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ENHANCING NUTRITIONAL QUALITY THROUGH LOW BUDGET NATURALWAY FARMING (*VRIKSHAYURVEDIC FARMING*) PRACTICES IN LITTLE MILLET-BLACK GRAM SEQUENTIAL CROPPING SYSTEM

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ABSTRACT

A Field experiment was conducted during 2021 -2022 at the Agricultural college and Research Institute, Madurai, India, to assess the impact of Low Budget Natural way Farming Practices on nutritional quality of grains in little millet – Black gram cropping system in comparison with conventional scientific practice. The experiment was laid out in split plot design with three replications. Viz., Four Main plot treatment as Biomass Transfer Technique (BMT) prior to sowing on N equivalent basis and five sub plot treatments with Tree Leaf Extract (TLE) as foliar spray and it was compared with conventional practice. The results revealed that in Little millet, the highest levels of calcium (16.73 mg $100g^{-1}$), Iron (4.93 mg $100g^{-1}$), Carbohydrate (65.85 mg $100g^{-1}$), Crude fibre (7.51 mg $100g^{-1}$), Crude fat (4.48 mg $100g^{-1}$) and Crude protein (7.43 mg $100g^{-1}$) were recorded in treatment M_4S_4 when *Delonix regia* @ 1.45 t ha^{-1} was applied as Green leaf manure on dry weight basis and *Aegle marmellos* @ 5% as foliar spray on 15, 30, 45 and 60 DAS. This was on par with M_3S_3 (*Gliricidia sepium* @ 1.50 t ha^{-1} + *Moringa olifera* @ 5%). Similarly in black gram, all grain quality parameters such as (calcium-132.63 mg $100g^{-1}$; Iron-7.32mg$100g^{-1}$; carbohydrate -58.56 mg $100g^{-1}$; Crude protein- 21.24 mg $100g^{-1}$, Crude fibre - 5.5 mg $100g^{-1}$ and Crude fat - 1.6 mg $100g^{-1}$) were superior in treatment M_3S_3 where *Gliricidia sepium* @ 1.50 t ha^{-1} applied as green leaf manure and *Moringa oleifera* @ 5% spray @ 15, 30 and 45 DAS. It is inferred that practicing Low Budget Naturalway Farming resulted in better nutritional quality equivalent or higher as that of conventional practice.

Key words: *Aegle marmellos*; *Delonix regia*; *Gliricidia sepium*; *Moringa oleifera*; Nutitional quality

Introduction

The Green Revolution marked a pivotal shift in India's agricultural landscape, transforming the nation from a food-importing to a food-exporting country through the adoption of synthetic fertilizers and high-yielding varieties (HYVs). However, this shift also ushered in increasing un-sustainability in crop production systems. Today, India now recognized as the world's most populous nation, the concern of food as well as nutritional security are more pressing than ever. So, it is a bit skeptical whether rice and wheat will be able to fulfil the hunger of billions of people. This is where the significance of millets becomes apparent. Millet cultivation has seen a significant decline about 20 to 40 percent since, green revolution primarily due to the introduction of HYVs of Rice and Wheat. The main reason of millet's unpopularity is the lack of technical understanding among farmers and processors, coupled with cultural challenges related to the adoption of new practices. Historically, millets were a staple in the Tribal regions of India, but, awareness of their nutritional benefits was limited (Shanthakumar *et al.*, 2010).

Millets are highly suitable to organic production system due to their low input requirement. Organic

Table 1: Nutrient content and approximate weight of Green leaf manures as N equivalent (dry weight basis).

Legume trees species	N (%)	P (%)	K (%)	Estimated weight of GLM based on moisture content	
				Fresh weight (t ha^{-1})	Dry weight (t ha^{-1})
Leucaena leucocephala (Lam.) de wit	3.60	0.26	1.38	3.95	1.70
Pongamia pinnata (L.) Pierre	3.31	0.41	2.23	2.50	2.00
Gliricidia sepium (Jacq.) Walp.	3.00	0.24	2.90	4.00	1.50
Delonix regia (Hook.) Raf.	3.10	0.48	0.56	3.65	1.45

farming and millet cultivation have been integral to Indian agriculture for millennia. It is exemplified by *vrikshayurveda*, best known alternative to the conventional method. This traditional Indian system of farming emphasizes the use of leguminous tree leaves for soil nutrition and various tree leaves extracts that act as growth stimulants, pest and disease control agents, and growth tonics (Swaminathan & Nandakumar, 2017). It is also referred as Low Budget Natural-way Farming (Swaminathan *et al.*, 2021) aligns with the principles of organic agriculture and has the potential to mitigate the adverse effects of chemical based farming

Nevertheless, *Vrikshauyrveda* is a documented material yet, it requires scientific validation to develop reliable recommendations for farmers. This approach aims to reduce dependence on external inputs, lower cultivation costs and promote sustainable and eco-friendly agriculture. The prologue of cereal crops habituated eating more cereal-based foods leading to the intake of excess carbohydrates that increased the risk of diabetes prompting an interest in traditional nutri-cereal crops like millets. (Maitra and Shankar, 2019).

Among the nutri-millets, little millet is one of the main short-duration; hardy native crops primarily grown under rainfed condition. In India, little millet is grown to an extent of 2.6 lakh ha with a production potential of 1.2 lakh tonnes, and in the state of Tamil Nadu, it is cultivated in 15411 ha and produces 21079 tonnes of grains (Government of Tamil Nadu, 2020). Little millet, a hardy crop with short life cycle, is purely grown in the rainfed condition (Vetriventhan *et al.*, 2020) with a production capacity of 1600 kg ha^{-1} but farmers obtain only 750 kg ha^{-1} due to the erratic monsoon rains and lack of adoption of improved soil and crop production technologies (Zerihun Tadele, 2016). Furthermore, integrating pulse crop in cropping system offers additional benefits (Mwila *et al.*, 2021). Black gram, nitrogen fixing pulse crop, is particularly promising for soil sustainability; besides this, it adds a substantial quantity of organic matter, thereby contributing to organic carbon build-up, making it a valuable addition to cropping systems. Based on need of its sustainability, this study highlights the potential to improve quality food grains.

Materials and Methods

Field Experiment was conducted at Agricultural college and Research Institute, Tamil Nadu Agricultural University, Madurai, during 2021-2022. Geographically, field was located at 9^0 54' N latitude, 78^0 5' E longitude and at an altitude of 147 m above sea level. The field with sandy clay loam soil was kept fallow for previous two seasons chose for this study. This experiment was laid out in split plot design with four main plots of BMT (Biomass Transfer Technique) as N equivalent basis of little millet (44:22:0 NPK kg ha^{-1}) applied on a dry weight basis (Table 1). Treatments *viz.*, (M_1 – *Leucaena leucocephala* @ 1.70 t ha^{-1} ; M_2 – *Pongamia glabra* 2.00 t ha^{-1}; M_3- *Gliricidia sepium* @ 1.50 t ha^{-1}; M_4 – *Delonix regia* @ 1.45 t ha^{-1} and Five sub plots of (LTS) Tree leaf extracts as Foliar spray @ 5% *Viz*., S_1- *Morinda tinctoria*; S_2 – *Mangifera indica*; S_3 – *Moringa oleifera*; S_4 – *Aegle marmellos*; S_5 – *Dalbergia sissoo* to a total of twenty treatment combinations with three replications. It was compared with conventional scientific practice with application of Recommended Dose of fertilizer (44:22:0 NPK kg ha^{-1}) for little millet and 25:50:25 NPK kg ha^{-1}. Little millet (CO 4) and blackgram VBN 8 variety was used for sowing. For LBNF practice Prior to sowing, Green leaves from above leguminous tree species were incorporated to the field as N equivalent basis of the crop and left to decompose for 45 days and Sowing was carried out at same day in all the treatments.

The leaf extracts were prepared separately by grinding fresh leaves with distilled water in a 1:1 proportion and kept for 6 hours and filtering it. Before sowing, seeds were fortified with 5 % leaf extract solution for 6 hours, shade dried and sown. Foliar nutrition of 5 % extract was applied at 15, 30 and 45 days after sowing as per treatments. The proximate chemical analyses of calcium, iron, carbohydrate, crude protein, and crude fibre, were done as per procedure after harvest and the data were analysed and subjected to ANOVA (Analysis of Variance) with 5% probability level (Gomez and Gomez, 1984).

Procedure for Proximate chemical analysis

Crude protein

Protein was analysed by the amount of nitrogen available in the grain sample by micro kjeldahl method and the nitrogen value multiplied by factor 6.25 gives the crude protein content of the sample in per cent (Ma and Zuazaga, 1942).

$$\text{Protein}(\%) = \text{Nitrogen}(\%) \times \text{conversion factor}(6.25)$$

$$\text{N}(\%) = \frac{\text{Sample titre value - blank titre value} \times \text{equivalent of nitrogen (14.01)} \times \text{N of HCL (0.1)}}{\text{Weight of the sample} \times 1000} \times 100$$

Crude fat

The fat content of the sample was estimated by the method described by Cohen (1917) and expressed in percentage.

$$\text{Fat}(\%) = \frac{(W3 - W2)}{W1} \times 100$$

W_1 = Weight of sample used

W_2 = Weight of flask

W_3 = Weight of flask with fat residue

Crude fibre

The crude fibre content was determined by the method described by Maynard (1970) and the loss in weight on ignition was expressed as percentage.

$$\text{Crude fibre}(\%) = \frac{(W3 - W2)}{W1} \times 100$$

W_1 = Weight of sample used

W_2 = Weight of crucible + sample

W_3 = Weight of sample crucible + ash

Carbohydrate content

Carbohydrate is first hydrolysed into simple sugars using dilute hydrochloric acid. In hot acidic medium glucose is dehydrated to hydroxyl methyl furfural. This compound forms with anthrone a green coloured product with absorption maximum at 630 nm. A standard graph was drawn by taking the concentration of glucose on X axis and spectrophotometer reading on Y axis. From the graph the concentration of glucose in the sample was calculated.

Calcium

Calcium gets complexed by EDTA followed by magnesium. In this experiment Ca is estimated first by using an indicator murexide at pH 12 in the presence of sodium hydroxide and titrated against 0.02 N EDTA till red colour changes from pinkish red to purple or violet. The percentage of calcium in the sample was calculated by the following formula and expressed as mg100 g^{-1} of the sample.

$$= 0.0004 \times \text{TV for Ca alone} \times \frac{T}{S} \times \frac{100}{\textit{Sample weight}}$$

Iron

The element Fe was estimated with the help of Atomic Absorption Spectrophotometer (ICE 3000 series) equipped with Solar AAS software (Ver. 3.15). The concentration of the iron (ppm) in the solution was measured by comparison with absorbance measurements on standards of known composition using iron sulphate. (Lindsay and Norvell, 1978).

Results and Discussions

Effect of LBNF practices on nutritional quality of calcium, Iron and Carbohydrate content

The increasing consciousness about health hazards due to chemical fertilizers consumers are looking forward towards chemical free food grains. For that inclusion of organics with green manures and green leaf manures is a promising tool for sufficient production of quality food grains for escalating population and better sustainability of agriculture in long run. The adoption of Low-Budget Natural Farming (LBNF) practices has a significant positive effect on the nutritional quality of calcium, iron, and carbohydrate content in food grains in both little millet and black gram (Table 1). In little millet, among GLM incorporation, calcium content (16.29 mg 100g^{-1}), iron (4.79 mg 100g^{-1}) and Carbohydrate (63.25 mg 100g^{-1}) was high in M_4 (*Delonix regia* @ 1.45 t ha^{-1}). It was on par with M_3 (*Gliricidia sepium* @ 1.50 t ha^{-1}) and low in M_1 (*Leucaena leucocephala* 1.70 t ha^{-1}). Regarding sub-plot treatments, calcium content (15.80 mg 100g^{-1}), iron (4.63 mg 100g^{-1}) and Carbohydrate (62.29 mg 100g^{-1}) was more in S_4 (*Aegle marmellos*). Treatment S_3 (*Moringa oleifera*), were on par and accumulated low in S_1 (*Morinda tinctoria*). Among interactions, M_4S_4 (*Delonix regia* @ 1.45 t ha^{-1} + *Aegle marmellos* @ 5%) exhibited the highest calcium content (16.73 mg 100g^{-1}), iron (4.93 mg 100g^{-1}) and Carbohydrate (65.85 mg 100g^{-1}) and was on par with M_3S_3 (*Gliricidia sepium* @ 1.50 t

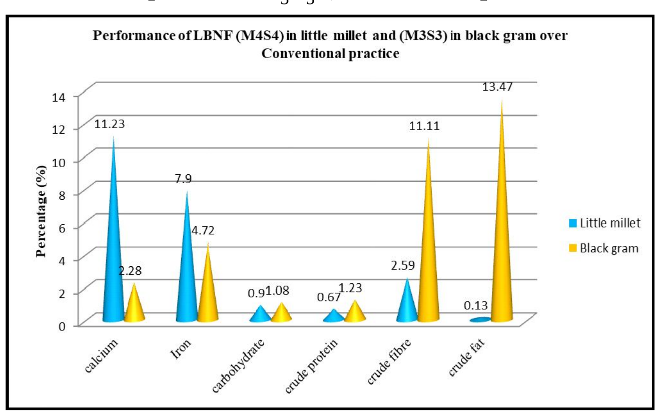

Fig. 1: Comparison of nutritional quality between LBNF and conventional practices for both little millet and black gram.

Table 2: Effect of LBNF practices on calcium, Iron and Carbohydrate content (mg $100g^{-1}$) of little millet and black gram grains.

GLM/BMT	Calcium (mg $100g^{-1}$)		Iron (mg $100g^{-1}$)		Carbohydrate (mg $100g^{-1}$)	
	Little millet	Black gram	Little millet	Black gram	Little millet	Black gram
M_1	14.44	115.97	4.11	6.89	58.52	55.85
M_2	15.14	119.57	4.35	7.06	59.89	56.65
M_3	16.03	128.52	4.69	7.22	62.62	57.86
M_4	16.29	127.42	4.79	7.2	63.25	57.48
C.D ($P \leq 0.05$)	**0.44**	**3.90**	**0.12**	**0.10**	**1.51**	**0.97**
S.Ed	**0.18**	**1.59**	**0.05**	**0.04**	**0.62**	**0.40**
LTS						
S_1	14.95	121.32	4.28	7.02	59.29	56.65
S_2	15.66	122.94	4.55	7.1	61.14	56.98
S_3	15.73	127.27	4.58	7.21	62.06	58.04
S_4	15.8	123.99	4.63	7.11	62.29	56.97
S_5	15.24	118.83	4.39	7.01	60.27	56.17
C.D ($P \leq 0.05$)	**0.35**	**2.25**	**0.08**	**0.13**	**1.11**	**0.98**
S.Ed	**0.17**	**1.10**	**0.04**	**0.06**	**0.54**	**0.48**
M×S (Interaction)	16.73	132.63	4.93	7.32	65.85	58.56
Conventional	15.04	129.67	4.57	6.99	65.20	57.93

M_1 – *Leucaena leucocephala*, **M_2** – *Pongamia glabra*, **M_3** – *Gliricidia sepium*, **M_4** – *Delonix regia*
S_1 – *Morinda tinctoria*, **S_2** – *Mangifera indica*, **S_3** – *Moringa oleifera*, **S_4** – *Aegle marmellos*, **S_5** – *Dalbergia sissoo*

ha^{-1} + *Moringa oleifera* @5%). The results of increased nutritional quality of little millet in LBNF practice over conventional scientific Practice by (11.23, 7.9 and 1.0 %) respectively (Fig. 1). This result is in line with the findings of (Bana *et al.*, 2016) by application of leaf compost @ 10 t ha^{-1} in pearl millet and (Aparna *et al.*, 2019) by 25 % N through crop residue composting in finger millet. The increase in iron content in little millet grains might also be due to foliar application of *Aegle marmellos* leaves. Which contains 1.06 ppm of Fe, as evidenced from these studies. Similarly in black gram, calcium (128.52 mg $100g^{-1}$), iron (7.22 mg $100g^{-1}$) and carbohydrate content (57.86 mg $100g^{-1}$) was excelled at M_3 (*Gliricidia sepium* @ 1.50 t ha^{-1}) in GLM incorporation and S_3 (*Moringa oleifera* @5%) calcium (127.27 mg $100g^{-1}$), iron (7.21 mg $100g^{-1}$) and carbohydrate content (58.04 mg $100g^{-1}$) in foliar spray. The content of calcium, iron, and carbohydrate was

Table 3: Effect of LBNF practices on Crude protein, crude fibre and Crude fat content (mg $100g^{-1}$) of little millet and black gram grains.

GLM	Crude protein (mg $100g^{-1}$)		Crude fibre (mg $100g^{-1}$)		Crude fat (mg $100g^{-1}$)	
	Little millet	Black gram	Little millet	Black gram	Little millet	Black gram
M_1	7.14	19.28	7.12	4.96	4.14	1.19
M_2	7.2	19.57	7.23	5.1	4.23	1.34
M_3	7.27	20.51	7.34	5.35	4.35	1.52
M_4	7.3	20.35	7.38	5.29	4.39	1.49
C.D ($P \leq 0.05$)	**NS**	**0.44**	**0.07**	**0.17**	**0.07**	**0.02**
S.Ed	**0.06**	**0.18**	**0.03**	**0.07**	**0.03**	**0.01**
LTS						
S_1	7.12	19.66	7.19	5.08	4.2	1.34
S_2	7.22	19.99	7.29	5.21	4.3	1.39
S_3	7.32	20.47	7.32	5.32	4.31	1.51
S_4	7.26	20.12	7.34	5.19	4.32	1.39
S_5	7.19	19.38	7.21	5.08	4.24	1.29
C.D ($P \leq 0.05$)	**0.13**	**0.43**	**0.09**	**0.11**	**0.06**	**0.03**
S.Ed	**0.06**	**0.21**	**0.04**	**0.05**	**0.03**	**0.02**
M×S (Interaction)	7.43	21.24	7.51	5.5	4.48	1.6
Conventional	7.38	20.98	7.32	4.95	4.42	1.41

M_1 – *Leucaena leucocephala*, **M_2** – *Pongamia glabra*, **M_3** – *Gliricidia sepium*, **M_4** – *Delonix regia*
S_1 – *Morinda tinctoria*, **S_2** – *Mangifera indica*, **S_3** – *Moringa oleifera*, **S_4** – *Aegle marmellos*, **S_5** – *Dalbergia sissoo*

excelled by *Gliricidia sepium* @ 1.50 t ha^{-1} as GLM and *Moringa oleifera* @ 5% as foliar spray over conventional practice by (2.28, 4.72, and 1.08 %). This might be due to the high mineral content in organically produced foods (Smith 1993). Foliar application of nutrients can easily take up the nutrients by plants than soil application and improves the quality. These findings are in support of (Zodape *et al.*, 2010).

Effect of LBNF practices on nutritional quality of crude protein, Crude fibre, crude fat content.

Proteins are building blocks of amino acids which help to repair cells and also for better human growth and development. The crude protein content was higher in pulses in comparison to other food grains. The crude protein, crude fibre and crude fat content in both little millet and black gram were the highest in LBNF practice and the data were presented in Table 2.

Among GLM incorporation, little millet continued to exhibit the same trend in terms of crude protein content in grains. Only sub-plot treatment showed apparent and significant values. The crude protein was high (7.32g $100g^{-1}$) in S_3 (*Moringa oleifera*) and it was on par with S_4 (*Aegle marmellos*). It was low in S_1 (*Morinda tinctoria*) which obtained (7.12 g $100g^{-1}$). The interaction was not significant in terms of crude protein in little millet and in black gram it shows significant difference, crude protein content (20.51 g $100g^{-1}$) was highest in M_3 (*Gliricidia sepium* @ 1.50 t ha^{-1}) in case of GLM incorporation and (20.47 g $100g^{-1}$) in S_3 (*Moringa oleifera*) in foliar spray. It might be due to more nitrogen uptake by plants and it is the essential constituent which influenced the protein content (Basavaraju 2007) in maize, (Pallavi *et al.*, 2016) in agri-silvi system and in finger millet reported similar findings.

In case of crude fibre and crude fat, it is a part of insoluble fractions of the total dietary fibre (TDF) content. Significantly different values were found between GLM incorporation, LTS as foliar spray and its interaction in both little millet and black gram. Regarding GLM incorporation, in little millet the highest crude fibre (7.38 g $100g^{-1}$) and crude fat (4.39 g $100g^{-1}$) was recorded in M_4 (*Delonix regia* @ 1.45 t ha^{-1}) and M_3 (*Gliricidia sepium* @ 1.50 t ha^{-1}) was on par. The lowest crude fibre and crude fat (7.12 g $100g^{-1}$ and 4.14 g $100g^{-1}$) was perceived in M_1 (*Leucaena leucocephala* @ 1.70 t ha^{-1}). Among LTS as foliar spray, S_4 (*Aegle marmellos* @ 5%) was high (7.34 g $100g^{-1}$) in crude fibre and 4.32 g $100g^{-1}$) in crude fat content. The lowest crude fibre and fat content was (7.19 and 4.2 g $100g^{-1}$) recorded in S_5 (*Dalbergia sissoo*) and S_1 (*Morinda tinctoria*). Among interaction with GLM incorporation and LTS as foliar spray showed significant differences. The crude fibre content and fat (7.51 and 4.48 g $100g^{-1}$) was high in M_4S_4 (*Delonix regia* @ 1.45 t ha^{-1} + *Aegle marmellos* @5%) and it was on par with M_3S_3 (*Gliricidia sepium* @ 1.50 t ha^{-1} +*Moringa oleifera @5%*). This was 0.7%, 2.59% and 0.2% over conventional scientific practice. In case of black gram, GLM incorporation and LTS as foliar spray showed significant differences. The highest crude fibre content (5.50 g $100g^{-1}$) and crude fat (1.6 g $100g^{-1}$) was high in M_3S_3 (*Gliricidia sepium @ 1.50* t ha^{-1} + *Moringa oleifera*). It was on par with M_4S_3 (*Delonix regia* @ 1.45 t ha^{-1} +*Moringa oleifera*) and it was excelled 1.23, 11.11, 13.47% over Conventional practice. These findings are in support of (Zodape *et al.*, 2010) who proved that foliar applications of *Kappaphycus alvarezhii* seaweed extract increased the yield and nutrition in green gram due to the presence of microelements and growth regulators. Similar results were observed by (Nasir *et al.*, 2016) and (Ullah *et al.*, 2019) when foliar application of moringa leaf extract increased Vitamin C, TSS, brix content and ascorbic acid content in Kinnow mandarian and cucumber.

Conclusion

From the study, it is concluded that, our Indian traditional agriculture *Vrikshayurveda* can significantly enhanced the soil health and food quality. Utilizing tree leaves as a "Natural game changer in crop production" Low Budget Naturalway Farming (LBNF) achieved the chemical free farming by improving the quality of grains in terms of iron, calcium, carbohydrate, protein, crude fibre and crude fat, thereby increased overall quality of food produce in little millet when adopting a treatment combination of *Delonix regia* @ 1.45 t ha^{-1} + *Aegle marmellos* @ 5% during both the years. Likewise in black gram, the highest grain quality characters were witnessed in treatment combination of *Gliricidia sepium* @ 1.50 t ha^{-1} + *Moringa oleifera* @5% as foliar spray.

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References

Anonymous (2020). "Government of Tamil Nadu, Department of Economics and Statistics, Report No 11/2020, PART II - XI Tables,." *Season and Crop Report 2019-20.*: 66-71.

Aparna, K., Rekha K.B., Vani K.P. and Prakash T.R. (2019). Growth and yield of finger millet as influenced by crop residue composting. *Journal of Pharmacognosy and Phytochemistry*, **8(4)**, 1108-1111.

Bana, R.S., Pooniya V., Choudhary A.K., Rana K.S. and Tyagi V.K. (2016). Influence of organic nutrient sources and moisture management on productivity, bio-fortification and soil health in pearlmillet (*Pennisetum glaucum*)+ clusterbean (*Cyamopsis tetragonaloba*) intercropping system of semi-arid India. *Indian Journal of Agricultural Sciences*, **86(11)**, 1, 418-411, 425.

Basavaraju, S.D. (2007). Integrated nitrogen management in maize (*Zea mays* L.) in a vertisol of Malaprabha command area. M. Sc.(Agri.) thesis submitted to the University of Agricultural Sciences, Dharwad (Karnataka).

Cohen, E.H. (1917). *Journal of Association of Official Analytical Chemists*. **54**, 212.

Gomez, K.A. and Gomez A.A. (1984). Statistical procedures for agricultural research: John wiley & sons.

Lindsay, W.L. and Norvell W.A.A. (1978). Development of a DTPA soil test for zinc, iron, manganese, and copper. *Soil science society of America journal*, **42(3)**, 421-428.

Ma, T. and Zuazaga G. (1942). Micro-Kjeldahl determination of nitrogen. A new indicator and an improved rapid method. *Industrial & Engineering Chemistry Analytical Edition*, **14(3)**, 280-282.

Maitra, S. and Shankar T. (2019). Agronomic management in little millet (*Panicum sumatrense* L.) for enhancement of productivity and sustainability. *International Journal of Bioresource Science*, **6(2)**, 91-96.

Maynard, A.J. (1970). Methods in Food Analysis. Academic Press, New York, London, 176.

Mwila, M., Mhlanga B. and Thierfelder C. (2021). Intensifying cropping systems through doubled-up legumes in Eastern Zambia. *Scientific reports*, **11(1)**, 1-13.

Nasir, M., Khan A.S., Basra S.M.A. and Malik A.U. (2016). Foliar application of moringa leaf extract, potassium and zinc influence yield and fruit quality of 'Kinnow'mandarin. *Scientia horticulturae*, **210**, 227-235.

Pallavi, C.H., Joseph B., MA M.A. Aariff Khan and Hemalatha S. (2016). Economic evaluation of finger millet under different nutrient management practices. *International journal of current microbiology and applied sciences*, **5(8)**, 690-698.

Shanthakumar, G., Yenagi N.B., Shekhar G.C. and Halikatti S.I. (2010). Food security and income enhancement of rural poor through improved production technology and value addition of nutritious small millets: A case study from Northern Karnataka. Minor Millets in South Asia: Learnings from IFAD-NUS Project in India and Nepal. 69.

Smith, B.L. (1993). Organic foods vs. supermarket foods: element levels. *Journal of applied nutrition*, **45(1)**, 35-39.

Swaminathan, C. and Nandakumar M.R. (2017). Vrikshayurvedic farming, The Traditional Indian Agriculture. Daya publishing House. A div. of Astral Int. Private Ltd. New Delhi.

Swaminathan, C., Nivethadevi P. and Nandakumar M.R. (2021). Low Budget Naturalway Farming (LBNF)-*Vrikshayurvedic farming* of Indian subcontinent. SSRN: https://ssrn.com/abstract=3764310.

Tadele, Zerihun (2016). Drought adaptation in millets: InTech.

Ullah, A., Ullah A., Amin F., Ali B., Ahmad W., Khan I., Khan R. and Khan F. (2019). Influence of foliar application of moringa leaf extract and humic acid on growth, yield and chemical composition of cucumber. *International Journal of Biosciences*, **14(1)**.

Vetriventhan, M., Azevedo V.C., Upadhyaya H.D., Nirmalakumari A., Kane-Potaka J., Anitha S., Antony S.A., Muthamilarasan M., Bhat B.V. and Hariprasanna K. (2020). Genetic and genomic resources, and breeding for accelerating improvement of small millets: current status and future interventions. *The Nucleus*, **63(3)**, 217-239.

Zodape, S.T., Mukhopadhyay S., Eswaran K., Reddy M.P. and Chikara J. (2010). "Enhanced yield and nutritional quality in green gram (*Phaseolus radiata* L.) treated with seaweed (*Kappaphycus alvarezii*) extract."