Effect of nutrient management options on productivity and nutritional quality of organically-grown *Basmati* rice under the long-term experiment (20 years) of *Basmati* rice-wheat cropping system

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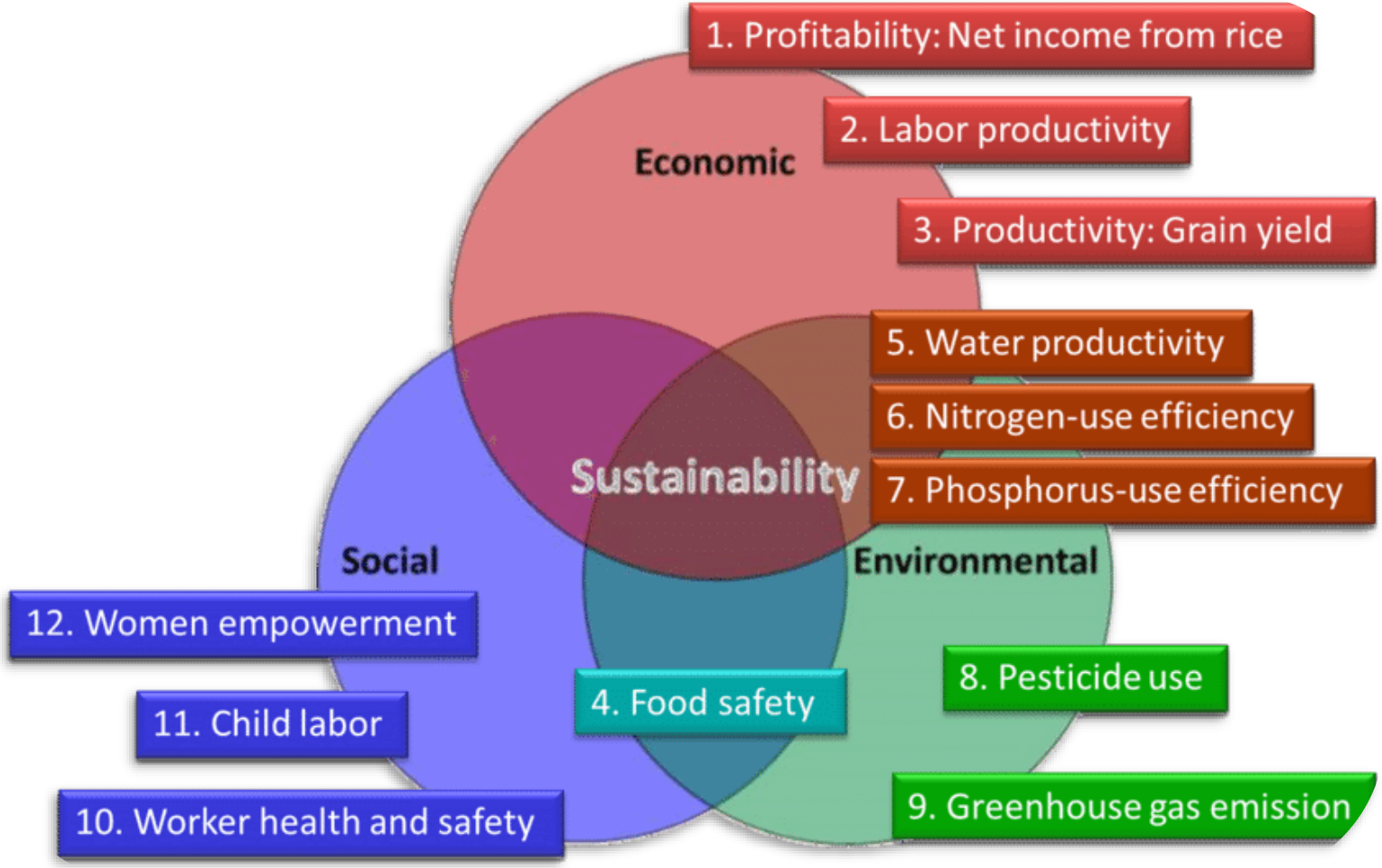
INTRODUCTION

- Rice (*Oryza sativa* L.)–wheat (*Triticum aestivum* L.) cropping system (RWCS) is the world's largest agricultural production system occupying around ~10 Mha in India with 85% area falling in Indo-Gangetic plains (Jat et al. 2019).

- Farmers face diverse problems in rice production, with issues such as declining factor productivity, nutrient loss, soil organic carbon content, soil salinization, and elevated nitrate levels in well water (Prasad et al. 2017).

- The area under aromatic rice is about 2.1 M ha land in India (APEDA, 2019). In this scenario, there is significant scope to expand the area of organic rice in India.

Principles for sustainable rice production as defined by the Sustainable Rice Platform



Source: The Sustainable Rice Platform (2017)

Why Organic Farming in Rice?

- Organic agriculture is a holistic strategy to restore soil fertility, improve the build-up of soil organic matter, and enhance nutrient uptake and concentration in grains.
- The inclusion of legumes as green manure in the RWCS has been reported to improve soil physicochemical properties, macro and micronutrient availability in the soil (Dhaliwal et al. 2019)
- India has exported 4.558 million tonnes of *Basmati* rice to the world, worth of 4,787.5 million US $ during the year 2022-23.
- Major export destination countries were Saudi Arab, Iran, Iraq, United Arab EMTs, and Yemen Republic, etc. (https://apeda.gov.in/apedawebsite).

The 4 Principles of Organic farming

HEALTH

Healthy soils produce healthy crops that foster the health of animals and people.
Organic agriculture is intended to produce high quality, nutritious food that contributes to preventive health care and well-being.

ECOLOGY

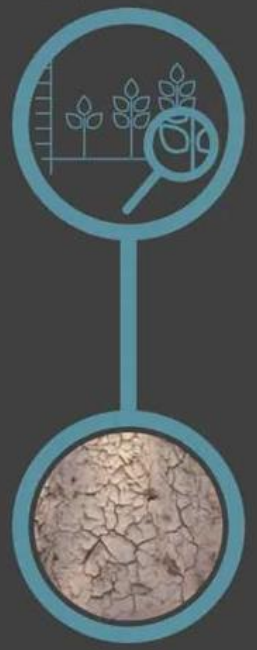
All land is home to wildlife and important for ecosystem services. Organic agriculture aims for ecological balance through the design of farming systems, establishment and good maintenance of habitats and conservation of agricultural biodiversity and genetic resources.

FAIRNESS

Equity, respect, justice and stewardship of the shared world. Organic agriculture aims to provide good food for all and a decent living for farmers and food workers.

CARE

Taking care of each other and our surroundings.
Organic agriculture focuses on how we can enhance efficiency and increase productivity without jeopardizing the health and well-being of people and the planet.



How can organic agriculture help us address challenges?

SOIL

Organic agriculture is centered on boosting soil health.
What are the benefits of healthy soil?

What are some of the benefits of healthy soil?

We can grow nourishing, nutrient-dense foods in it without using inputs like artificial fertilizers
It provides us with higher crop yields in the long term

BIODIVERSITY

Organic agriculture seeks to maintain and boost biodiversity. Why does that matter?

What are some of the reasons biodiversity matters?

-Seed and crop diversity makes farms and landscapes more resilient to challenges (such as pest incursions) and change (such as global warming)
-Monoculture impacts negatively on soil health and biodiversity

LIVELIHOODS

How can organic agriculture help create more sustainable, secure and resilient livelihoods?

What are some of the key questions when considering sustainable livelihoods?

-What is the difference between food security and food sovereignty?
-How can organic agriculture contribute to more secure and resilient food production?

CLIMATE CHANGE

How can organic agriculture contribute to addressing the climate crisis?

Some contributions include:

-Soil that's cultivated organically stores more carbon than that which is cultivated for conventional agriculture
-It reduces greenhouse gas emissions by omitting the use of pesticides

Source: Global landscapes forum (2023)

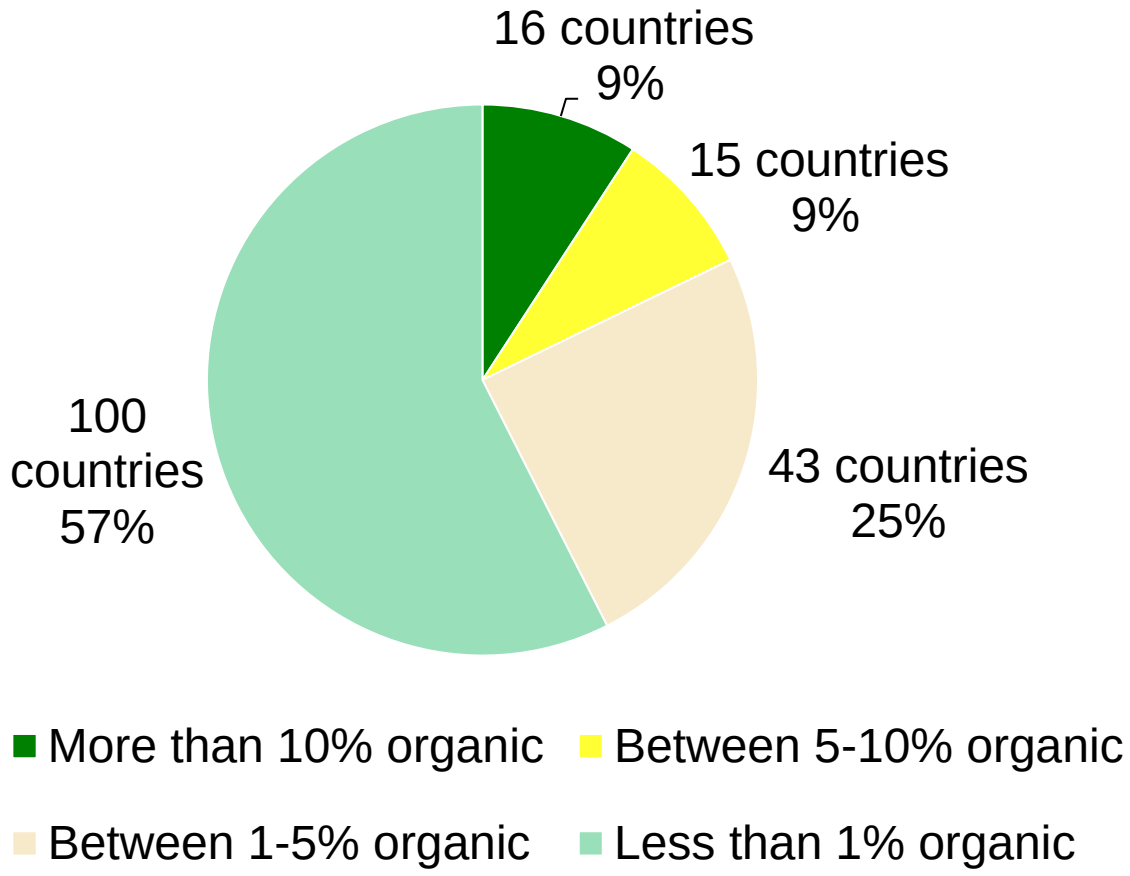
PERCENTAGE OF AREA UNDER ORGANIC FARMING IN THE TOTAL CULTIVATED AREA IN DIFFERENT COUNTRIES OF THE WORLD

The country with the highest share is **Liechtenstein (41.6 percent)**, followed by Austria (26.5 percent),

The First Organic country **Estonia** share **(22.4%)**, percentage of area under organic farming in the total cultivated area

India, share **(2.0%)** of the total net sown area under organic farming

Increase of organic agricultural land:
India: 3,59,000 ha (+16%) in 2020



Source: FiBL survey 2022 www.organic-world.net – statistics.fibl.org

Global Organic Agriculture Trend

74.9 m ha Organic farmland in million hectares

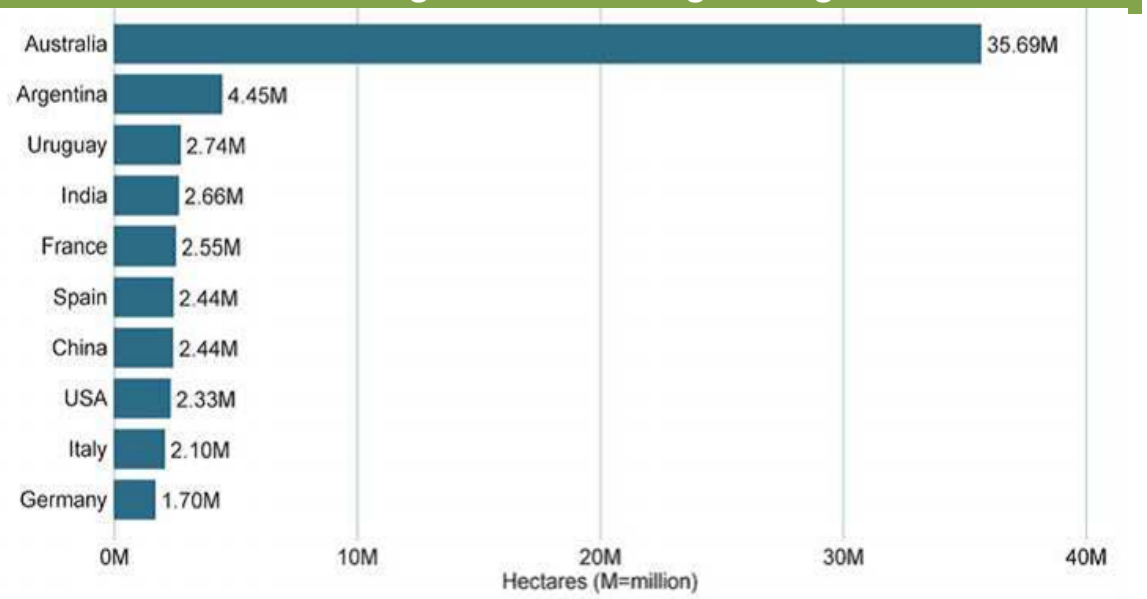
190 Countries with organic farming

Organic Farmers is increasing……

3.4 M Organic farmers

+ 7.6% From 2019

Countries with the largest areas of organic agricultural land



1.5 percent of the global agricultural land is organic

Top ten countries with the largest organic agricultural areas represent 78% of the world's organic agricultural land.

Source: FiBL survey 2022 www.organic-world.net – statistics.fibl.org

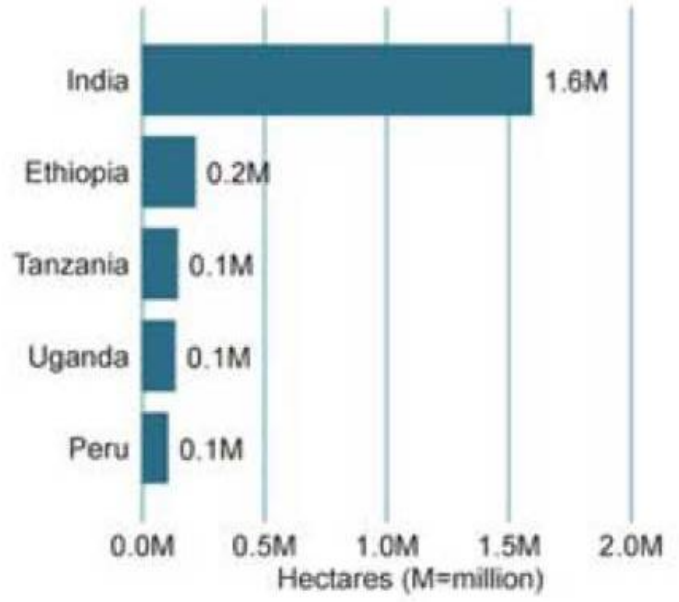
Organic Producers Trend during 2020

World 3.4 million producers

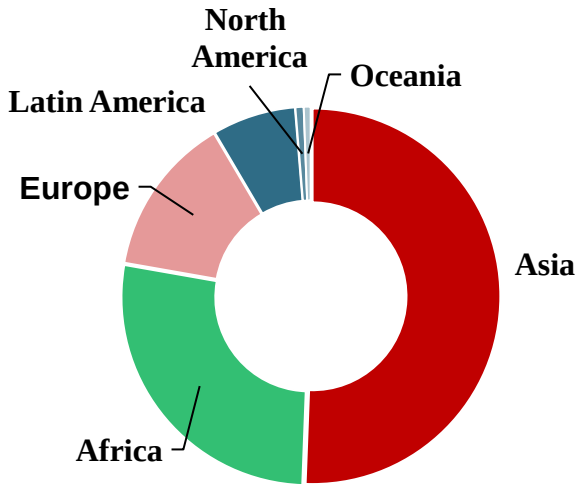
1.81 M in Asia

+7.6% growth since 2019

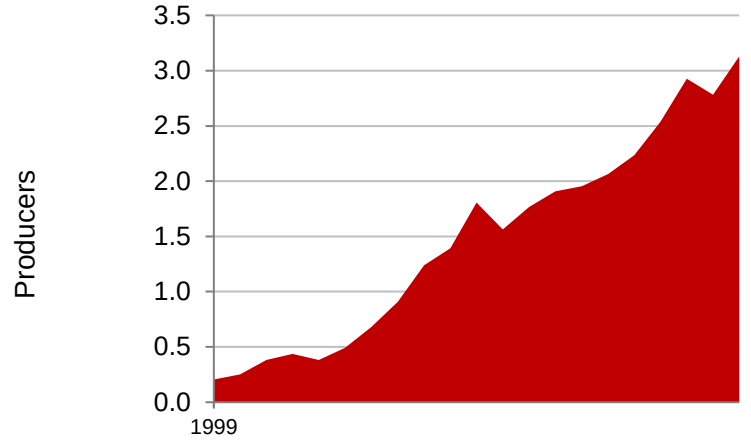
The country with organic producers is India, followed by Ethiopia and Tanzania



More than 90% of the producers are in Asia, Africa, and Europe



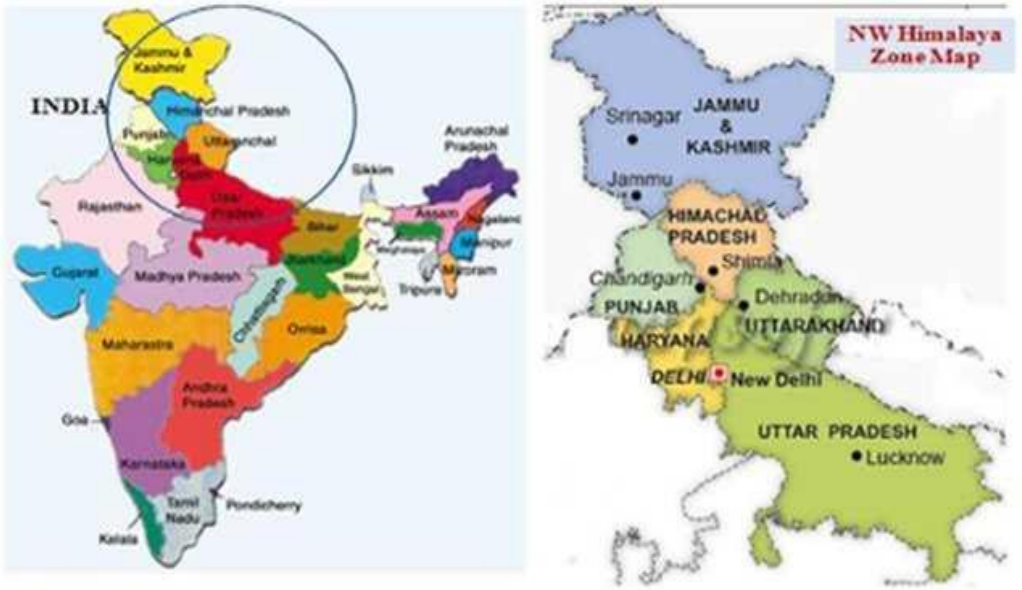
There has been an increase in the number of producers by 2,40,000 or 7.6% btw 2019-20



Development of the number of organic producers 1999-2019

Source: FiBL survey 2022 www.organic-world.net – statistics.fibl.org

The areas of *Basmati* rice production in India*:*
Punjab, Haryana, Delhi, Uttarakhand, Himachal Pradesh, J & K and western Uttar Pradesh



- Considering the importance of ***Basmati* rice** as a major export commodity and as a safe food with high commercial value in Indian and International markets

- We hypothesized that organic *Basmati* rice production with locally available organic manures such as **FYM, *Sesbania,* and Blue Green Algae (BGA)** could be a strategy for future rice production with this experiment which was initiated in **Year 2003**

TREATMENT DETAILS

Title of Experiment

Effect of nutrient management options on productivity and nutritional quality of organically-grown *Basmati* rice under the long-term experiment (20 years) of *Basmati* rice-wheat cropping system

Treatments
T_1: Control
T_2: FYM @ 10 t ha^{-1} (farm yard manure)
T_3: *Sesbania* green manuring (SGM)
T_4: SGM + BGA (Blue green algae)
T_5: SGM + FYM
T_6: SGM + FYM + BGA

Experimental design	Randomized Block Design
Replications	3
Plot size	4.8 m x 4.8 m = 23.04 m^2
Rice variety	Pusa Basmati 1

Location of the Experiment : ICAR-Indian Agricultural Research Institute, New Delhi

OBJECTIVES

- To study the effect of different combinations of organic manures on the yield and grain quality of rice
- To assess the impact of different combinations of organic manures on soil health under organic farming in rice
- To find out the most economic combination of organic manures and biofertilizers for organic farming of rice

HISTORY OF THE EXPERIMENT

- The present experiment was initiated in **year 2003** and continuing…
- **Rice-Wheat cropping system** is been followed till date

Table 1. Effect of organic nutrient management options on the productivity of *Basmati* rice under the long-term experiment (20 years)

Treatment	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest Index (%)
Control	2.23^{c}	8.42^{d}	10.65^{d}	20.9^{b}
FYM @ 10 t/ha	3.62^{b}	11.44^{bc}	15.07^{bc}	24.1^{a}
Sesbania green manuring (SGM)	3.43^{b}	11.13^{c}	14.56^{c}	24.3^{a}
SGM + Blue-green algae (BGA)	3.63^{b}	11.38^{bc}	15.01^{bc}	24.2^{a}
SGM + FYM	4.16^{a}	12.35^{ab}	16.51^{ab}	25.2^{a}
SGM + FYM + BGA	4.32^{a}	12.58^{a}	16.90^{a}	25.6^{a}
	0.097	0.206	0.348	0.456
LSD (P =0 .05)	0.310	0.658	1.118	1.654

Field experiment treatments photos

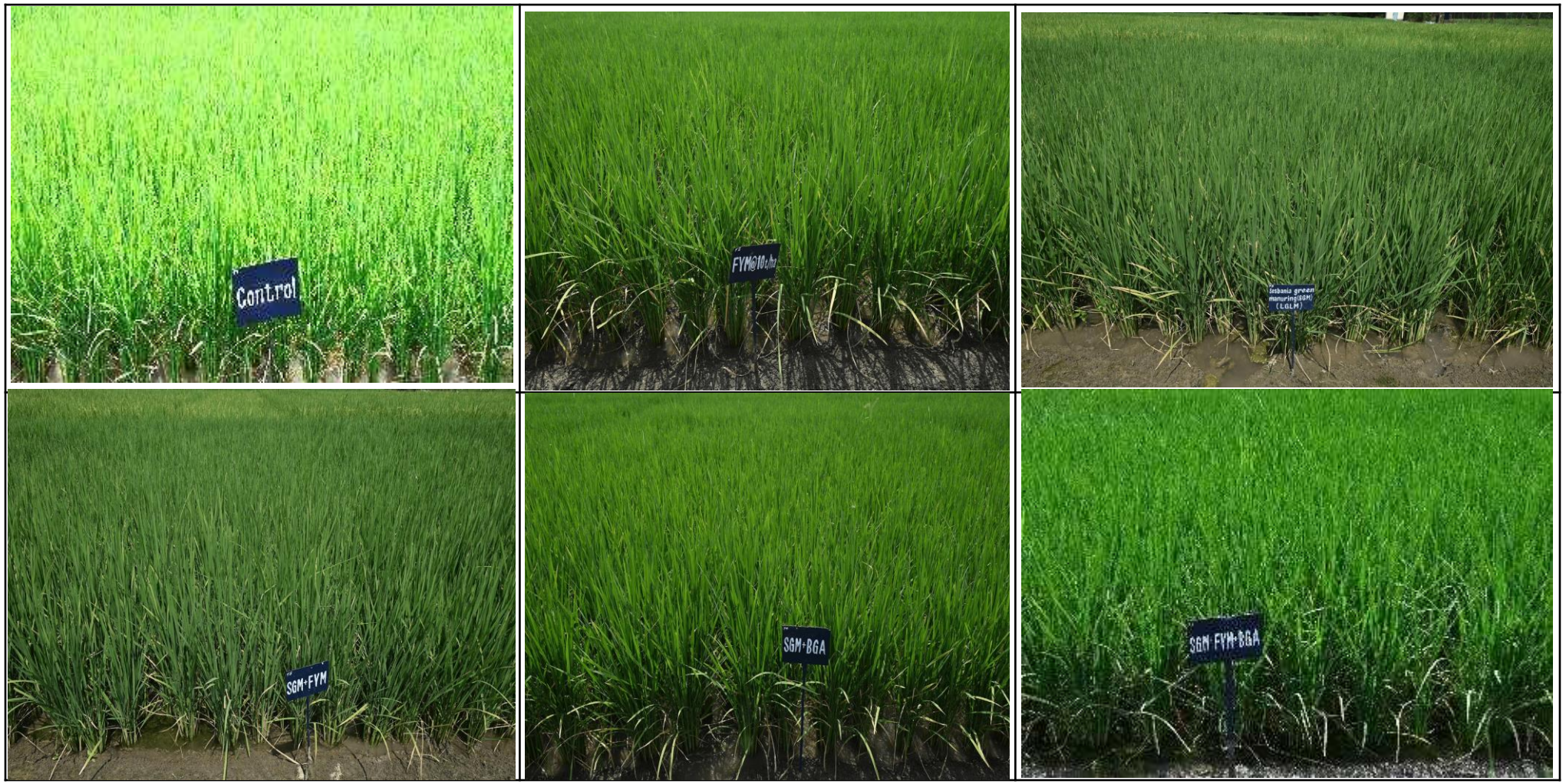
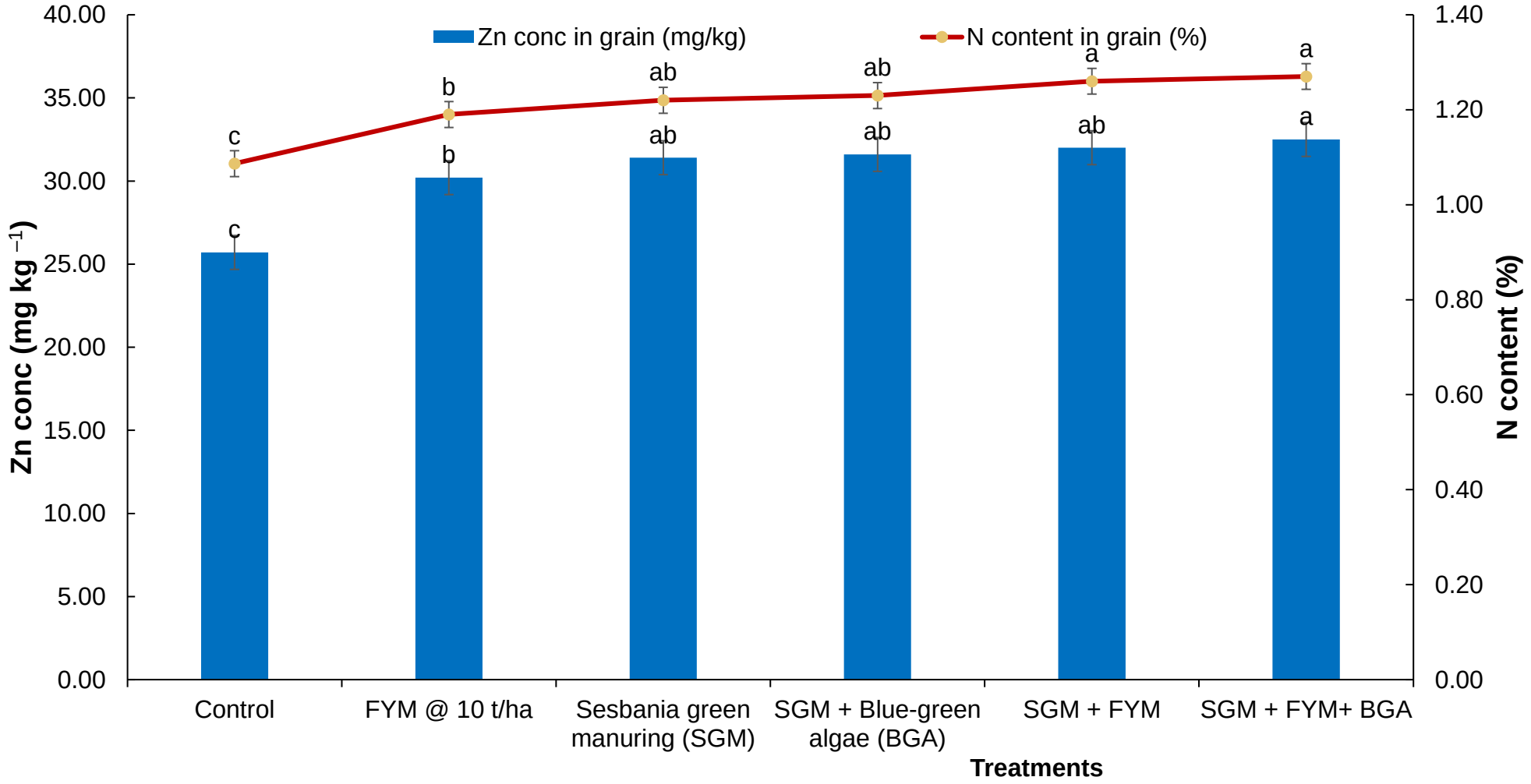


Figure 1. Effect of nutrient management options on zinc and nitrogen content of organically-grown *Basmati* rice under long-term experiment (20 years)



Application of SGM + FYM + BGA recorded the highest nitrogen content in the grain being 14.4% higher, similarly 20.9% higher zinc concentration in rice grain over the control.

Table 2. Effect of organic nutrient management options on nitrogen and zinc uptake in grain of *Basmati* rice under the long-term experiment (20 years)

Treatment	Nitrogen uptake in grain (kg ha^{-1})	Zinc uptake in grain (g Zn ha^{-1})
Control	24.24^{e}	57.31^{e}
FYM @ 10 t/ha	43.08^{cd}	109.32^{d}
Sesbania green manuring (SGM)	41.85^{d}	107.70^{d}
SGM + Blue-green algae (BGA)	44.65^{c}	114.71^{c}
SGM + FYM	52.42^{b}	133.12^{b}
SGM + FYM+ BGA	54.86^{a}	140.40^{a}
	0.99	1.38
LSD (P =0 .05)	3.14	4.36

Figure 2. Effect of nutrient management options on crude protein (%) content of organically-grown *Basmati* rice under long-term experiment (20 years)

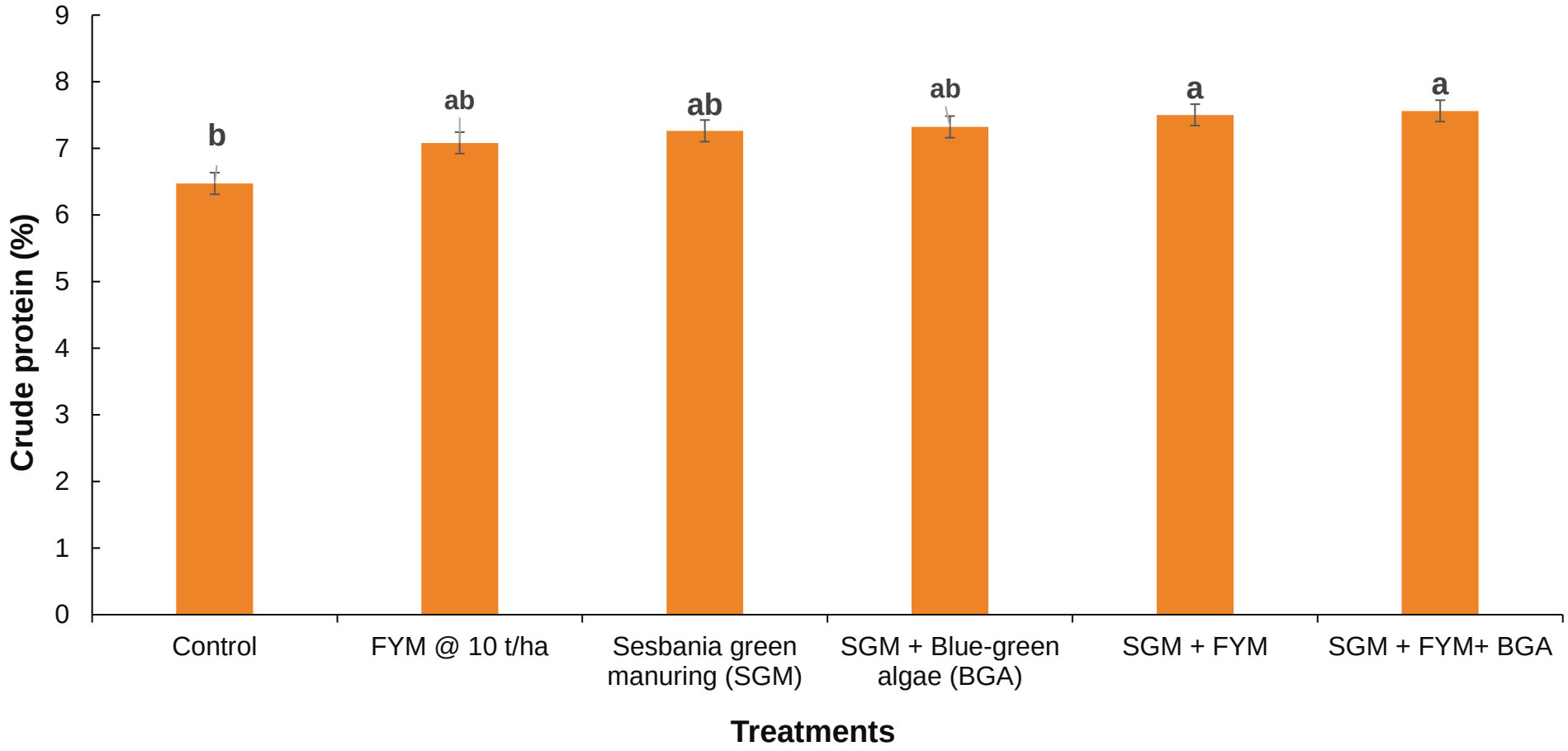


Table 3. Effect of organic nutrient management options on the soil biomass carbon and soil dehydrogenase activity of *Basmati* rice under the long-term experiment (20 years)

Treatment	Soil microbial biomass carbon (µg g^{-1} soil)	Soil dehydrogenase activity (µg TPF g^{-1} soil h^{-1})
Control	227.2^{e}	17.9^{d}
FYM @ 10 t/ha	372.3^{d}	25.4^{b}
Sesbania green manuring (SGM)	430.1^{c}	21.2^{c}
SGM + Blue-green algae (BGA)	448.2^{b}	26.0^{b}
SGM + FYM	471.2^{a}	26.1^{b}
SGM + FYM + BGA	470.4^{a}	33.3^{a}
	6.55	0.79
LSD (P =0 .05)	19.2	2.31

Figure 3. Effect of nutrient management options on total organic carbon (TOC) of organically-grown *Basmati* rice under long-term experiment (20 years)

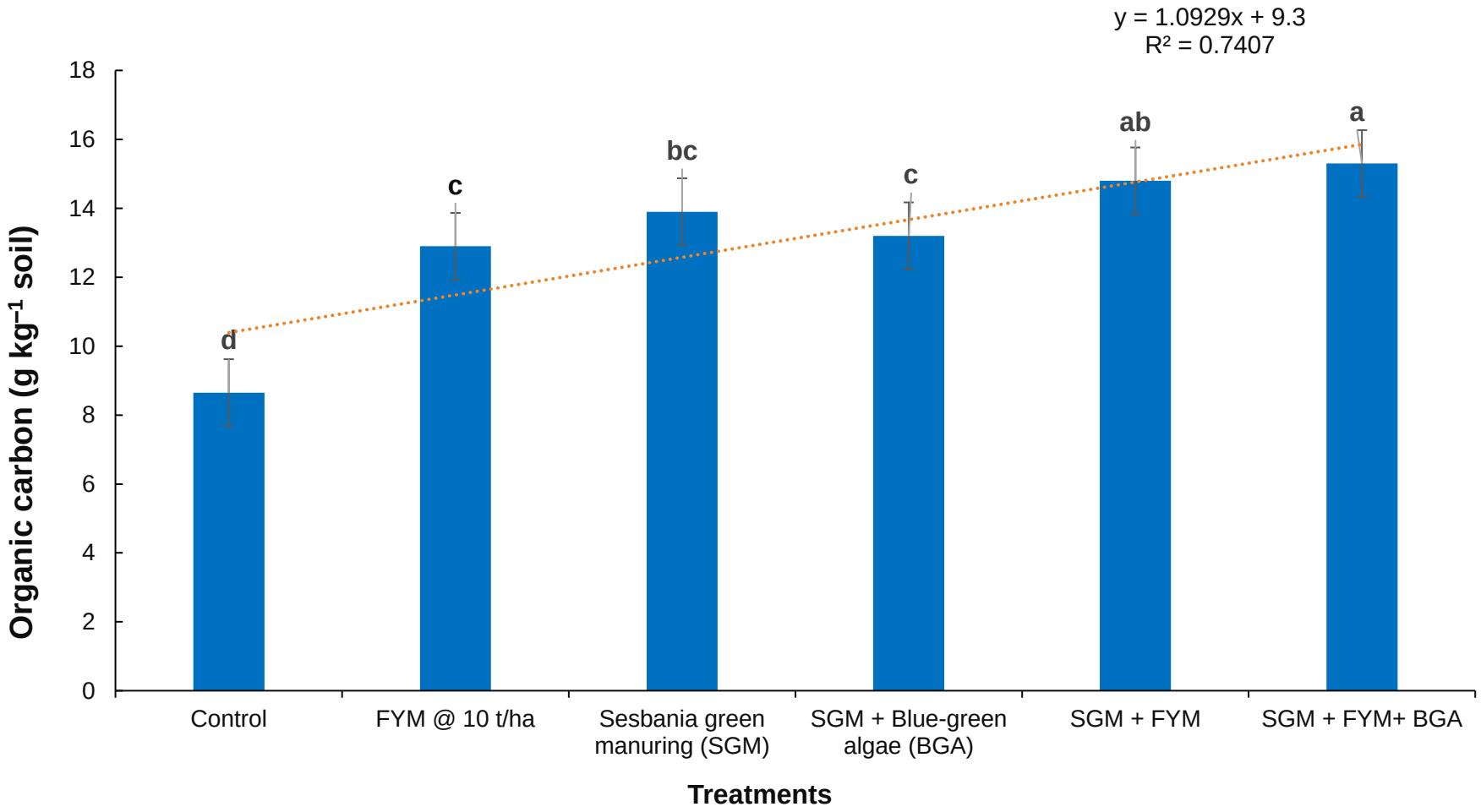
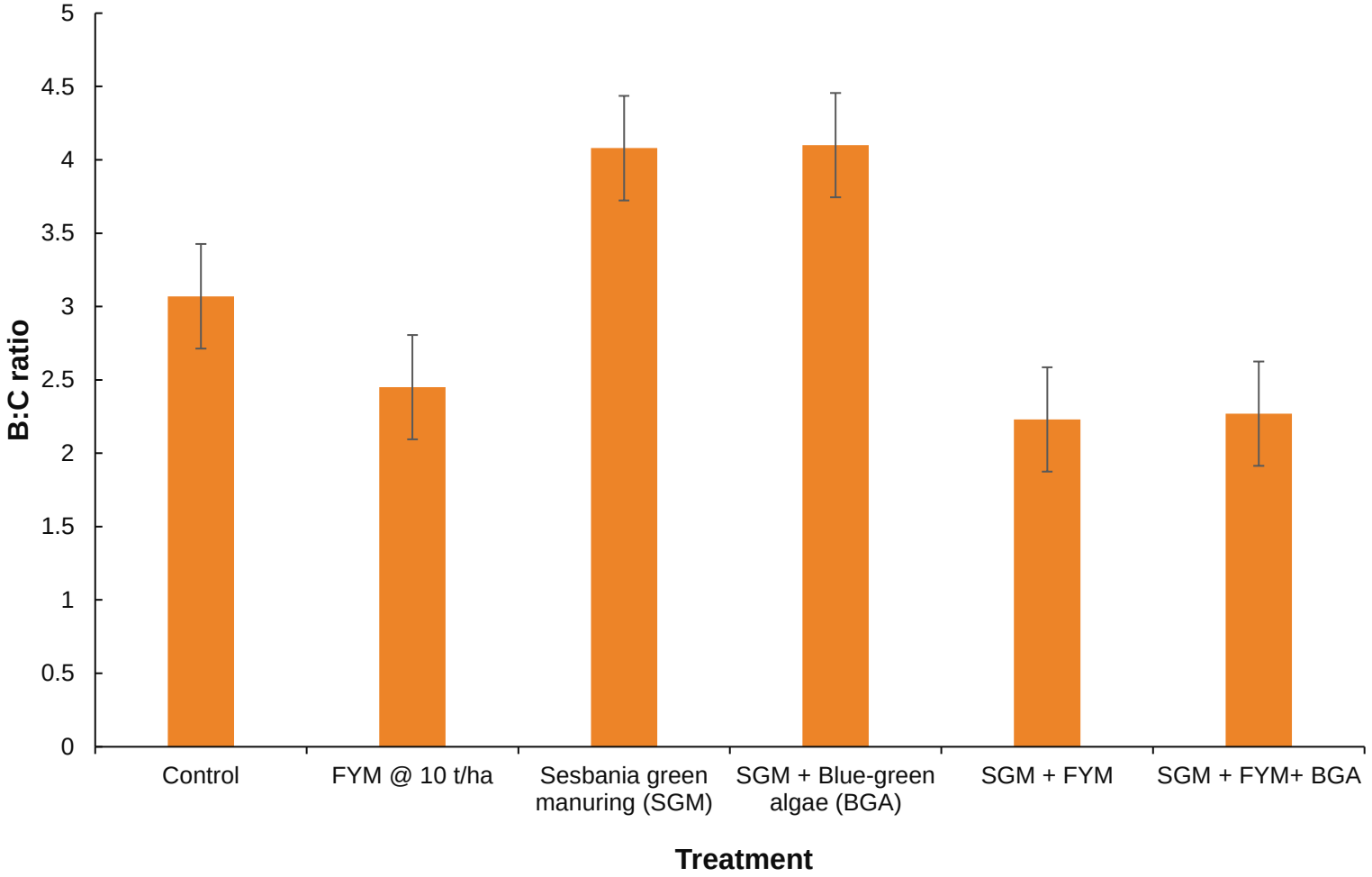


Table 4. Effect of organic nutrient management options on economic returns of *Basmati* rice under the long-term experiment (20 years)

Treatment	Cost of cultivation (US $ ha^{-1})	Gross returns (US $ ha^{-1})	Net returns (US $ ha^{-1})
Control	281.2	927.7	646.6
FYM @ 10 t/ha	505.1	1506.0	1001.0
Sesbania green manuring (SGM)	329.4	1427.0	1097.6
SGM + Blue-green algae (BGA)	332.5	1510.2	1177.7
SGM + FYM	553.3	1730.7	1177.4
SGM + FYM+ BGA	556.4	1797.3	1240.8
S/NS (p=0.05)	-	S	S

Figure 4. Effect of organic nutrient management options on economic returns of *Basmati* rice under the long-term experiment (20 years)



From niche to mainstream: An agenda for organic marketing of *Basmati* rice

Intensive campaign

- Organic Mela's
- State–wide awareness programmes on the advantages of organic produce
- Workshops and seminars for consumers, teachers, traders, farmers, government officials

Channels for marketing organic produce

- Direct marketing/linkages by farmer's groups with end-user institutions
- Existing vegetable, fruit, and grocery vendors
- Organic farm produce outlets
- The tourism industry sources organic produce

Availability of quality organic manure to the farmers

- Crop rotation, tree crops, cover crops, leguminous crops, green manure
- Link organic municipal solid waste to farms –> organic matter recycling

Ensure farm inputs for organic farming

- Ensure markets for good quality input materials at reasonable price
- Training for local resource persons

From niche to mainstream: An agenda for organic marketing of *Basmati* rice

Encourage the use of organic farm produce in the food industry

Forward contracting and price policy

- To increase supply, producers need to be confident about the long-term future of the market
- Price of the organic products is about 20–30% higher than conventional products

Provide financial incentives for promoting organic farming

- Interest-free loans to especially small and marginal farmers
- Assistance during the conversion period

Introduce organic farming in educational institutions

- Introduce organic farming in educational institutions through academic inputs

SUMMARY

- Based on the long-term study of organic nutrient management options for *Basmati* rice it can be concluded that the application of *Sesbania* green manuring (SGM) + FYM (10 t ha^{-1}) + BGA is the best option to achieve the highest productivity and nutritional quality of organically grown *Basmati* rice

- It was also noticed that, in the organic cultivation of *basmati* rice-wheat cropping system, through the application of bio-fertilizers nearly 25% quantity of organic manures can be reduced without affecting the crop yields.

- The use of organic sources improved the soil physicochemical properties, SOC, and availability of nutrients which in turn increased the grain yield, macro and micronutrient content in grains and their uptake by *Basmati* rice

CONCLUSION

- Organic agriculture offers the most sustainable solution for developing the agriculture sector and provides food security with the least negative impacts on the environment.
- Strong policy is required for the overall framework of the systems approach
- Coordination of research, extension, and farmers to encourage farmers' participatory research and to educate the farmers about organic *basmati* rice production
- Subsidy for critical inputs, easy and low-interest credits, and farmers-friendly crop insurance policies can help the farmers to include pulses in *basmati* rice-wheat with minimum risk and in turn contribute to the well-being of the nation

Field visit to organic *basmati* rice farm

THANK YOU