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Effect on integrated nutrient management on finger millet (*Eleusine coracana* (L.) Gaertn.): A review

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Abstract
Millets, one of the ancient foods known to mankind, are often referred to as the crops of the future due to its adaptability to harsh soil and climatic conditions and ability to support sustainable diets. Among millets, finger millet, recognised as *Ragi* ranks fourth in importance. In spite of multi-farious benefits, millets are cultivated as rainfed crops in marginal lands with few or no external inputs. Therefore, nutrient management assumes paramount importance in boosting the productivity of the crop. Integrated Nutrient Management (INM) and organic nutrition are two means for achieving these goals of sustainability. It was found that INM had significant effect on finger millet in terms of growth and growth attributes, yield attributes and yield, nutritional quality of the grains, nutrient uptake, nitrogen ue efficiency indices, soil nutrient status and economics. Several studies have also brought out the positive effects of adopting organic nutrition in finger millet.

Keywords: integrated nutrient management (INM), finger millet, yield, growth, nutritional quality, economics

Introduction
Millets have been recognized as super cereals by virtue of their climate resilience and superior nutritional profile. Finger millet (*Eleusine coracana* (L.) Gaertn.), the domesticated coarse cereal of African origin, forms staple food for the people in the drier parts of India, Africa and some of the other Asian countries. Being a minor millet, finger millet cultivation is traditionally rainfed and confined to marginal soils, resulting large yield gaps. Optimization of nutrient management with emphasis on organics will help in attaining and sustaining higher yields. The present study was undertaken to assess the effect of integrated nutrient management on the growth, yield, nutritional quality and profitability of finger millet. The research work done in this area is reviewed in this chapter. The work done on related cereals and millets were also considered to get a comprehensive view on the topic.

Finger millet as a super cereal
Adaptation and Resilience of Finger Millet
Finger millet (*Eleusine coracana* (L.) Gaertn.) is the staple food for people in the dry areas and is cultivated by farmers on marginal lands with limited resources. Since the crop is primarily cultivated and consumed by the small to marginal households, it is often referred to as 'poor man's crop' or as 'famine food'. Of the total millet area in the world, 12 per cent is finger millet, spread over more than 25 countries in Africa and Asia, accounting for 10 per cent of the total millet production (Dida *et al*., 2008; Kumar *et al*., 2016a) [18, 34]. It is estimated that, in India, the crop covered an area of 1.27 million hectares with a total production and productivity of 1.93 million tonnes and 1.60 tonnes per hectare respectively (DES, 2017) [14].
The crop has extraordinary potential to adapt itself to multiple stresses encountered in rainfed to dry areas. Finger millet is a principal tropical millet with adaptations to survive drought and nutrient deficiencies in the dry and semi-dry regions of India (Mandal and Swamy, 2005) [41].
Mgonja *et al.* (2007) [43] highlighted the status of finger millet as a famine crop by virtue of its capability to assure year-round food supply due to its long shelf life and storage-pest resistance of grains, which extended to more than 10 years.
Gupta *et al*. (2014) [26] reported reduced leaf area, high water use efficiency and high CO_2 fixation rate in finger millet, making it a crop suitable for semi-arid climates. Finger millet was also observed to utilize nitrogen efficiently.

The drought tolerating capacity of finger millet was accredited to its proficient antioxidant properties and augmented signal discernment (Chandra *et al*., 2016) [10]. Finger millet is conferred with adaptation to different agro-climatic conditions, ability to thrive on marginal soils, tolerance to major pests, diseases and drought and weed suppression capacity (Prakasha *et al*., 2018) [53]. Finger millet, being a C_4 crop, helped in sequestering carbon, resulting in CO_2 abatement (Brahmachari *et al*., 2018) [8].

Nutritional and Nutraceutical Importance of Finger Millet
The endosperm of finger millet acts as sinks of carbon and nitrogen compounds and this in turn increases the protein content (Balconi *et al*., 1997) [6]. The occurence of essential amino acids such a tryptophan and methionine marked the superiority of finger millet over the soft cereals like rice and wheat (Fernandez *et al*., 2003) [21]. That the slow digestibility property of finger millet in diets was able to provide energy throughout the day. They also noted the diaphoretic, diuretic and vermifuge properties of finger millet (Dida and Devos, 2006) [17]. Finger millet is free of gluten and this makes it valuable to people ailing from celiac diseases (Pagano, 2006) [47]. Further, the risk of gastrointestinal tract inflictions and diabetes could be efficiently curbed by including finger millet in routine diets. Chethan and Malleshi (2007) [11] observed that the level of antioxidant in whole meal of finger millet was around 2.0 to 2.6 gallic acid equivalents (gae). The high polyphenol content in the seed coat of finger millet confers it with anti-cancer, anti-diabetic and anti-oxidant activities. Devi *et al*. (2011) [16] reported that among different millets, finger millet had the highest calcium content (0.38%), dietary fibre (18%) and phenolic components (0.3-3%). Finger millet is a rich protein source and the nutraceutical property of protein in finger millet is that it maintains homeostasis (Mathangi and Sudha, 2012) [42]. Finger millet has been reported to contain certain anti-nutritional factors, *viz*., tannins, non-starch polysaccharides (betaglucans), protease inhibitors, oxalates and phytates, which could affect the nutrient digestibility (Kumar *et al*., 2016b) [36]. However, the anti-nutrients have been identified to possess commendable therapeutic value. The anti-nutrients like polyphenols, tannins, flavonoids, etc. have therapeutic role in managing diabetes, cardiovascular conditions, cataract, inflammation, gastrointestinal disorders and cancer (Sarita and Singh, 2016) [61].

Unlike many other crop-borne proteins, the finger millet protein has not registered any allergic reactions (Pandian *et al*., 2017) [50]. Finger millet contains five to eight per cent protein (Devi and Sinthiya, 2018) [15]. Giridhar (2019) [23] reported that finger millet contained proteins (5-8%), ether (1-2%), carbohydrates (65-75%), 2.5 to 3.5 per cent minerals and 15 to 20 per cent dietary fibres. Phytochemicals present in finger millet act as antioxidants and helps to maintain physiological balance and protect against oxidative damage (Prajapati *et al*., 2019) [52]. The comparison made between the nutritional profile of rice and finger millet revealed the pre-eminence of the latter in terms of the contents of total, soluble and insoluble dietary fibre, flavonoids and phenolics (Lansankara *et al*., 2020) [37]. Ramesh *et al*. (2020a) [57] observed that compared to other crops, the fat content in finger millet was relatively low and it was a rich source of essential amino acids. On the whole, finger millet is a crop which has the capacity to address the global concerns about rising temperature, poor soils, reduction in agricultural productivity, food insecurity and malnutrition.

Effect of integrated nutrient management on finger millet
Integrated nutrient management (INM) is a system approach in which all the possible nutrient resources, both on-site and off-site are mobilized, integrated and managed, giving due importance to all. The poor availability, imbalanced and inconsistent nutrient content and high cost of transport pose problems in promoting organic nutrition. Thus, the conjunctive use of chemical fertilizers and organics in soil fertility management is considered as the alternative to come out of the 'vicious spiral' of agrochemical menace (Palaniappan and Annadurai, 1999) [48].

Growth and Growth Attributes
Studies conducted in the sandy soils of Bapatla by Babu (2006) revealed that finger millet responded significantly to application of recommended dose of NPK as fertilizers in conjunction with farm yard manure (FYM) at the rate of 3 t ha^{-1} with respect to plant height, number of tillers and dry matter production. Finger millet supplied with 100 per cent recommended dose of fertilizers (RDF) at the rate of 50: 40: 25 kg NPK ha^{-1} combined with FYM (7.5 t ha^{-1}) resulted in higher total dry matter production, in the red sandy loam soils of Bengaluru (Govindappa *et al*., 2009) [25]. Saunshi (2012) [63] reported that FYM at the rate of 10 t ha^{-1} supplemented with bio-digested liquid manure augmenting with rock phosphate and poultry manure equivalent to 60 kg N ha^{-1} resulted in taller plants (141.1 cm), higher leaf area (1886.3 cm^2 per plant), leaf area index (6.29) and total dry matter accumulation (43.08 g per plant). Dass *et al.* (2013) [13] observed that growth attributes of finger millet was significantly better when 50 per cent RDF was subsituted with FYM, during two out of three study years in eastern India. A field experiment carried out at Dapoli showed that addition of 150 per cent FYM and RDF resulted in taller plants with more number of tillers, functional leaves and dry matter accumulation per hill in finger millet (Nevse *et al*., 2013) [46].

In a study undertaken by Thimmaiah *et al*. (2016) [68] at Shivamogga in rainfed finger millet, it was observed that among the nutrient management practices tested, application of recommended dose of NPK in conjunction with FYM (7.5 t ha^{-1}) and plant growth promoting rhizobacteria (PGPR) at the rate of 2 kg ha^{-1} followed by top dressing with vermicompost and composted coconut fronds each at 3.75 t ha^{-1} at 25 days after transplanting resulted in superior plant height (145.27 cm), greater leaf area (1177.30 cm^3 per plant), tiller count (4.07 per plant) and total dry matter production (59.13g per plant). Raman and Krishnamoorthy (2016) [55] reported that finger millet responded positively to the substitution of 50 per cent of recommended dose of N with vermicompost + recommended doses of P and K in conjunction with biofertilizer (*Azospirillum* + Phosphobacteria), with respect to plant height, leaf area index and dry matter production. Gani *et al*. (2016) [22] reported significantly superior plant height, leaf area index and relative growth rate with RDF and poultry manure at 5 t ha^{-1}. Application of FYM in adequate quantity (7.5 to 10 t ha^{-1}) was observed to enhance the root growth and development of finger millet (Prabhakar *et al*., 2017) [51]. Mahapatra (2017) [39] compared the effect of different organic sources and chemical fertilizers in finger millet. He concluded that 100 per cent recommended dose of nutrients as inorganic fertilizers resulted in maximum plant height, tiller production, leaf area and dry matter and at all stages of observation.

Hundred per cent recommended dose of nutrients supplemented with organic manures resulted in significantly taller plants (81.11 cm), leaf area index (2.61), tillers per hill

(4.96) and SPAD (27.93) in finger millet (Goudar *et al*., 2017) [24], They attributed this to the better nutrient availability and improvement in the soil properties. Hebbal *et al*. (2018) [29] highlighted the importance of INM through their observation on significantly superior plant height (68.7 cm), tiller count (10.8), leaf area (1934 cm^2) and dry matter production (39.74 g per hill) with FYM (7.5 t ha^{-1}) + recommended dose of fertilizers (50:40:37.5 kg NPK ha^{-1}) as compared to lower values with application of FYM alone on N equivalent basis. Ullasa *et al*. (2020) [71] recorded significantly taller plants (83.4 cm) with more number of leaves (52.8) and leaf area index (5.16) at 90 days after transplanting and dry matter production at harvest (35.8 g per hill) with recommended dose of FYM in conjunction with vermicompost (4 t ha^{-1}) on nitrogen equivalent basis. Finger millet recorded taller plants at grand growth stage and maturity, with application of 25 per cent nitrogen as vermicompost + *Azosprillum* + 50 per cent nitrogen as inorganic fertilizer, at Anand (Gujarat) during the *kharif* season (Himanshi and Shroff, 2020) [31].

Yield Attributes and Yield

Integrating organic nutrient sources with inorganics was observed to enhance the productive tiller count and finger length of finger millet in the clay loam soils of Coimbatore (Jagathjothi *et al*., 2008) [32]. Adesemoye *et al.* (2008) [1] reported that plant growth promoting rhizobacteria (PGPR) promoted plant growth, yield and nitrogen content in grain. The field experiment undertaken by Govindappa *et al*. (2009) [25] red sandy loam soils of Bengaluru, registered superior grain and straw yields for rainfed finger millet when nutrients were applied totally as inorganic in conjunction with recommended dose of FYM (7.5 t ha^{-1}). Yield parameters of finger millet were observed to improve significantly in response to application of 75 per cent RDF along with FYM (5 t ha^{-1}) and biofertilizers (Ahiwale *et al*., 2011) [2]. Sankar *et al*. (2011) [60] observed that FYM at (10 t ha^{-1}) in conjunction with 50 per cent recommended dose of NPK as chemical fertilizers resulted in significantly higher yield than that with 100 per cent recommended NPK in finger millet. Substitution of 50 per cent RDF with vermicompost increased the yield of finger millet in contrast to application of nutrients as inorganic alone (Chander *et al.*, 2013) [9]. Integrated application of 100 per cent recommended dose of NPK integrated with FYM increased the grain yield (3125 kg ha^{-1}) and straw yield (5123 kg ha^{-1}) of finger millet and this was attributed to enhanced sink capacity and efficient utilization of nutrients (Arulmozhiselvan *et al*., 2015) [4]. Tsado *et al*. (2016) [69] did not observe significant effect for INM on finger millet. Their study recorded longest fingers (15.3 cm), higher number of fingers (12), seeds per ear (4855) and grain yield (4530.7 kg ha^{-1}) application of 100 per cent recommended dose of nutrients as inorganic fertilizers. Application of recommended dose of NPK and FYM (7.5 t ha^{-1}) + PGPR (2 kg ha^{-1}) followed by top dressing with vermicompost (3.75 t ha^{-1}) + coconut frond compost (3.75 t ha^{-1}) at 25 DAT recorded higher yield in terms of grain and straw, the grain yield being 118.9 per cent and 87 per cent greater than the local farmers' practice and recommended dose of NPK alone, respectively (Thimmaiah *et al*., 2016) [68].

Integration of organic and inorganic nutrient sources enhanced plant metabolism and growth, and consequently recorded higher grain yield. Mineralisation of organic sources of nutrients favoured better nutrient absorption through improved shoot and root (Pallavi *et al.*, 2016) [49]. Ullasa *et al.* (2017) [70] investigated the influence of organic nutrition in finger millet. They observed that the effect of application of 100 per cent recommended dose of NPK as vermicompost based on nitrogen equivalence + FYM (7.5 t ha^{-1}) and FYM alone at the rate of 7.5 t ha^{-1} was significantly high and comparable with respect to the number of productive tillers and fingers per head, finger length and grain yield per plant. In a field experiment conducted during the *kharif* season at Shivamogga, Naik *et al*. (2017) [44] reported the benefit of applying FYM (10 t ha^{-1}) along with biodigestor liquid manure equivalent in two splits at 70 kg N ha^{-1} in significantly increasing the panicle weight (12.22g), thousand grain weight (13.87g), grain yield (1.84 t ha^{-1}), straw yield (3.49 t ha^{-1}) and harvest index (0.46). The study conducted by Hatti *et al*. (2018) [28] recorded significantly higher grain yield (3.03 t ha^{-1}) and straw yield (4.69 t ha^{-1}) with 100 per cent recommended dose of NPK integrated with FYM at the rate of 7.5 t ha^{-1}. Roy *et al.* (2018a) [59] reported significant increase in grain and straw yield of finger millet with different doses of inorganic fertilizers along with FYM and biofertilizers. Grain yield (3.77 t ha^{-1}) and straw yield (6.98 t ha^{-1}) were significantly greater with FYM (10 t ha^{-1}) + 75 per cent recommended dose of fertilizers + biofertilizers (*Azospirillum brasilense* + *Bacillus* spp. + *Psuedomonas fluorescens* @ 20 g kg^{-1} seed each) + $ZnSO_4$ (12.5 kg ha^{-1}) + borax (5 kg ha^{-1}). Maitra *et al.* (2020) [40] also observed increased growth and productivity of finger millet in response to application of 100 per cent of RDF as organic or application of organics in combination with inorganic nutrient sources. Application of FYM (7.5 t ha^{-1}) and substituting the recommended dose of nutrients with vermicompost on N equivalent basis resulted in significantly higher number of productive tillers, finger per ear head, finger length and higher yield (Ullasa *et al.*, 2020) [71]. Aravind *et al*. (2020) [3] studied the impact of organic supplements on the productivity of finger millet. They opined that the substantial yield increase in response to organics was due to better availability of nutrients to crops through mineralization and solubilisation effects of organic manures.

Nutritional Quality

In an experiment conducted at New Delhi, Bana *et al.* (2016) noted that application of leaf compost (10 t ha^{-1}) resulted in higher iron, zinc and protein content in grains of pearl millet, followed by FYM (10 t ha^{-1}), leaf compost mixed cow dung compost (10 t ha^{-1}) and 100 per cent recommended dose of fertilizers, respectively. Seventy-five per cent recommended dose of nitrogen in combination with 25 per cent N as poultry manure resulted in higher content of nitrogen (1.31%), phosphorus (0.264%) and potassium (0.47%) in finger millet (Pallavi *et al.*, 2016) [49]. Rani *et al*. (2017) [58] carried out a field study on the influence of nutrient management on the production and nutritional quality of finger millet in the sandy loam soils of Vizianagaram. Integration of inorganic nutrients and organics recorded higher contents of protein, zinc and iron in the grains of finger millet. Krishnaprabu (2019) [33] assessed the response of pearl millet to INM. He observed that the nutrient content, protein content and protein yield of pearl millet were significantly superior with 75 per cent of recommended dose of fertilizers in association with biofertilizers (5 kg ha^{-1}) incubated with vermicompost (500 kg ha^{-1}).

Effect of INM on nutrient uptake

Pallavi *et al*. (2016) [49] undertook an experiment on the response of rainfed finger millet to INM and reported significantly higher nitrogen uptake with 100 per cent RDF, followed by 75 per cent recommended dose of nitrogen as inorganics + 25 per cent nitrogen as poultry manure and 75 per cent recommended dose of nitrogen + 25 per cent nitrogen as vermicompost. Uptake of phosphorus and potassium was highest with by 75 per cent recommended dose of nitrogen as inorganics + 25 per cent N as poultry manure followed by 100 per cent RDF. While total uptake of N and P were observed to be significantly higher in finger millet supplied with 75 per cent recommended dose of fertilizers + FYM (10 t ha^{-1}) + biofertilizer + $ZnSO_4$ (12.5 kg ha^{-1}) + borax (5kg ha^{-1}), K uptake was higher with 100 per cent recommended dose of fertilizers + FYM (10 t ha^{-1}) + biofertilizer + ZnSO4 (12.5 kg ha^{-1}) + borax (5kg ha^{-1}) (Roy *et al*., 2018) [59] The field study conducted by Harika *et al*. (2019) [27] on the effect of INM on nutrient uptake of finger millet, revealed highest values for uptake of major nutrients with 100 per cent recommended dose of fertilizers. Total NPK uptake of finger millet was reported to respond significantly to the application of 125 kg neem cake + vermicompost (1.25 tons ha^{-1}) + NPK (50: 50: 50 kg NPK ha^{-1}) + borax (2%) spray at flowering (Kumar, 2020) [35]. Results of the study undertaken by Prashanth *et al*. (2020) [54] in the eastern dry cracks of Karnataka, showed that continuous application of 100 per cent recommended dose of NPK as FYM enhanced the nutrient content and uptake by the grains, straw, roots and stubbles of finger millet. Nutrient uptake of pearl millet was reported to increase significantly with integrated nutrient management. The treatment comprising 100 per cent recommended dose of fertilizers in combination with pressmud (2.5 t ha^{-1}) resulted in higher NPK uptake (Nalini *et al*., 2020) [45]. Shilpa *et al*. (2021) [64] assessed the effect of INM on long-term basis in finger millet and reported that the crop recorded significantly higher uptake of nitrogen (63.43 kg ha^{-1}), phosphorus (11.35 kg ha^{-1}) and potassium (78.85 kg ha^{-1}) in response to application of 100 per cent recommended dose of fertilizers + FYM (10 t ha^{-1}). They concluded that INM, not only supported crops with essential nutrients in accordance with their nutrient requirement, but, it also created congenial soil physico-chemical properties required for a healthy soil.

Effect of INM on nitrogen use efficiency

Nitrogen use efficiency is a complex trait which measures how efficiently a crop can utilize and retain applied N. World over, all conventional agricultural systems have low nitrogen use efficiency, indicative of a non-synchrony between the crop demand and supply of N. Liang *et al*. (2013) [38] unrevealed the manner in which organic manures helped to synchronise N supply according to the crop demand. Application of chemical N in conjunction with organic manures resulted in N immobilization during early crop growth stages followed by release of mineral N from the microbial N pool during the grand growth stage of the crop. Integrated nutrient management has been identified as a potential approach for improving fertilizer use efficiency, especially with respect to nitrogen sources (Das *et al*., 2015) [12]. Nitrogen use efficiency could be enhanced by the application of N fertilizers in combination with organic manures. The slow-release behavior of organic manures also led to considerable residual effect on the succeeding crops (Sarkar, 2015) [62]. Biofertilizers, like PGPR comprising efficient microbial strains have been reported to supplement fertilizer N requirement of crops and enhance nitrogen use efficiency (Singh, 2015) [65]. Enhancing the nitrogen use efficiency of crops, usually less than 40 per cent, is a major challenge in soil fertility and nutrient management. One of the promising options feasible for increasing nitrogen use efficiency is INM. Integrated use of N fertilizers and organic manures helped in maintaining continuous supply of N, reduced losses and thus resulted in more effective utilization of the applied N. Organic nutrient sources operate like slow-release fertilizers, synchronizing temporal and spatial nutrient requirement of the crops, both from the labile soil pool and applied sources (Dwivedi *et al*., 2016) [16]. Zhang *et al*. (2016) [72] reported the importance of combining organic manures and fertilizers in a rational manner for enhancing nitrogen use efficiency. They observed that nitrogen use efficiency decreased with accumulation of soil residual nitrate, when excessive N was combined with organics. Ramesh *et al*. (2020b) [56] could not observe enhancement in nitrogen use efficiency in foxtail millet with INM. On the contrary they recorded higher agronomic nitrogen use efficiency with 125 per cent recommended dose of N.

Effect of INM on soil nutrient status

Govindappa *et al*. (2009) [25] reported increase in soil N balance with increase in application of organics and inorganics. Residual P and K were significantly higher with 100 per cent recommended dose of fertilizers + FYM (7.5 t ha^{-1}). Sankar *et al*. (2011) [60] observed higher NPK status in soil following finger millet cultivation which received 100 per cent recommended dose of NPK in conjunction with FYM (10 t ha^{-1}) when compared to chemical fertilizers alone. Long term application of FYM as component of INM for finger millet was observed to increase the carbon stock of the soil after the crop (Srinivasarao *et al*., 2012) [67]. Application of 100 per cent NPK along with FYM enhanced the cation exchange capacity, soil organic carbon, and availability of N, P and K status of the soil compared to chemical fertilizers alone in finger millet – maize sequence (Hemalatha and Chellamuthu, 2013) [30]. As part of the study was conducted by Roy *et al*. (2018) [59] to assess the performance of finger millet under INM, it was observed that the available N and P status of the soil increased significantly with the application of FYM (10 t ha^{-1}) + biofertilizer + $ZnSO_4$ (12.5 kg ha^{-1}) + borax (5kg ha^{-1}) + 100 per cent recommended dose of fertilizers, while available K remained non-significant. Prashanth *et al*. (2020) [54] reported that continuous adoption of INM involving 100 per cent recommended dose of NPK as chemical fertilizers in association with FYM increased the availability of macronutrients in soil. Significantly higher soil organic carbon content was registered with recommended dose of FYM (7.5 t ha^{-1}) + 100 per cent recommended dose of N as FYM on N equivalent basis compared to that with FYM in combination with 75 per cent recommended N as vermicompost, in finger millet (Ullasa *et al.*, 2020) [71].

Effect of INM and organic nutrition on economics of cultivation

Substituting 50 per cent of the recommended dose of fertilizers with organic sources on N equivalent basis resulted in the highest net returns and BCR (2.39) in finger millet (Dass *et al.*, 2013) [13]. The study carried out by Thimmaiah *et al*. (2016) [68] on the effect of INM on finger millet revealed that gross returns, net returns and benefit cost ratio (BCR) varied significantly with diverse sources of nutrients like inorganic fertilizers, organic manures and biofertilizers. Hundred per cent recommended NPK + FYM (7.5 t ha^{-1}) + PGPR (2 kg ha^{-1}) + top dressing with vermicompost (3.75 t ha^{-1}) and frond compost (3.75 t ha^{-1}) at 25 DAT recorded higher gross returns. While, the same treatment avoiding vermicompost recorded the highest net returns, BCR was observed to be higher when top dressing with organics was avoided. The unit cost of production increased progressively with integration of organics and it ranged from ₹4.60 to ₹10.29 per kg grains. Naik *et al*. (2017) [44] probed into the possibilities of organic cultivation of finger millet and observed that among the organic nutrition options tested, application of FYM (10 t ha^{-1}) + biodigested liquid manure in two splits at 75 kg N ha^{-1} registered better economics in terms of gross returns, net returns and benefit cost ratio. This study highlighted the importance of effective utilization of on-farm resources for realizing higher returns from organic nutrition. Harika *et al*. (2019) [27] recorded highest gross returns from finger millet with the application of 75 per cent RDF along with FYM (2 t ha^{-1}) and *Azospirillum*. Net returns and BCR were highest when 100 per cent recommended dose of nutrients was supplied as chemical fertilizers. Integrated application of chemical fertilizers and organic manures along with biofertilizer (*Azospirillum*). Highest net returns was realized with 50 recommended dose of N as fertilizers + 25 per cent N as vermicompost + *Azospirillum*. However, BCR was highest when the entire dose of N was applied as chemical fertilizers (Himanshi and Shroff, 2020) [31]. Singh (2020) [66] observed that the yield of crops raised as organic was on an average 6.79 per cent lower than conventional farming. He also suggested the need for premium price for organic produce for profitability. Organic produce is generally more costly than conventional produce mainly because of its limited supply and higher production cost on account of higher cost of organic inputs and labour per unit of output (FAO, 2021) [20].

The review made on the impact of INM on growth, yield, nutritional quality and economics of finger millet and other minor millets revealed the advantage accrued as a result of integrating chemical fertilizers, organic sources and biofertilizers. A judicious and rational blending of nutrient sources is imperative to harvest the benefits of INM. Several studies have brought out the positive effects of adopting organic nutrition in finger millet. However, organic nutrition was observed to become cost effective only with proper utilization of on-farm nutrient sources and premium price for the produce.

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