CURRENT FARM SCIENCE
Volume 1 Issue 1 (July-Dec 2026) | e-ISSN: Applied | Page No: 63-77

Bio-Energy Auditing, System Productivity and Economics of Low Budget Naturalway Farming Practices in Little Millet - based Cropping System under Southern Agro Climatic Zone of Tamil Nadu

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Article ID: CFS 005

Abstract

Two field trails were carried out in 2019–2020 and 2020–2021 at the Agricultural College and Research Institute, Tamil Nadu Agricultural University, Madurai, Tamil Nadu, to assess the energy balance, system productivity and economics of Low Budget Natural Farming (LBNF) practices in little millet-based cropping systems typical of the Southern Agro-climatic Zone of Tamil Nadu. The first year followed a little millet–little millet–black gram sequence, and the second year a little millet–black gram sequence. Twenty treatment combinations were tested, formed from four biomass transfer materials (Leucaena leucocephala, Pongamia glabra, Gliricidia sepium and Delonix regia) and five leaf tea foliar sprays (Morinda tinctoria, Mangifera indica, Moringa oleifera, Aegle marmelos and Dalbergia sissoo); the Crop Production Guide (CPG) recommendation and a zero-input (ZI) practices served as comparisons. Observations covered energy input and output, energy-use efficiency, energy productivity, net energy, little millet equivalent yield and economic returns. In both years, LBNF treatments needed less input energy than CPG. Delonix regia biomass combined with Aegle marmelos leaf tea spray (M4S4) recorded the highest energy-use efficiency (29.21%) and energy productivity (0.39 kg MJ^{-1}) during 2019–2020, while recorded 25.34% and 0.36 kg MJ^{-1}, respectively, during 2020–2021. M4S4 recorded the highest little millet equivalent yield (2451.14 kg ha^{-1}) in the first year, whereas Gliricidia sepium + Moringa oleifera (M3S3) recorded the highest yield (1790.77 kg ha^{-1}) in the second year. Net returns and benefit–cost ratios followed a similar pattern. Overall, LBNF raised energy efficiency, productivity and profitability while lessening dependence on purchased inputs.

Key words: Little millet; Low Budget Natural Farming; energy-use efficiency; bio-energy; system productivity; biomass transfer; leaf tea spray; economics

INTRODUCTION

Energy is a key resource in crop production, underpinning food supply, rural livelihoods and wider socio- economic progress. Agricultural production depends on many energy sources, such as seed, farmyard manure, fertilizers, plant protection chemicals, irrigation and farm machinery, so it both consumes energy and returns it in the form of bio-energy. (Alam et al*.,* 2005). Rising energy prices and shifting agricultural policies have changed how energy use relates to which makes efficient energy management increasingly important (Mittal and Dhawan, 1988 and Stout, 1990). Better energy use efficiency can help sustain soil fertility and productivity and is therefore a requirement for farming that is both economically viable and environmentally sound. Intensive conventional systems rely heavily on chemical fertilizers, pesticides, irrigation and mechanization, resulting in carrying large external energy inputs. Growing cereal after cereal year after year adds to resource and energy demand and harms soil health. Intensification has been linked to greater energy consumption (Pratibha et al., 2015). higher cultivation costs from rising fuel and labour prices (Das et al., 2014 a, b), deteriorating soil health (Gupta et al., 2006), falling groundwater tables (Humphreys et al*.,* 2010), environmental pollution (Singh et al*.,* 2008) and stagnating yields (Busari et al*.*, 2015). Such problems underline the need for alternative approaches that cut reliance on energy-intensive purchased inputs without sacrificing crop output.

Millets are increasingly seen as suitable for resource-efficient, climate-resilient farming, since they need fewer resources, use water efficiently and tolerate variable climates (Wang et al*.,* 2018). Millet-based cropping systems can support food and nutritional security while addressing climate change adaptation and sustainable agricultural production (Singh et al., 2017). Adding legumes into existing cropping systems may further raise system productivity and energy efficiency through biological nitrogen, lowering the need for external inputs.

Low Budget Naturalway Farming (LBNF) aka Vrikshayurvedic farming makes use of locally available natural resources. Green leaf manures supply basal nutrition and tree leaf extracts rich in secondary metabolites serve as a source of foliar nutrition, together they may promote nutrient recycling and crop performance and reduce indirect energy requirements. However, information on the energy efficiency, system productivity and economic performance

of tree-based LBNF practices in little millet-based cropping systems remains limited. Therefore, this study set out to assess the energy consumption, productivity and economic aspects of a little millet-based cropping system in comparison with conventional and zero input practices.

MATERIALS AND METHODS

Site description and soil characteristics: Field trials were conducted in 2019–2020 and 2020–2021 at the Central Farm of Agricultural College and Research Institute, Tamil Nadu Agricultural University, Madurai, Tamil Nadu, India. (9°54′ N, 78°05′ E; 147 m MSL). The site lies in the Southern Agro-climatic Zone of Tamil Nadu with a semi-arid tropical climate, and normal annual rainfall of 846 mm, mainly received during October–December. The soil, a sandy clay loam of the Madukkur series, (*Typic Ustichapustalf*) contained 56.7% sand, 16.4% silt and 27.3% clay. Soil properties at 0–30 cm depth had pH 7.9, EC 0.46 dS m^{-1} and oxidizable soil organic carbon 0.25%. with available N, P, K at 224, 13.2 and 276.5 kg ha^{-1}, respectively. Initial microbial counts were 42.8 CFU g^{-1} soil bacteria, 39.6 CFU g^{-1} soil fungi and 30.5 CFU g^{-1} soil actinomycetes, respectively.

Experimental setup, design and Treatments: The field had been left fallow for the preceding two years. Two different little millet-based cropping systems were examined. During 2019–2020, the cropping sequence was little millet–little millet–black gram, whereas during 2020–2021, little millet–black gram was followed. The experiment was laid out in a split-plot design with three replications comprising 20 treatment combinations. Four treatments of Biomass Transfer Technique (BMT) [M_1- *Leucaena leucocephala,* M_2 *–Pongamia glabra,* M_3-*Gliricidia sepium and* M_4- *Delonix regia*] and five treatments of Leaf Tea Spray (LTS) as foliar spray *Viz.,* [S_1 – *Morinda tinctoria*, S_2 – *Mangifera indica*, S_3 – *Moringa oleifera*, S_4 – *Aegle marmellos* and S_5 – *Dalbergia sissoo*] and it was compared with Conventional practice and Zero input Practice.

BMT materials were applied at a rate equivalent to 44:22:0 kg NPK ha^{-1} on an N basis and left to decompose for 6–7 weeks before sowing. Conventional and zero-input plots were raised in the same manner, the latter receiving nothing apart from seed. LBNF plots were hand-weeded at 15 and 45 days after sowing (DAS) and irrigated as needed. In the conventional plots, all operations followed the TNAU Crop Production Guide, whereas the zero-input plots omitted nutrition and intercultural operations.

***Measurements and calculations*:** Little millet and black gram were manually harvested, and system productivity was expressed as little millet equivalent yield (LMEY), computed with the following equation:

Little millet equivalent yield (kg ha^{-1}) =	(yield (kg/ha) +∑ respective crop yield in the system) × MrSP of the respective crop (Rs/kg)
	MSP of little millet (Rs/kg)

where MrSP stands for Market Sale Price.

Energy inputs were grouped as renewable (seeds, organic manures, biofertilizers and crop residues) and non-renewable (human labour, fuel, machinery, fertilizers and agro-chemicals). Input and output energy were estimated using standard energy equivalents given by Devasenapathy et al. (2009) and the energy indices listed below were then calculated.

Parameters	Unit
Energy use efficiency	%
Energy productivity	kg MJ^{-1}
Specific energy	MJ kg^{-1}
Net energy	MJ ha^{-1}
Energy intensity	MJ kg^{-1}

Economic analysis considered only the variable cost of production, human labour, machinery (tractor, plough, cultivator, seed drill and sprayer), seed, chemical fertilizers, organic manures and herbicides. Cost of cultivation, gross return, net return and benefit cost ratio were worked out from the input costs and market prices prevailing during the study, as suggested by Bhandari (1998). Gross returns (GR) were based on the prevailing market prices of the produce, and net returns (NR) were obtained by subtracting the total cost of cultivation and Gross returns (NR = GR – TC). System net returns were obtained by summing the net returns of all component crops, and the net benefit ratio was calculated as NR/TC.

Statistical analysis: Both experiments followed a split-plot design. Data were subjected to analysis of variance with the AGRES statistical package, and treatment means were separated using the Tukey studentized range test.

RESULTS AND DISCUSSION

Energy relationship

Energy auditing is a useful way to judge the efficiency, sustainability and environmental performance of agricultural production systems. The energy balances of the low-budget natural farming (LBNF) practices over the two years were presented in Tables 1 and 2. In the first year, the cropping sequence consisted of little millet–little millet–black gram, whereas in the second year, little millet–black gram was cultivated. In first year, the mean input energy consumption was far lower under LBNF practices (5642.91 MJ ha^{-1}) than CPG practices (27807.88 MJ ha^{-1}). Of the LBNF treatments, M_4S_4 (*Delonix regia* + *Aegle marmellos*) recorded the highest total output energy (164844.58 MJ ha^{-1}) and net energy (159201.67 MJ ha^{-1}) followed by M_3S_3 (*Gliricidia sepium* + *Moringa oleifera*) which recorded output energy (158937.84 MJ ha^{-1}) and net energy (153294.93 MJ ha^{-1}) respectively. CPG and Zero input practices had total output energies of (177125.48 MJ ha^{-1} and 45771.74 MJ ha^{-1}) and net energies of (149317.60 MJ ha^{-1} and 40938.86 MJ ha^{-1}), respectively. Significantly, Energy use efficiency and energy productivity followed the same trend. M_4S_4 (*Delonix regia* + *Aegle marmellos*) exhibited the highest energy use efficiency (29.21%) and energy productivity (0.39 kg MJ^{-1}) followed by M_3S_3 (*Gliricidia sepium* + *Moringa oleifera*) with values of 28.17 % and 0.38 kg MJ^{-1} respectively. Whereas CPG and zero input practices had energy use efficiencies of (6.37 % and 9.47%) and energy productivities of (0.09 kg $MJ^{-1}$and 0.07 kg MJ^{-1}), respectively. The high energy requirement of conventional production systems stems chiefly from greater use of inorganic fertilizers, agrochemicals and other external inputs which are known to raise energy consumption in agricultural systems considerably (Sorensen et al., 2014). LBNF treatments thus converted a smaller energy investment into useful crop output than input-intensive CPG practice.

The second year showed a similar pattern. Input energy requirement was only (4045.71 MJ ha^{-1}) under LBNF compared with (19096.69 MJ ha^{-1}) under CPG. Bio-energy outputs (102530.01 MJ ha^{-1}) and net energy (98484.30 MJ ha^{-1}) were highest in M_4S_4 (*Delonix regia* + *Aegle marmellos*) followed by M_3S_3 (*Gliricidia sepium* + *Moringa oleifera*) which obtained output energy and net energy of (102407.33 MJ ha^{-1} and 98361.62 MJ ha^{-1}) respectively. CPG recorded highest total output energy of (111206.88 MJ ha^{-1}) and net energy of (92110.19 MJ ha^{-1}) because of its greater energy investment and ZI practices recorded the lowest output and net energy values (38778.00 MJ ha^{-1} and 35354.12 MJ ha^{-1}), respectively. The highest energy use efficiency (25.34%) and energy productivity (0.36 kg MJ^{-1}) was enumerated in M_4S_4 (*Delonix regia* + *Aegle marmellos*) followed by M_3S_3 (*Gliricidia sepium* + *Moringa oleifera*) with values

of 25.31 % and 0.37 kg MJ^{-1} respectively. Whereas CPG and Zero input practices had energy use efficiencies of 5.82% and 11.33% with energy productivities of (0.09 kg MJ^{-1}) for both practices. The smaller energy requirement of LBNF can be put down to locally available tree biomass and botanical inputs, which lessened the need for purchased, energy-intensive materials. Swaminathan et al. (2020) emphasized that reducing energy-intensive operations can decrease energy, labour and time requirements. These results suggest that renewable biological resources under LBNF can improve energy-use efficiency while still giving favourable output energy in millet-based systems.

The superior energy performance of LBNF was particularly evident in the *Delonix regia* + *Aegle marmelos* combination. Compared with CPG, LBNF recorded 6.20 and 6.47 per cent higher net energy during the first and second years, respectively, while energy-use efficiency was 78.19 and 77.03 per cent higher. The net energy advantage of LBNF over CPG was 9.88 GJ ha^{-1} during 2019–20 and 6.37 GJ.ha^{-1} during 2020–21. These gains are probably due to the natural release of nutrients as tree biomass decomposes and to the botanical leaf extracts, which keep indirect energy inputs low. Energy use and productivity are directly shaped by the cropping system and its management (Tuti et al., 2012). Although CPG produced higher output energy, it required greater dependence on indirect and non-renewable energy inputs (Saad et al., 2016). In contrast, LBNF relies more on renewable biological resources, including tree biomass and plant-derived inputs, thereby reducing external energy requirements. Efficient utilization of these locally available resources through appropriate agronomic practices can therefore contribute to improved resource-use efficiency and long-term sustainability of cropping systems (Venkatesh et al., 2019).

Little millet equivalent yields and System profitability

System Productivity of the component crops was expressed as little millet equivalent (LEY) yield so that overall performance could be compared across the biomass transfer and leaf extract treatments (Table 3). During first year the highest LEY (2451.14 kg ha^{-1}) was perceived in M_4S_4 (*Delonix regia* as GLM and *Aegle marmellos* leaf extract as foliar spray and LEY of (1790.77 kg ha^{-1}) in M_3S_3 (*Gliricidia sepium* + *Moringa oleifera*) in the second year. In CPG plots, a LEY of 2751.50 kg ha^{-1} and 2047.50 kg ha^{-1} were recorded during first and second year respectively, under zero input plots, it was 385.74 kg ha^{-1} and 389.05 kg ha^{-1}, respectively. The higher LEY under CPG was associated with greater external input use and crop productivity;

however, the energy and economic analyses demonstrated that this higher biological output was accompanied by considerably greater production costs and energy requirements.

System profitability indicates the profit or loss from adopting a cropping system. In the first year, M4S4 had the highest system profitability (₹231.01 ha^{-1} $year^{-1}$), followed by M3S3, whereas during the second year M3S3 recorded the highest profitability (₹178.46 ha^{-1} $year^{-1}$). CPG recorded ₹140.63 and ₹120.54 ha^{-1} $year^{-1}$ during the first and second years, respectively. In contrast, ZI resulted in a loss of ₹23.35 ha^{-1} $year^{-1}$ during the first year and only a marginal profit of ₹2.23 ha^{-1} $year^{-1}$ during the second year.

System economics and Benefit Cost ratio

The benefit–cost ratio (BCR) expresses the relationship between the costs and benefits of a proposed venture. Total cost of cultivation, gross returns, net returns and B: C ratios were worked out for two years for different treatments and are presented in Tables 4 & 5**.** During first year the highest gross returns (₹ 134942.40), Net returns (₹ 84317.40) and B:C ratio (1:2.67) was observed under M_4S_4 (*Delonix regia + Aegle marmellos*) followed by M_3S_3 (*Gliricidia sepium + Moringa oleifera*), which obtained a gross return, Net return and B:C ratio of (₹ 131957.05, ₹ 81332.05 and 1:2.61). CPG practices had a gross return, Net returns and B:C ratio of (₹ 151490.00, (₹ 51329.22 and 1:1.51) and zero input practices showed a gross return of (₹ 21254.00) and net loss of ₹ -8521.00. It showed a B: C ratio of (1: 0.71), which is less than return per rupee invested.

During second year, M_3S_3 gained the highest gross returns (₹ 98661.93) net returns (₹ 65136.93) and B:C ratio of (1:2.94), followed by M_4S_4 which obtained a gross return, net returns and B:C ratio of (₹ 95516.25, ₹ 61991.25 and 1:2.85). CPG and zero input practices showed a gross return and net return of (₹112800.00, ₹ 43995.50) and (₹ 21437.50, ₹ 812.50). The zero input practices showed a benefit cost ratio of (1:1.04) and CPG practices had a B: C ratio of (1:1.64) during the second year respectively.

The highest economic efficiency of LBNF practice is primarily associated with lowest expenditure. During the first year 2019-2020 M4S4 recorded (39% and 110 %) higher net returns than CPG and ZI, respectively. While the corresponding advantages in B:C ratio were (Rs.1.16 and Rs.1.96) over CPG and Z.I practices. In the succeeding year (2020-2021) even with one less crop of little millet, under LBNF practice of *Gliricidia sepium* as GLM and *Moringa oleifera* as foliar spray excelled with the highest net returns (32% and 98.75%) and B:C ratio (Rs.1.30 and

Rs.1.90) more than CPG and Z.I practices. These findings align with (Mohan Kumar et al., 2017). Which also noted higher B: C ratios in organic farming compared to conventional methods in ragi and maize cultivation.

CONCLUSION

Low Budget Naturalway Farming (LBNF) in little millet–based cropping systems markedly cut energy inputs and, compared with conventional and zero-input practices, improved energy-use efficiency, system productivity and net returns. Treatments such as *Delonix regia* + *Aegle marmelos* (M4S4) and *Gliricidia sepium* + *Moringa oleifera* (M3S3) recorded the highest energy efficiency, yields and benefit–cost ratios over the two years. The findings confirm that tree-based LBNF practices is a promising low-input, and resource efficient route to sustainable little millet production under the southern Agro-climatic zone of Tamil Nadu.

Statements and declarations

Acknowledgement:

Authors wish to thank Tamil Nadu Agricultural University for facilities to conduct field and laboratory studies and express gratitude during time of study.

Conflict of Interest: Authors declare that there is no conflict of interest.

Data Availability: The authors confirm that all the data supporting the findings of this study are available within the manuscript only.

Author Contributions: Field studies, Implementation and writing the original drafts by P.N, reviewing & editing is done by CS; Formal analyses were done by P.N & R.D

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Table 1.Energy auditing for little millet–little millet–black gram cropping system (2019-2020)

Treatments	Energy input (MJ ha^{-1})	Grain yield (kg ha^{-1})	Straw yield + haulm yield (kg ha^{-1})	Energy output (MJ ha^{-1})	Energy use efficiency (%)	Energy productivity (kg MJ^{-1})	Specific energy (MJ kg^{-1})	Net energy (MJ ha^{-1})	Energy intensity (MJ kg^{-1})
M1S1	5642.91	1330.80	6680.02	103063.01	18.26	0.24	4.24	97420.10	12.87
M1S2	5642.91	1543.69	7436.65	115650.37	20.49	0.27	3.66	110007.46	12.88
M1S3	5642.91	1443.03	7041.08	109226.04	19.36	0.26	3.91	103583.13	12.87
M1S4	5642.91	1591.66	7804.17	120949.53	21.43	0.28	3.55	115306.62	12.87
M1S5	5642.91	1295.02	6050.41	94666.92	16.78	0.23	4.36	89024.01	12.89
M2S1	5642.91	1529.51	7323.89	114032.42	20.21	0.27	3.69	108389.51	12.88
M2S2	5642.91	1804.71	8483.39	132571.61	23.49	0.32	3.13	126928.70	12.89
M2S3	5642.91	1842.05	8360.95	131590.01	23.32	0.33	3.06	125947.10	12.90
M2S4	5642.91	1790.50	7924.75	125379.73	22.22	0.32	3.15	119736.82	12.91
M2S5	5642.91	1547.76	7633.42	118169.82	20.94	0.27	3.65	112526.91	12.87
M3S1	5642.91	1670.49	7934.36	123735.70	21.93	0.30	3.38	118092.79	12.88
M3S2	5642.91	2006.89	9606.27	149579.66	26.51	0.36	2.81	143936.75	12.88

M3S3	5642.91	2153.11	10182.97	158937.84	28.17	0.38	2.62	153294.93	12.88
M3S4	5642.91	2017.65	9477.99	148134.33	26.25	0.36	2.80	142491.42	12.89
M3S5	5642.91	1901.06	8856.09	138646.71	24.57	0.34	2.97	133003.80	12.89
M4S1	5642.91	1947.93	9350.87	145520.45	25.79	0.35	2.90	139877.54	12.88
M4S2	5642.91	1911.07	8844.80	138652.73	24.57	0.34	2.95	133009.82	12.89
M4S3	5642.91	2111.48	10096.88	157249.76	27.87	0.37	2.67	151606.85	12.88
M4S4	5642.91	2217.48	10579.81	164844.58	29.21	0.39	2.54	159201.67	12.88
M4S5	5642.91	1902.06	9079.42	141453.03	25.07	0.34	2.97	135810.12	12.88
CPG	27807.88	2468.00	11267.67	177125.48	6.37	0.09	11.27	149317.60	12.90
ZI	4832.88	316.70	3289.30	45771.74	9.47	0.07	15.26	40938.86	12.69

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*

Table2. Energy auditing for little millet–black gram cropping system (2020-2021)

Treatments	Energy input (MJ ha^{-1})	Grain yield (kg ha^{-1})	Straw + haulm yield	Energy output (MJ ha^{-1})	Energy-use efficiency (%)	Energy productivity (kg MJ^{-1})	Specific energy	Net energy (MJ ha^{-1})	Energy intensity

			(kg ha^{-1})				(MJ kg^{-1})		(MJ kg^{-1})
M1S1	4045.71	892.60	4117.93	64595.36	15.97	0.22	4.53	60549.65	12.89
M1S2	4045.71	1036.79	4445.97	70815.46	17.50	0.26	3.90	66769.75	12.92
M1S3	4045.71	1033.32	4509.77	71561.90	17.69	0.26	3.92	67516.19	12.91
M1S4	4045.71	1012.16	4627.43	72721.68	17.98	0.25	4.00	68675.97	12.89
M1S5	4045.71	885.47	4097.15	64230.75	15.88	0.22	4.57	60185.04	12.89
M2S1	4045.71	1061.08	4633.92	73521.93	18.17	0.26	3.81	69476.22	12.91
M2S2	4045.71	1201.79	5166.02	82241.51	20.33	0.30	3.37	78195.80	12.92
M2S3	4045.71	1250.79	5396.13	85838.20	21.22	0.31	3.23	81792.49	12.91
M2S4	4045.71	1210.94	4463.12	73589.78	18.19	0.30	3.34	69544.07	12.97
M2S5	4045.71	1055.70	4640.49	73524.86	18.17	0.26	3.83	69479.15	12.91
M3S1	4045.71	1141.70	5007.12	79372.00	19.62	0.28	3.54	75326.29	12.91
M3S2	4045.71	1306.55	6028.68	94564.79	23.37	0.32	3.10	90519.08	12.89
M3S3	4045.71	1485.67	6445.44	102407.33	25.31	0.37	2.72	98361.62	12.91
M3S4	4045.71	1325.22	6085.03	95543.62	23.62	0.33	3.05	91497.91	12.89
M3S5	4045.71	1283.84	5740.72	90631.46	22.40	0.32	3.15	86585.75	12.90
M4S1	4045.71	1295.60	5937.88	93268.77	23.05	0.32	3.12	89223.06	12.89
M4S2	4045.71	1293.38	5793.72	91434.13	22.60	0.32	3.13	87388.42	12.90
M4S3	4045.71	1395.44	6304.50	99319.16	24.55	0.34	2.90	95273.45	12.90

M4S4	4045.71	1457.25	6488.68	102530.01	25.34	0.36	2.78	98484.30	12.90
M4S5	4045.71	1242.63	5690.71	89400.48	22.10	0.31	3.26	85354.77	12.89
CPG	19096.69	1710.00	6885.59	111206.88	5.82	0.09	11.17	92110.19	12.94
ZI	3423.88	317.50	2728.86	38778.00	11.33	0.09	10.78	35354.12	12.73

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*

Table 3. Economics under Low Budget Naturalway Farming (LBNF) in little millet – little millet – Black gram cropping system (2019-2020)

Treatments	Total cost of cultivation (Rs. ha^{-1})	Total gross returns (Rs. ha^{-1})	Total net returns (Rs. ha^{-1})	B:C ratio
M1S1	50625.00	82285.50	31660.50	1.63
M1S2	50625.00	95346.25	44721.25	1.88
M1S3	50625.00	89970.93	39345.93	1.78
M1S4	50625.00	96980.50	46355.50	1.92
M1S5	50625.00	81108.10	30483.10	1.60
M2S1	50625.00	94879.55	44254.55	1.87
M2S2	50625.00	109194.63	58569.63	2.16
M2S3	50625.00	112771.13	62146.13	2.23
M2S4	50625.00	108998.20	58373.20	2.15
M2S5	50625.00	95283.00	44658.00	1.88
M3S1	50625.00	103075.05	52450.05	2.04
M3S2	50625.00	122774.65	72149.65	2.43
M3S3	50625.00	131957.05	81332.05	2.61
M3S4	50625.00	123422.37	72797.37	2.44
M3S5	50625.00	116381.00	65756.00	2.30

M4S1	50625.00	119115.15	68490.15	2.35
M4S2	50625.00	117134.95	66509.95	2.31
M4S3	50625.00	129412.40	78787.40	2.56
M4S4	50625.00	134942.40	84317.40	2.67
M4S5	50625.00	114748.62	64123.62	2.27
CPG	100160.78	151490.00	51329.22	1.51
ZI	29775.00	21254.00	-8521.00	0.71

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*

Table 4. Economics under Low Budget Naturalway Farming (LBNF) in littlemillet–Blackgram cropping system (2020-2021)

Treatments	Total cost of cultivation (Rs. ha^{-1})	Total gross returns (Rs. ha^{-1})	Total net returns (Rs. ha^{-1})	B:C Ratio
M1S1	33525.00	59518.00	25993.00	1.78
M1S2	33525.00	69773.71	36248.71	2.08
M1S3	33525.00	70077.76	36552.76	2.09
M1S4	33525.00	66537.69	33012.69	1.98
M1S5	33525.00	60386.92	26861.92	1.80
M2S1	33525.00	71694.39	38169.39	2.14
M2S2	33525.00	78015.00	44490.00	2.33
M2S3	33525.00	82290.64	48765.64	2.45
M2S4	33525.00	79471.48	45946.48	2.37
M2S5	33525.00	70783.28	37258.28	2.11

M3S1	33525.00	76173.54	42648.54	2.27
M3S2	33525.00	86269.29	52744.29	2.57
M3S3	33525.00	98661.93	65136.93	2.94
M3S4	33525.00	87527.34	54002.34	2.61
M3S5	33525.00	84665.95	51140.95	2.53
M4S1	33525.00	85432.88	51757.88	2.55
M4S2	33525.00	85445.85	51920.85	2.55
M4S3	33525.00	92664.23	59139.23	2.76
M4S4	33525.00	95516.25	61991.25	2.85
M4S5	33525.00	80884.80	47359.80	2.41
CPG	68804.50	112800.00	43995.50	1.64
ZI	20625.00	21437.50	812.50	1.04

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*