yield potential and to save the crops from insect pests and diseases respectively, no doubt, has doubled or tripled or more our total food production, but has also created a number of health hazards and deteriorated the agro-ecosystem badly. This situation has compelled us to switch over to organic farming to cultivate valuable crops for healthy and safer foods. Today, the organic food production is drawing attention globally. The demand of organic foods is growing by leaps and bounds especially in the developed countries. In the last decade, organic farming in India has also attracted a number of farmers. Most of the farmers are cultivating organic produce successfully, but still it has to get a momentum. It requires full-fledged support of Government institutions, ICAR research institutes, SAUs, NGOs, *etc.* Then only the movement of organic food production for the people can be made a successful step.

Organic agriculture offers trade opportunities for farmers in the developing and developed countries. According to the ITC and UNCTAD/GAT, more than 130 countries produce certified organic foods. This market of organic products is expected to grow globally in the coming years with high growth rates of over 15 percent. This organic market expansion makes it possible for farmers to reap the benefits of a trade with relatively high price premiums.

Use of fertilizers and pesticides had their designated aims of increased productivity and reduced damage due to pests respectively. But, the productivity of many crops has not shown proportionate improvement in the last 10-15 years-despite the increased use of fertilizers. Similarly, extensive use of pesticides has not reduced the losses due to pests. With these two facts in background-a stage has now reached to review whether promoting the use of agro-chemicals is appropriate strategy or not.

Organic farm production is an environment-friendly approach that optimizes the health and productivity of interdependent communities of animals and people. To the extent feasible, the system relies on crop rotations, crop residues, animal manures, legumes, green manures, of-farm organic wastes, bio-fertilizers and using natural biological and environmental-friendly spray to maintain soil productivity and to control insects, pests, weeds and plant diseases. Organic farms should have high standards of biodiversity and animal welfare.

But, in the journey of ever challenging agricultural development, we have reached a stage-where the basis of production itself is in perilous situation. Because, the use of agro-chemicals has damaged our eco-system and delicate balance between various components of eco-system. The biological basis of fertility imparts self-supporting feature in soil. Reducing organic carbon status on one hand and treating the soil as mere physical medium to supply the nutrients on the other-have ignored the biological basis of soil fertility. Similarly, the pest control by pesticides alone is akin to chemical invasion on eco-system. A pest is part of biological equilibrium in an eco-system and killing the pest by pesticides not only damages the eco-system but also kills predators and natural enemies of pests. A pest can express itself though biological survival/buoyancy mechanisms. These truths are undermined by advocation of increases pesticide use.

This book is written to enlighten the students and research workers that the use of agro-chemicals is perilous to our soils, eco-systems, water, foods, human health, animal health as well as productivity/pest control issues. The use of agro-chemicals has left us with unsustainable production systems. Unsustainability factors are so pervasive and profound that urgent imperatives need lies to achieve sustainability production-lest the food security will be jeopardy in heavily populated countries like China and India.

EDITORS

ABOUT THE BOOK

Organic farming methods are widely used in all three groups of countries (developed, developing and underdeveloped) in the world. In developing and underdeveloped countries organic farming is mostly preferred due to lack of chemicals and economics while, in developed countries it is accepted for avoiding demerits of chemical fertilizers and pesticides and protecting environment. Organic farming is crop rotations, use of biofertilizers and animal manures, and biological pest control. However, indiscriminate and increasing use of chemical fertilizers and pesticides has led to serious problems in agroecosystem such as pest resistance, secondary pest outbreak, pest resurgence, destruction to ecocycles and endemic soil fauna and dying of soil, *etc*. The present book will be helpful for understanding characteristics of biofertilizers, vermiculture and biocontrol agents, their production techniques and applications and thus, solve the above problems. We strongly feel that this book is a need of modern agriculture.

Organic farming is thus considered as a movement directed towards the philosophy of "Back to Nature". It aims at low input farming thus reducing dependence on inorganic fertilizers, plant protection chemicals and weedicides.

The book contains 30 chapters each contributed by authorities in their field of specialization highlighting their vast experience relevant to Natural, Organic, Biological, Ecological and Bydynamic aspects of no–chemical farming.

Considering the vast scope and huge export potential of organic foods from India, such types of information on status, strategy and scope in the form of a book was a long – felt need. Since, this is the beginning of popularizing such technologies, the outcome of this book will serve the purpose of the target audience.

This book should be of interest and use to students, teachers, researchers of agricultural colleges and universities, administrators and extension officers, consultants, rural development and training centres and other agencies who are involved in production and promotion of organic food.

The book will serve as a good reference book on Organic Food Production in India.

About the Editors

Dr. V. N. Tiwari (b1944) specialized in Soil Microbiology having 42 years of research and 26 years of teaching experience at CSAUT Kanpur. He has published over 160 articles in Journals of National and International repute. He has been honoured by several prestigious awards.

Dr. D. K. Gupta (b1963) holds a brilliant academic career. He has been awarded certificate for the excellent work done in the field of Agricultural Extension. At present Dr. Gupta is officer–in–charge of Agricultural Research Substation, Gonera, Kotputli (Rajsathan). He has developed folders on Crop production technology for a number of crops for use of field staff and cultivators.

Dr. S. R. Maloo is professor and Head of Plant Breeding and Genetics, MPUAT, Udaipur. He has an excellent academic carrier. In recognition of his high teaching abilities and distinguished services he was awarded Best University Teacher Award (1998). He has published over 160 articles in Journals of National and International repute. He has already published four books.

Dr. L. L. Somani (b1945) retired from the post of Director Resident Instructions MPUAT, Udaipur in October, 2005. He is the author/editor of over 80 books. He has published over 300 research papers and articles in Journals of high repute. Dr. Somani has been honoured by several honorous and awards.

CONTENT

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1

ORGANIC FARMING : RETROSPECT AND PROSPECT

K.K.M. Nambiar

Introduction

The organic farming refers to the development of a farm as organic whole, a carefully integrated and balanced system, rather than to a unit which specifically utilize recycled organic matter. Organic matter is the major sources of fertility in organic framing, so its inputs and optimum levels tend to be higher than conventional system reliant on fertilizers for nutrient inputs.

What is Organic Farming

The conceptual view of soil organic matter is that of a continuum ranging from fresh plant litter to humic substance, the final products of humification. It is composed of a mixture of above–and below ground plant residues (primary resources), microbial residues (secondary resources), and humic components.

The soil organic C can be divided into active (labile) and resistant fractions (Van Veen and Paul, 1981) (1) Labile C consists of water-soluble C (simple sugars, organic acids and proteins) and (2) the microbial biomass and microbial products readily metabolize during the initial stages of incubation (3) the resistant fraction consisting of lignin-containing compounds and/or physically protected C.

Factors affecting C turnover rates

The C turnover rates are controlled by three main groups of factors: the site-specific environment (climatic factors, such as water regime and temperature, and interaction with soil matrix) which result in a definite resources quality (chemical composition of litter) and both factors, in turn, control the nature of the decomposer community.

The strutt Report (1970) on soil structure and soil fertility suggested that the arable soils contain not less than 3.0% organic matter (1.75% organic C). It is suggested that sandy soils should contain more than 2.0%, loamy soils 2.2-3.5% and clayey soils 3.0-4.5%.

Soil Organic Matter

Humus		Fresh and incompletely decomposed plant and animal residues
Strictly humus Substances: Groups: Humic acids Fulvic acids Humus Hymatomelanic acid	Products of advanced composition of organic residues and products resynthesised by microorganisms (protein-like substances, carbohydrates, waxes, fats, tannins, lignins, *etc*)	

Why Soil Organic Matter is so resilient to Soil?

Soil organic matter is a key component of soils affecting many reaction that occur in soils. The interaction of chemicals used as pesticides with organic matter is another important factor affecting the fate of pesticides in the soil environment. The fertile soils have an adequate supply of organic matter. The function of organic matter in soil is the both direct and indirect.

The direct role is concerned with the provision of nutrients via the process of decomposition and mineralization; its indirect role is associated with its effect on the physicochemical properties of the soils.

A soil with adequate organic matter is easily cultivated, has good tilth and aeration, and facilities roots and moisture penetration.

Interactions between humic substances and metal ions has been described as ion-exchange, surface adsorption, chelation, coagulation and peptization reaction (Hodgson, 1963). for example, the importance of SOM in the reaction with Zn^{2+}.

A. Soil Aggregation and Structure

Root residues are superior to the top residues in providing good soil aggregation because roots are well distributed through soil thus the gums and polysaccharides arising from their decomposition are also well distributed and are in a position to act as cement between soil particles as they are being formed into aggregates by the root pressure.

B. Colloidal Properties

The colloidal complex of a soil plays a major role in supplying nutrients to plants grown thereon. Humus is colloidal in nature and its role in influencing soil fertility is considerable. It is involved in three function.

(i) exchange capacity;

(ii) buffering capacity; and

(iii) chelation of metals.

C. Cation Exchange Capacity (CEC)

The organic matter of most minerals soils account for about 30-65% of the total CEC; in sandy and organic soils more than 50% of the CFC is likely due to organic components of the soils.

D. Buffer Capacity

The buffering capacity of soils is of the great practical significance. If this does not exist, it would be difficult to conceive of agriculture. Acids and bases are continually being produced in field soils; large pH and osmotic fluctuations would occur without buffering capacity and organism would be injured, for most of them grow well within a narrow pH and osmotic range.

Humus as a Chelate

Humic colloids are known to play an important role in controlling the availability of microorganism through chelation. The metals can be held on the exchange complex of colloids but sometime the bonds are too strong thus the metal are difficult to replace. It also helps chelation of toxics metals like Al and Fe from soil solution and lower their activities below the harmful levels to plant growth.

Long Term Effects of Organics *Vs* Inorganics on Crop Yields

While reviewing the response behavior of crops in the field in the old permanent manurial experiment at Coimbatore (Tamil Nadu) in progress since, 1909, Nambiar (1994) reported that the effect of cattle manure (FYM) was inferior to mineral fertilizers for the first 36 crops but its superiority over mineral fertilizers became evident from 37th crop. Similar effects of sheepdung and cowdung were also seen on crop yields in the old series of permanent plot experiment at Kanpur (Utter Pradesh) which began in 1885 and concluded in 1934. The effects of FYM was also witnessed in the both the old series of permanent plot experiments (1908-30) and the modified old series (1939-69) as well as in the new series of permanent plot experiment (1932-69) at Pusa (Bihar). The effect of organics was much more pronounced in the case of acidic soils where application of mineral fertilizers without amendment with lime fail to sustain productively. While continuous application of mineral N, P and K equivalents of FYM failed to yield after 11-12 annual cropping cycles of maize and wheat in the permanent plot experiment in progress since 1956 on acidic Paleustalfs soil at Ranchi (Bihar) where application of FYM alone or in combination with mineral N, P and K fertilizers not only sustained to be functioning in acidic soils as a soil ameliorant through chelation of Al and or Fe leading to reduction in their concentration to levels thought to be beneficial to the plant growth.

The result from the World's classical experiments at the Broadbalk field (Rothamsted) continuing for more than 150 years have consistently shown that the effect of FYM is superior to mineral fertilizers resulting in the highest degree to stability in crop yields. Similarly, continuous dressing of FYM at 35 Mg/ha/yr for more than 45 years (1856-1901) in Hoosfield experiment (England) not only raised the yield of barely in comparison to minerals NPK fertilizers but also improved the soil productively which was visible even after a long gap of 48 years. On the contrary, wheat yield at Broadbalk field over a 13-year period showed that FYM did not have any such effects which could not to be achieved by suitable combination of chemicals fertilizers.

Similarly, application of FYM at 10 Mg/ha over a short period of 3 years did not show any improvement in rice yield over mineral NPK fertilizes (DRR 1993-95) when the NPK contents were almost equal in respect of both the sources (Table-1). Nevertheless, the role of organics is well recognised in maintaining sustained productivity but the quantity required for optimal nutrient supply is enormous and its availability is a limiting factor.

Table 1. Effects of organics V/s inorganics on yield of rice-based cropping systems

Treatment	Mean grain yield (Mg/ha)				
Site→	Titabar(Assam)		Maruteru(AP)		Mandhya (Karnataka)
Season→	Monsoon rice	Winter rice	Monsoon rice	Winter rice	Monsoon rice
No. of crop→	(3)	(3)	(3)	(2)	(3)
100% NPK	4.22	3.66	6.45	5.83	4.67
50% NPK	3.30	2.89	4.75	4.24	4.24
50% NPK+50% GM-N	3.47	3.06	5.17	4.80	4.32
50% NPK+50%FYM-N	3.52	2.99	5.41	4.59	4.35
50% NPK + 25%GM-N+25% FYM-N	3.48	3.03	5.35	4.65	4.83
FYM (10 Mg/ha)	3.58	3.02	5.39	4.41	3.79
Unmanured	2.48	2.30	3.46	1.64	2.73
Recommended NPK dose (N-P_2O_5 - K_2O/ha)	40:20:20	40:20:20	60:40:40	120:60:45	100:50:50

Source: DRR annual report (1993-95)

Integrating Organic With Inorganic for Yield Sustainability

Integration of organic with minerals NPK fertilizers provided greater stability in crop production in intensive farming system in comparison to either exclusive use of organics or minerals fertilizers. However, the effect was more pronounced on certain soils than on others. Thus, substantial increase in yield (Table-2) due to integrated use of organic and inorganic was seen over the last 17 year period (1970-87) in the All India Coordinated Long Term Fertilizer Experiments (Nambiar, 1994). Thus, the integrated use of organic with inorganic holds great promise in providing greater sustainability in crop production under the modern intensive farming.