



International Journal of Research in Agronomy

E-ISSN: 2618-0618
P-ISSN: 2618-060X
© Agronomy
NAAS Rating (2026): 5.20
www.agronomyjournals.com
2026; 9(3): 256-263
Received: 05-12-2025
Accepted: 25-01-2026

Victor Debbarma
Assistant Professor (Agronomy),
Department of Livestock Farm
Complex, College of Veterinary
Sciences & Animal Husbandry,
R.K. Nagar, West Tripura, India

Param Debbarma
Assistant Professor, Department of
Livestock Products Technology,
College of Veterinary Sciences &
Animal Husbandry, R.K. Nagar,
West Tripura, India

Bijoy Kumar Sarkar
Associate Professor and Head,
Department of Livestock Products
Technology, College of Veterinary
Sciences & Animal Husbandry,
R.K. Nagar, West Tripura, India

Hamari Debbarma
Veterinary Officer, Animal
Resources Development
Department, Government of
Tripura, Pandit Nehru Complex
Rd, Gurkhabasti, Agartala,
Tripura, India

John Debbarma
Assistant Professor (Agronomy),
Department of Livestock Farm
Complex, College of Veterinary
Sciences & Animal Husbandry,
R.K. Nagar, West Tripura, India

Corresponding Author:

Victor Debbarma
Assistant Professor (Agronomy),
Department of Livestock Farm
Complex, College of Veterinary
Sciences & Animal Husbandry,
R.K. Nagar, West Tripura, India

System of crop intensification and organic sources of nutrient on grain quality parameters of cereals under organic production system

Victor Debbarma, Param Debbarma, Bijoy Kumar Sarkar, Hamari Debbarma and John Debbarma

DOI: <https://www.doi.org/10.33545/2618060X.2026.v9.i3d.5091>

Abstract

The experiment was carried out for both the crops viz., finger millet and rice during *Kharif* season 2016 and 2017 at Crop Research Farm, SHUATS Model of Organic Farm (SMOF), Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj (U.P.) to study the 'System of Crop Intensification and Organic Sources of Nutrient on Grain Quality Parameters of Cereals under Organic Production System'. The pooled data recorded in finger millet that highest carbohydrate content of 75.87% in the treatment M₁ (System of Finger millet Intensification technique, 30 DAS) and highest protein content of 8.29% with exactly same values by M₃ (Late Conventional Transplanted Finger millet, 40 DAS) with M₁ (System of Finger millet Intensification, 30 DAS), though it was found non-significant. Considering Farm yard manure (10 t/ha) pooled data showed highest percentage in carbohydrate content of 75.88% and protein contain of 8.30%, though there was no significance difference. The pooled data recorded in rice that highest carbohydrate contain of 77.48% and highest protein contain of 7.31% in the treatment M₁ (System of Rice Intensification method of transplanting), though it was found non-significant. Considering Farm yard manure (16 t/ha) pooled data showed highest percentage in carbohydrate content of 77.48% and considering Poultry manure (2.6 t/ha) pooled data showed highest percentage in protein contain of 7.33%, though there was no significance difference.

Keywords: SFMI, SRI, planting methods, organic sources of nutrient and quality parameters

Introduction

Cereal crops play a vital role in global food security and constitute the staple diet for a large proportion of the world's population. Rice is the primary staple food for more than half of the global population and contributes significantly to daily caloric intake. The global millets production was estimated at 27.8 m t. India is the largest global producer with a 41.04% global market share (Business Wire, 2018) [2]. Finger millet contains rich amounts of calcium (0.38%), protein (6% - 13%) and carbohydrates (65% - 75%). The seeds are abundant source of dietary fiber (18%), minerals (2.5% - 3.5%), essential amino acids, viz., isoleucine, leucine, methionine, phenylalanine, phytates, tannins, phenolic compounds, trypsin inhibitory factors and also gluten-free (Sood *et al.*, 2016; Chandra *et al.*, 2016) [11, 3].

In recent decades, the intensive use of chemical fertilizers and pesticides in conventional agriculture has resulted in soil degradation, environmental pollution and declining soil fertility. These challenges have increased the interest in sustainable and organic farming systems that rely on natural inputs for maintaining soil health and crop productivity (Reganold and Wachter, 2016) [8]. The nutrients required by plants can be supplied through organic sources such as farmyard manure, poultry manure, vermicompost, bokashi manure, green manure and foliar application of organic inputs like cattle urine to maintain soil fertility and sustain crop yields (Debbarma *et al.* 2024) [4]. These organic amendments improve soil physical, chemical and biological properties and enhance nutrient availability to plants.

The System of Crop Intensification (SCI) has emerged as an innovative agroecological approach aimed at increasing crop productivity while reducing dependence on external inputs. The concept of SCI is derived from the principles of the System of Rice Intensification (SRI), which

involves practices such as wider spacing, use of young seedlings, improved soil aeration and better water and nutrient management (Uphoff, 2002) [12]. These practices stimulate root growth, improve nutrient uptake and enhance crop productivity. The application of intensification principles has also been extended to other crops such as finger millet through the System of Finger Millet Intensification (SFMI). Studies have reported that SFMI practices significantly improve plant growth, yield attributes, grain yield and grain quality compared to conventional cultivation methods. Integration of organic nutrient sources with intensification practices further enhances crop overall performance by improving soil fertility and nutrient availability (Debbarma *et al.* 2024) [4].

Grain quality parameters such as protein content, carbohydrate composition, mineral concentration and fiber content are important indicators of nutritional value in cereal crops. Crop management practices and nutrient sources play a crucial role in determining these quality parameters. Organic nutrient sources provide a balanced supply of macro and micronutrients and improve nutrient uptake efficiency, which can positively influence grain nutritional quality (Worthington, 2001) [13].

Although several studies have evaluated the effects of crop intensification techniques on yield improvement, limited research has focused on their combined influence with organic nutrient sources on grain quality parameters of cereals under organic production systems. Understanding the interaction between intensification practices and organic nutrient management is essential for developing sustainable strategies that enhance both productivity and nutritional quality of cereal crops.

Therefore, the present study was undertaken to evaluate the effect of “System of Crop Intensification and organic sources of nutrient on grain quality parameters of cereals under organic production system”.

Materials and Methods

The experiment was carried out for both the crops (finger millet and rice) during *Kharif* season 2016 and 2017 at Crop Research Farm, SHUATS Model of Organic Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology & Sciences, Prayagraj (U.P.). SHUATS Model Organic Farm (SMOF) with 2 hectares (5 acres) area has been Certified by Lacon Quality Certification (P) Ltd. [Accreditation No. NPOP/NAB/006, Ministry of Commerce, Govt. of India] till 2017 the field was in its 9th year of conversion. The soil of the experimental plots was sandy loam in texture, low in available nitrogen, medium in available phosphorus and high in available potash with 7.68 soil pH. For finger millet the experiment was laid out in split plot design with three replications, having three planting methods, viz., System of Finger millet Intensification [SFMI (30 DAS), 25 × 25 cm] technique, Conventional Transplanted Finger millet [CTFM (30 DAS), 25 × 10 cm] and Late Conventional Transplanted Finger millet [LCTFM (40 DAS), 25 × 10 cm]; three organic sources of nutrient, viz., Poultry manure (1.7 t/ha), Farm yard manure (10 t/ha) and *Vermicompost* (2.5 t/ha) were studied. For rice the experiment was laid out in split plot design with three replications, having three planting methods, viz., System of Rice Intensification method of transplanting [SRI (mt), 20 × 20 cm], Conventional Transplanted Rice (CTR, 20 × 15 cm) and Direct Seeded Rice (DSR, 20 × 10 cm); three organic sources of nutrient, viz., Poultry manure (2.6 t/ha), Farm yard manure (16 t/ha) and *Vermicompost* (4 t/ha) were studied. Green manure *dhaincha* (*Sesbania aculeata* L.) was grown during *zaid* season

and organic liquid manure (*Panchagavya* and Fish Amino Acid) was sprayed in all the treatment; and both the crop seeds were treated with *jeevamruth* organic formulation. There were total 9 treatment combinations in all. The net plot size was 5 × 4 m and net experimental area 540 m². The agronomic practices for finger millet, viz., weeding with cycle weeder in SFMI technique, manual and hand weeding in CTFM and LCTFM methods were done and irrigation was given according to the schedules for all treatments. The agronomic practices for rice, viz., weeding with cono weeder in SRI method of transplanting, manually in CTR and DSR methods were done and irrigation was given according to the schedules for all treatments. The finger millet variety ‘VL Mandua- 352 (VL 352)’ was sown. The rice variety ‘Sonam’ was sown. Data on carbohydrate (%), protein (%), fat (%), ash (%) and moisture (%) were recorded. Data recorded on qualitative parameters were tabulated and subjected to statistical analysis as per Gomez and Gomez, 1976 [6].

Carbohydrate (%) in cereal grains

The carbohydrates content of grain can be determined by calculating the percent remains after the entire component have been measured, viz., moisture, protein, fat and ash. The following formula was used for calculation (Ranganna, 2003) [7].

$$\text{Carbohydrate (\%)} = 100 - [\text{Protein (\%)} + \text{Moisture (\%)} + \text{Fat (\%)} + \text{Ash (\%)}]$$

Protein (%) in cereal grains

It is calculated by the formula, Protein (%) = N (%) × power factor [finger millet (5.4); rice (5.95)]. The nitrogen content of grains was analyzed by micro-Kjeldahl digestion and distillation method (Amma, 1989) [1].

The micro-Kjeldahl’s method for total nitrogen content (%) essentially involves digestion of the sample to convert N compounds in the sample to NH₄ form. The 200 mg of plant sample and an equal amount of catalyst mixture (prepared by mixing 25.0 g K₂SO₄ + 5.0 g CuSO₄. 5H₂O + 0.5 g of metallic selenium) is transferred to a micro Kjeldahl digestion flask. On adding 3 ml of conc. H₂SO₄ the digestion flask is transferred to digestion assembly with a fume hood. The contents are first heated slowly. When the initial vigorous reaction is over, the contents are heated briskly until it become clear. Organic N is transformed into ammonium sulphate during the digestion process.

The digestion contents are transferred to distillation flask of a micro Kjeldahl distillation unit which has water filled large flask with round bottom for generating steam to boil the contents placed in distillation flask. The distillation flask is connected to a condenser, and the condenser outlet is dipped in 25 ml of 2% boric acid containing mixed indicator. On adding of 10 ml of 40% NaOH into distillation flask, the feeding funnel is closed and water in large round flask is heated to boil for generating steam for boiling the contents in distillation flask. In 9 minutes of distillation about 55 ml of distillate is collected in boric acid forming ammonium borate which makes the weak boric acid alkaline.

The ammonium borate is back titrated by adding 0.02N HCl until the reaction mixture changes its colour from green to pink. The standard acid used in back titration of ammonium borate is a measure of N content of the plant sample. Similar procedure for blank sample was followed.

$$\% \text{ Nitrogen in plant sample} = \frac{S - B \times 0.02 N \times ME \times 100}{W}$$

Where,

S is ml of standard acid used in the titration of the sample distillate

B is the ml of standard acid used in the titration of the blank distillate

N is the normality of the acid used in the titration of the distillate

ME is the milligram equivalent weight of nitrogen, i.e., 0.014

W is the mass of plant sample taken in gram for the preparation of the sample digest.

Fat (%) in the cereal grains

The extractor and extract flask were cleaned and dried. The extract flask was weighed on chemical balance up to 2 decimal. Two gram of prepared sample was placed on whatman paper number 42 which was folded in to a shape of thimble and was placed inside the extractor. Two hundred fifty (250) ml of ether solvent was added in the extractor flask and to avoid overheating, the intensity of heat from electric coil was lowered with the help of regulator. For the complete removal of fat of grain sample, four cycles of siphoning was needed and 1000 ml of ether solvent were used. The solvent was kept in flask and only the fat content was heated gently till the smell of ether was not there. It was taken out and kept for cooling and the weight was taken. It was represented in percentage. The following formula was used for calculation (Ranganna, 2003) ^[7].

$$\text{Fat percentage} = \frac{(X - Y)}{\text{Weight of sample (g)}} \times 100$$

Where,

X is final weight of flask

Y is initial weight of flask

Moisture (%) in the cereal grains

This method consists in measuring the weight lost by prepared sample. The moisture content was determined by the air oven method and the methodology was used as follows. The temperature of the oven was set at 80° C and samples were placed inside the oven and the final weights of samples were measured after the 8 hours (Ranganna, 2003) ^[7].

$$\text{Moisture percentage} = \frac{(X - Y)}{X} \times 100$$

Where,

X = Initial weight of grain sample

Y = Final weight of grain sample

Ash (%) in the cereal grains

The ash content in rice was determined by the Bunsen burner and muffle furnace. Two g sample was prepared and put in the crucible and the initial weight was taken. The samples were kept over the Bunsen burner for 5 to 6 minutes. Samples were put inside the muffle furnace at 525° C for 4 hours samples and thereafter it was cooled and the final weight recorded. The difference in weights gave the total ash content and was expressed as percent (Ranganna, 2003) ^[7].

$$\text{Ash percentage} = \frac{(X - Y)}{X} \times 100$$

Where,

X = Initial weight of grain sample

Y = Final weight of grain sample

Results and Discussion

Carbohydrate content in grain (%)

The result regarding the effect of different planting methods and organic sources of nutrient on qualitative parameter namely carbohydrate content (%) in cereal grains is given in the table 1.1, 1.2, 2.1 and 2.2.

In finger millet highest carbohydrate (75.88% in 2017 and 75.87% in pooled analysis) was registered in the treatment M1 (System of Finger millet Intensification technique, 30 DAS) in 2017 and pooled; and of 75.87% registered with exactly same values by M2 (Conventional Transplanted Finger millet, 30 DAS) and M3 (Late Conventional Transplanted Finger millet, 40 DAS) in 2016, though it showed no significant difference.

Data pertaining to organic sources of nutrient showed highest in carbohydrate percentage. It further registered with exactly same values in both the years and pooled by S2 (Farm yard manure, 10 t/ha), though it was found non-significant. Further, data also revealed that S3 (Vermicompost, 2.5 t/ha) was registered with exactly the same values with S2 (Farm yard manure, 10 t/ha) in 2016. Shan *et al.*, (2012) ^[10] reported that the quality parameter is mainly a varietal character. High amount of carbohydrate in finger millet grain with organic source of nutrient may be due to higher alpha amylase activity. Starch is the major source of carbohydrate in finger millet which consists of amylose and amylopectin (Deshpande and Devasenapathy, 2010) ^[5].

Appraisal of the data on carbohydrate percentage remained unchanged with planting methods and organic sources of nutrient during both the years and in pooled.

In rice highest carbohydrate (77.47% and 77.48%) was registered in the treatment M1 (System of Rice Intensification method of transplanting) in both the years of evaluation and pooled, though it was found no significance difference.

Data pertaining to organic sources of nutrient showed highest in carbohydrate percentage. It further registered that S2 (Farm yard manure, 16 t/ha) has highest carbohydrate percentage of 77.48% with exactly same values in both the years and pooled, though it showed no significant difference.

Appraisal of the data on carbohydrate percentage remained unchanged with planting methods and organic sources of nutrient during both the years and in pooled.

Protein content in grain (%)

The data regarding the effect of different planting methods and organic sources of nutrient on qualitative parameter namely protein content (%) in cereal grains in the table 1.1, 1.2, 2.1 and 2.2.

In finger millet highest protein (8.29% in 2016 and 8.30% in 2017) was registered in the treatment M₁ (System of Finger millet Intensification technique, 30 DAS) in both the years of evaluation and pooled, though it showed no significant difference. Further, it was registered exactly same values by M₃ (Late Conventional Transplanted Finger millet, 40 DAS) with M₁ (System of Finger millet Intensification, 30 DAS) in 2016 and pooled.

Data pertaining to organic sources of nutrient showed highest in protein percentage. It further registered that S₂ (Farm yard manure, 10 t/ha) has highest percentage in protein content in both the years and pooled, compared to other organic sources of nutrient, though it was found non-significant. Further, by S₁ (Poultry manure, 1.7 t/ha) it was registered exactly same value with S₂ (Farm yard manure, 10 t/ha) in 2017.

Appraisal of the data on protein percentage remained unchanged with planting methods and organic sources of nutrient during both the years and in pooled.

In rice highest protein (7.30% in 2016 and 7.33% in 2017) was registered in the treatment M₁ (System of Rice Intensification method of transplanting) in both the years of evaluation and pooled, though it showed no significant difference.

Data pertaining to organic sources of nutrient showed highest in protein percentage. It further registered that S₁ (Poultry manure, 2.6 t/ha) has highest protein percentage of 7.30% and 7.36% in both the years and pooled respectively, though it showed no significant difference. Nitrogen being an important element and constituent of the amino acids and protein probably, increased uptake of nitrogen, which in turn might have resulted in the increment of the crude protein content. The increase in grain quality with application of organic source of nutrient may be due to better nutrient availability and its uptake by crop. This might have lead to accumulation of higher quantities of seed components like calcium carbonate and increased the lipid metabolism which helps in increasing the protein content in seed. These results are in line with findings of Roy and Singh (2006) [9].

Appraisal of the data on protein percentage remained unchanged with planting methods and organic sources of nutrient during both the years and in pooled.

Fat content in the grain (%)

The performance regarding the effect of different planting methods and organic sources of nutrient on qualitative parameter namely fat content (%) in cereal grains is given in the table 1.1, 1.2, 2.1 and 2.2.

In finger millet highest fat content was registered in the treatment M₁ (System of Finger millet Intensification technique, 30 DAS) in 2016 and by M₃ (Late Conventional Transplanted Finger millet, 40 DAS) in 2017; and registered of 1.24% with exactly same values by M₁ (System of Finger millet Intensification, 30 DAS) and M₂ (Conventional Transplanted Finger millet, 30 DAS) in pooled, though it was found non-significant.

Data pertaining to organic sources of nutrient showed highest percentage in fat content. It further registered by S₁ (Poultry manure, 1.7 t/ha) has highest percentage in fat content (1.17% in 2016 and 1.19% in 2017) in both the years as compared to other organic sources of nutrient, and found non-significant. Further, it was registered statistically highest fat content of 1.26% by S₃ (Vermicompost, 2.5 t/ha) in pooled analysis.

Appraisal of the data on fat percentage remained unchanged with planting methods and organic sources of nutrient during both the years and in pooled.

In rice highest fat content of 1.77% with exactly same values was registered in the treatment M₃ (Direct Seeded Rice) during both the years and pooled; and by M₁ (System of Rice Intensification method of transplanting) with M₃ (Direct seeded Rice) in 2017, though it was found to be non-significant.

Data pertaining to organic sources of nutrient showed highest percentage in fat content. It further registered by S₁ (Poultry manure, 2.6 t/ha) and S₂ (Farm yard manure, 16 t/ha) of 1.74% with exactly same values in 2016, though it was found non-significant. Further, it was registered statistically highest fat content by S₃ (Vermicompost, 4 t/ha) of 1.78% and 1.76% in 2017 and pooled respectively and found non-significant.

Appraisal of the data on fat percentage remained unchanged with planting methods and organic sources of nutrient during both the years and in pooled.

Ash content in grain (%)

The finding regarding the effect of different planting methods and organic sources of nutrient on qualitative parameter namely ash content (%) in cereal grains is given in the table 1.1, 1.3, 2.1 and 2.3.

In finger millet highest ash content (2.36% registered with exactly same values) was registered in the treatment M₂ (Conventional Transplanted Finger millet, 30 DAS) during both the years and pooled, though it was found non-significant. Further, it was also registered with exactly same values by M₁ (System of Finger millet Intensification technique, 30 DAS) in 2016 and M₃ (Late Conventional Transplanted Finger millet, 40 DAS) in 2017.

Data pertaining to organic sources of nutrient showed highest percentage in ash content. It further registered that with exactly same values of 2.37% by S₁ (Poultry manure, 1.7 t/ha) and S₂ (Farm yard manure, 10 t/ha) in 2016; and of 2.39% by S₃ (Vermicompost, 2.5 t/ha) in 2017, though it showed no significant difference. Further, it was registered of 2.35% with exactly same value by S₁ (Poultry manure, 1.7 t/ha), S₂ (Farm yard manure, 10 t/ha) and S₃ (Vermicompost, 2.5 t/ha) in pooled analysis.

Appraisal of the data on ash percentage remained unchanged with planting methods and organic sources of nutrient during both the years and in pooled.

In rice highest ash content (1.09% and 1.08%) was registered in the treatment M₂ (Conventional Transplanted Rice) in 2016 and pooled respectively; and of 1.08% in 2017 by M₁ (System of Rice Intensification method of transplanting), though it was found non-significant.

Data pertaining to organic sources of nutrient showed highest percentage in ash content. It further registered that S₁ (Poultry manure, 2.6 t/ha) and S₂ (Farm yard manure, 16 t/ha) of 1.08% with exactly same values in 2016 and by S₃ (Vermicompost, 4 t/ha) in 2017, though it was found no significance difference.

Appraisal of the data on ash percentage remained unchanged with planting methods and organic sources of nutrient during both the years and in pooled.

Moisture content in grain (%)

The observation regarding the effect of different planting methods and organic sources of nutrient on qualitative parameter namely moisture content (%) in cereal grains is given in the table 1.1, 1.3, 2.1 and 2.3.

In finger millet highest moisture (12.37% in 2016 and 12.34% in 2017) content was registered in the treatment M₂ (Conventional Transplanted Finger millet, 30 DAS) during both the years and in pooled; though it showed no significant difference.

Data pertaining to organic sources of nutrient showed highest percentage in moisture content. It further registered that S₃ (Vermicompost, 2.5 t/ha) has highest percentage in fat content of 12.37% and 12.33% in both the years and pooled compared to other organic sources of nutrient, though it was recorded non-significant.

Appraisal of the data on moisture percentage remained unchanged with planting methods and organic sources of nutrient during both the years and in pooled.

In rice highest moisture content of 12.40% in 2017 was registered in the treatment M₂ (Conventional Transplanted Rice) and of 12.42% by M₃ (Direct Seeded Rice) in pooled; and by M₁ (System of Rice Intensification method of transplanting) and M₃ (Direct Seeded Rice) of 12.47% with exactly same values of in 2016, though it was found non-significant.

Data pertaining to organic sources of nutrient showed highest percentage in moisture content. It further registered that S₃ (Vermicompost, 4 t/ha) has highest moisture content of 12.50% and 12.43% in 2016 and pooled respectively; and by S₂ (Farm yard manure, 16 t/ha) of 12.40% in 2017, though it was recorded non-significant.

Appraisal of the data on moisture percentage remained unchanged with planting methods and organic sources of nutrient during both the years and in pooled.

Table 1.1: System of Finger Millet Intensification and organic sources of nutrient on grain quality parameters of organic finger millet

Treatment	Qualitative percentage														
	Carbohydrate content in grain (%)			Protein content in grain (%)			Fat content in grain (%)			Ash content in grain (%)			Moisture content in grain (%)		
	2016	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled
Planting methods															
M ₁	75.86	75.88	75.87	8.29	8.30	8.29	1.19	1.17	1.24	2.36	2.34	2.35	12.31	12.31	12.31
M ₂	75.87	75.86	75.86	8.28	8.28	8.28	1.12	1.17	1.24	2.36	2.36	2.36	12.37	12.34	12.36
M ₃	75.87	75.86	75.86	8.29	8.29	8.29	1.16	1.19	1.21	2.33	2.36	2.34	12.36	12.31	12.33
SE (d) ±	0.02	0.04	0.02	0.03	0.02	0.02	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.02	0.02
CD (P = 0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Organic sources of nutrient															
S ₁	75.84	75.86	75.85	8.28	8.30	8.29	1.17	1.19	1.22	2.37	2.33	2.35	12.34	12.32	12.33
S ₂	75.88	75.88	75.88	8.30	8.30	8.30	1.14	1.18	1.22	2.37	2.33	2.35	12.31	12.31	12.31
S ₃	75.88	75.86	75.87	8.27	8.27	8.27	1.16	1.16	1.26	2.31	2.39	2.35	12.38	12.33	12.36
SE (d) ±	0.04	0.04	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.01	0.03	0.03	0.02
CD (P = 0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

M₁ - System of Finger millet Intensification (SFMI, 30 DAS) technique; M₂ - Conventional Transplanted Finger millet (CTFM, 30 DAS); M₃ - Late Conventional Transplanted Finger millet (LCTFM, 40 DAS); S₁ - Poultry manure (1.7 t/ha); S₂ - Farm yard manure (10 t/ha); S₃ - Vermicompost (2.5 t/ha) (at 25, 35 and 50 DAS); DAS - Days after transplanting; NS - Non-significant; SEd (±): Standard error of deviation; CD: Critical difference

Table 1.2: Interaction System of Finger millet Intensification and organic sources of nutrient on grain quality parameters of organic finger millet

Planting Methods	Carbohydrate content in grain (%)				Protein content in grain (%)				Fat content in grain (%)			
	Organic sources of nutrient				Organic sources of nutrient				Organic sources of nutrient			
	S ₁	S ₂	S ₃	Mean	S ₁	S ₂	S ₃	Mean	S ₁	S ₂	S ₃	Mean
2016												
M ₁	75.81	75.86	75.90	75.86	8.29	8.30	8.27	8.29	1.20	1.20	1.17	1.19
M ₂	75.85	75.87	75.90	75.87	8.28	8.30	8.27	8.28	1.10	1.13	1.13	1.12
M ₃	75.85	75.90	75.85	75.87	8.28	8.30	8.28	8.29	1.20	1.10	1.17	1.16
Mean	75.84	75.88	75.88		8.28	8.30	8.27		1.17	1.14	1.16	
Interaction		SE (d) ±	CD (P = 0.05)			SE (d) ±	CD (P = 0.05)			SE (d) ±	CD (P = 0.05)	
(PM × OS)		0.07	NS			0.04	NS			0.04	NS	
2017												
M ₁	75.87	75.90	75.87	75.88	8.30	8.33	8.27	8.30	1.20	1.13	1.17	1.17
M ₂	75.83	75.87	75.87	75.86	8.30	8.27	8.27	8.28	1.17	1.20	1.13	1.17
M ₃	75.87	75.87	75.83	75.86	8.30	8.30	8.27	8.29	1.20	1.20	1.17	1.19
Mean	75.86	75.88	75.86		8.30	8.30	8.27		1.19	1.18	1.16	
Interaction		SE (d) ±	CD (P = 0.05)			SE (d) ±	CD (P = 0.05)			SE (d) ±	CD (P = 0.05)	
(PM × OS)		0.08	NS			0.09	NS			0.04	NS	
Pooled												
M ₁	75.84	75.88	75.88	75.87	8.29	8.32	8.27	8.29	1.20	1.22	1.30	1.24
M ₂	75.84	75.87	75.88	75.86	8.29	8.28	8.27	8.28	1.23	1.25	1.25	1.24
M ₃	75.86	75.88	75.84	75.86	8.29	8.30	8.28	8.29	1.22	1.20	1.22	1.21
Mean	75.85	75.88	75.87		8.29	8.30	8.27		1.22	1.22	1.26	
Interaction		SE (d) ±	CD (P = 0.05)			SE (d) ±	CD (P = 0.05)			SE (d) ±	CD (P = 0.05)	
(PM × OS)		0.05	NS			0.05	NS			0.03	NS	

M₁ - System of Finger millet Intensification (SFMI, 30 DAS) technique; M₂ - Conventional Transplanted Finger millet (CTFM, 30 DAS); M₃ - Late Conventional Transplanted Finger millet (LCTFM, 40 DAS); S₁ - Poultry manure (1.7 t/ha); S₂ - Farm yard manure (10 t/ha); S₃ - Vermicompost (2.5 t/ha) (at 25, 35 and 50 DAS); DAS - Days after transplanting; NS - Non-significant; SEd (±): Standard error of deviation; CD: Critical difference

Table 1.3: Interaction System of Finger millet Intensification and organic sources of nutrient on grain quality parameters of organic finger millet

Planting Methods	Ash content in grain (%)				Moisture content in grain (%)			
	Organic sources of nutrient				Organic sources of nutrient			
	S ₁	S ₂	S ₃	Mean	S ₁	S ₂	S ₃	Mean
2016								
M ₁	2.40	2.33	2.33	2.36	12.30	12.30	12.33	12.31
M ₂	2.37	2.40	2.30	2.36	12.40	12.30	12.40	12.37
M ₃	2.33	2.37	2.30	2.33	12.33	12.33	12.40	12.36
Mean	2.37	2.37	2.31		12.34	12.31	12.38	
Interaction		SE (d) ±	CD (P = 0.05)			SE (d) ±	CD (P = 0.05)	
(PM × OS)		0.04	NS			0.06	NS	
2017								
M ₁	2.33	2.30	2.40	2.34	12.30	12.33	12.30	12.31
M ₂	2.30	2.37	2.40	2.36	12.40	12.30	12.33	12.34
M ₃	2.37	2.33	2.37	2.36	12.27	12.30	12.37	12.31
Mean	2.33	2.33	2.39		12.32	12.31	12.33	
Interaction		SE (d) ±	CD (P = 0.05)			SE (d) ±	CD (P = 0.05)	
(PM × OS)		0.04	NS			0.05	NS	
Pooled								
M ₁	2.37	2.32	2.37	2.35	12.30	12.32	12.32	12.31
M ₂	2.33	2.38	2.35	2.36	12.40	12.30	12.37	12.36
M ₃	2.35	2.35	2.33	2.34	12.30	12.32	12.38	12.33
Mean	2.35	2.35	2.35		12.33	12.31	12.36	
Interaction		SE (d) ±	CD (P = 0.05)			SE (d) ±	CD (P = 0.05)	
(PM × OS)		0.02	NS			0.04	NS	

M₁ - System of Finger millet Intensification (SFMI, 30 DAS) technique; M₂ - Conventional Transplanted Finger millet (CTFM, 30 DAS); M₃ - Late Conventional Transplanted Finger millet (LCTFM, 40 DAS); S₁ - Poultry manure (1.7 t/ha); S₂ - Farm yard manure (10 t/ha); S₃ - Vermicompost (2.5 t/ha) (at 25, 35 and 50 DAS); DAS - Days after transplanting; NS - Non-significant; SEd (±): Standard error of deviation; CD: Critical difference

Table 2.1: System of Rice Intensification and organic sources of nutrient on grain quality parameters of organic rice

Treatment	Qualitative percentage														
	Carbohydrate content in grain (%)			Protein content in grain (%)			Fat content in grain (%)			Ash content in grain (%)			Moisture content in grain (%)		
	2016	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled
Planting methods															
M ₁	77.47	77.48	77.48	7.30	7.33	7.31	1.71	1.77	1.74	1.07	1.08	1.07	12.47	12.36	12.41
M ₂	77.46	77.47	77.47	7.28	7.32	7.30	1.74	1.74	1.74	1.09	1.07	1.08	12.42	12.40	12.41
M ₃	77.45	77.47	77.46	7.26	7.33	7.30	1.77	1.77	1.77	1.06	1.06	1.06	12.47	12.37	12.42
SE (d) ±	0.03	0.04	0.03	0.06	0.03	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.03	0.02	0.02
CD (P = 0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Organic sources of nutrient															
S ₁	77.46	77.47	77.46	7.30	7.36	7.33	1.74	1.76	1.75	1.08	1.07	1.07	12.43	12.37	12.40
S ₂	77.48	77.48	77.48	7.28	7.33	7.30	1.74	1.74	1.74	1.08	1.06	1.07	12.42	12.40	12.41
S ₃	77.45	77.47	77.46	7.26	7.30	7.28	1.73	1.78	1.76	1.06	1.08	1.07	12.50	12.36	12.43
SE (d) ±	0.03	0.03	0.02	0.05	0.04	0.02	0.03	0.03	0.02	0.02	0.02	0.02	0.03	0.02	0.02
CD (P = 0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

M₁ - System of Rice Intensification (SRI) method of transplanting; M₂ - Conventional Transplanted Rice (CTR); M₃ - Direct Seeded Rice (DSR); S₁ - Poultry manure (2.6 t/ha); S₂ - Farm yard manure (16 t/ha); S₃ - Vermicompost (4 t/ha) (at 25, 35 and 50 DAS/DAT); NS - Non-significant; DAS - Days after sowing; DAT - Days after transplanting; SEd (±): Standard error of deviation; CD: Critical difference

Table 2.2: Interaction System of Rice Intensification and organic sources of nutrient on grain quality parameters of organic rice

Planting Methods	Carbohydrate content in grain (%)				Protein content in grain (%)				Fat content in grain (%)			
	Organic sources of nutrient				Organic sources of nutrient				Organic sources of nutrient			
	S ₁	S ₂	S ₃	Mean	S ₁	S ₂	S ₃	Mean	S ₁	S ₂	S ₃	Mean
2016												
M ₁	77.48	77.50	77.44	77.47	7.32	7.30	7.26	7.30	1.70	1.70	1.73	1.71
M ₂	77.45	77.47	77.47	77.46	7.31	7.27	7.26	7.28	1.73	1.80	1.70	1.74
M ₃	77.45	77.47	77.44	77.45	7.25	7.27	7.26	7.26	1.80	1.73	1.77	1.77
Mean	77.46	77.48	77.45		7.30	7.28	7.26		1.74	1.74	1.73	
Interaction		SE (d) ±	CD (P = 0.05)			SE (d) ±	CD (P = 0.05)			SE (d) ±	CD (P = 0.05)	
(PM × OS)		0.05	NS			0.08	NS			0.05	NS	
2017												
M ₁	77.47	77.50	77.47	77.48	7.36	7.33	7.30	7.33	1.77	1.73	1.80	1.77
M ₂	77.44	77.47	77.50	77.47	7.36	7.30	7.30	7.32	1.77	1.73	1.73	1.74
M ₃	77.48	77.48	77.44	77.47	7.35	7.35	7.30	7.33	1.73	1.77	1.80	1.77
Mean	77.47	77.48	77.47		7.36	7.33	7.30		1.76	1.74	1.78	

Interaction		SE (d) ±	CD (P = 0.05)			SE (d) ±	CD (P = 0.05)			SE (d) ±	CD (P = 0.05)	
(PM × OS)		0.06	NS			0.07	NS			0.05	NS	
Pooled												
M ₁	77.48	77.50	77.45	77.48	7.34	7.32	7.28	7.31	1.73	1.72	1.77	1.74
M ₂	77.45	77.47	77.49	77.47	7.34	7.28	7.28	7.30	1.75	1.77	1.72	1.74
M ₃	77.47	77.47	77.44	77.46	7.30	7.31	7.28	7.30	1.77	1.75	1.78	1.77
Mean	77.46	77.48	77.46		7.33	7.30	7.28		1.75	1.74	1.76	
Interaction		SE (d) ±	CD (P = 0.05)			SE (d) ±	CD (P = 0.05)			SE (d) ±	CD (P = 0.05)	
(PM × OS)		0.04	NS			0.04	NS			0.03	NS	

M₁ - System of Rice Intensification (SRI) method of transplanting; M₂ - Conventional Transplanted Rice (CTR); M₃ - Direct Seeded Rice (DSR); S₁ - Poultry manure (2.6 t/ha); S₂ - Farm yard manure (16 t/ha); S₃ - Vermicompost (4 t/ha) (at 25, 35 and 50 DAS/DAT); NS - Non-significant; DAS - Days after sowing; DAT - Days after transplanting; SEd (±): Standard error of deviation; CD: Critical difference

Table 2.3: Interaction System of Rice Intensification and organic sources of nutrient on grain quality parameters of organic rice

Planting Methods	Ash content in grain (%)				Moisture content in grain (%)			
	Organic sources of nutrient				Organic sources of nutrient			
	S ₁	S ₂	S ₃	Mean	S ₁	S ₂	S ₃	Mean
2016								
M ₁	1.10	1.03	1.07	1.07	12.43	12.47	12.50	12.47
M ₂	1.10	1.10	1.07	1.09	12.40	12.37	12.50	12.42
M ₃	1.03	1.10	1.03	1.06	12.47	12.43	12.50	12.47
Mean	1.08	1.08	1.06		12.43	12.42	12.50	
Interaction		SE (d) ±	CD (P = 0.05)			SE (d) ±	CD (P = 0.05)	
(PM × OS)		0.04	NS			0.05	NS	
2017								
M ₁	1.10	1.07	1.07	1.08	12.33	12.40	12.33	12.36
M ₂	1.03	1.10	1.07	1.07	12.40	12.40	12.40	12.40
M ₃	1.07	1.00	1.10	1.06	12.37	12.40	12.33	12.37
Mean	1.07	1.06	1.08		12.37	12.40	12.36	
Interaction		SE (d) ±	CD (P = 0.05)			SE (d) ±	CD (P = 0.05)	
(PM × OS)		0.04	NS			0.04	NS	
Pooled								
M ₁	1.10	1.05	1.07	1.07	12.38	12.43	12.42	12.41
M ₂	1.07	1.10	1.07	1.08	12.40	12.38	12.45	12.41
M ₃	1.05	1.05	1.07	1.06	12.42	12.42	12.42	12.42
Mean	1.07	1.07	1.07		12.40	12.41	12.43	
Interaction		SE (d) ±	CD (P = 0.05)			SE (d) ±	CD (P = 0.05)	
(PM × OS)		0.03	NS			0.03	NS	

M₁ - System of Rice Intensification (SRI) method of transplanting; M₂ - Conventional Transplanted Rice (CTR); M₃ - Direct Seeded Rice (DSR); S₁ - Poultry manure (2.6 t/ha); S₂ - Farm yard manure (16 t/ha); S₃ - Vermicompost (4 t/ha) (at 25, 35 and 50 DAS/DAT); NS - Non-significant; DAS - Days after sowing; DAT - Days after transplanting; SEd (±): Standard error of deviation; CD: Critical difference

Conclusion

The findings of the two year study on the quality parameters of organic cereal grains revealed that planting methods and organic sources of nutrients had no significant effect on grain quality parameters of finger millet and rice during both the years and in pooled analysis. However, comparatively higher values of some quality traits were observed under System of Finger Millet Intensification technique and System of Rice Intensification methods of transplanting. Among organic sources, farmyard manure and poultry manure recorded slightly higher quality parameters, indicating that organic nutrient management can maintain good grain quality under organic production systems.

References

1. Amma MK. Plant and soil analysis. Kottayam: Rubber Research Institute of India, Rubber Board; 1989.
2. Business Wire. Global millet market analysis, growth, trends and forecast 2018-2023. 2018.
3. Chandra D, Chandra S, Pallavi, Sharma AK. Review of finger millet (*Eleusine coracana* (L.) Gaertn): A powerhouse of health-benefiting nutrients. Food Science and Human Wellness. 2016;5:149-155.
4. Debbarma V, Abraham T, Singh V, Lal BR. Agronomic response of system of finger millet intensification technique on growth and yield of organic finger millet (*Eleusine coracana* L.). International Journal of Environment and Climate Change. 2024;14(2):174-188.
5. Deshpande HH, Devasenapathy P. Effect of green manuring and organic manures on yield, quality and economics of rice (*Oryza sativa* L.) under lowland condition. Karnataka Journal of Agricultural Sciences. 2010;23(2):235-238.
6. Gomez KA, Gomez AA. Three or more factor experiment. In: Statistical procedures for agricultural research. 2nd ed. 1976:139-141.
7. Ranganna S. Handbook of analysis and quality control for fruit and vegetable products. New Delhi: Tata McGraw-Hill Publishing Company Limited; 2003:7-12.
8. Reganold JP, Wachter JM. Organic agriculture in the twenty-first century. Nature Plants. 2016;2:1-8.
9. Roy DK, Singh BP. Effect of level and time of nitrogen application with and without vermicompost on yield, yield attributes and quality of malt barley (*Hordeum vulgare*). Indian Journal of Agronomy. 2006;51:40-42.
10. Shan FA, Bhat MA, Ganai MA, Hussain A, Bhat TA. Effect of crop establishment and weed control practices on the performance of rice (*Oryza sativa* L.). Applied Biological Research. 2012;14(1):79-85.
11. Sood S, Kumar A, Babu BK, Gaur VS, Pandey D, Kant L,

- Pattnayak A. Gene discovery and advances in finger millet (*Eleusine coracana* (L.) Gaertn.) genomics: An important nutri-cereal of future. *Frontiers in Plant Science*. 2016;7:1-17.
12. Uphoff N. Opportunities for raising yields by changing management practices: The system of rice intensification in Madagascar. In: Uphoff N, editor. *Agroecological innovations: Increasing food production with participatory development*. London: Earthscan; 2002:145-161.
 13. Worthington V. Nutritional quality of organic versus conventional fruits, vegetables and grains. *Journal of Alternative and Complementary Medicine*. 2001;7(2):161-173.