



Efficacy of organic inputs on nutrient management and cost-benefit ratio on pulse crops in organic farming

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Summary

The wide range of external solid organic sources of nutrients viz., FYM, vermicompost, goat manure, etc., are available, out of them, FYM & vermicompost are found to good in terms of yield and quality of the different pulse crops. Several options are available for liquid manures, among them higher yield, quality and cost-benefit ratio of the produce reported with the application of *Panchagavya* and *jeevamrut*. Crop residue mulching with organic manures was also found effective. Integrated application of organic and natural inputs as solid and liquid manures gave better results than sole application.

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Keywords: Natural farming, organic farming, nutrient management, cost-benefit ratio

Introduction

Nowadays, organic farming is attracting worldwide attention as it offers a potential alternative to ecologically exploitative modern agriculture. Organic farming has twin objectives of the system being sustainable and environmentally safe. For India with its ever-increasing population, sustainable agriculture has to be based on site-specific balanced and adequate fertilization and an integrated plant nutrient supply system (IPNS) involving organics, inorganic and biofertilizers (Haldhar et al. 2017).

India shares about 35 - 36 % and 27 - 28 % of the total area and production of pulses worldwide. In India, 17 % of the total cultivated area (23 million hectares of land) is under pulse crops, with an annual production of 12-15 million tons (*Pulses in India Retrospect & Prospects -2017*) The productivity is very low which is 500 kg/ha. The productivity of pulse crops became stagnated since the last three decades because of less success in getting improved varieties and less area under cultivation. The current demand of pulses is about 20-25 million tons and in the ensuing years, it will be required more in future. Hence, to meet the requirement of the ever-increasing population of our country, it is necessary to increase the productivity of pulse crops. Fig 1. showed that the organic export product by India about the total volume of export – 8,88,179 MT in 2020-2021. Pulses play a vital role in human animals and in the agricultural economy by many ways: For a balanced diet, daily 85 - 104 gm of pulses per capita is required. According to WHO report, per capita availability came down to 33.19 gm per day

per capita as compared to 74.10 g during 1955 against the minimum requirement of 85 gm per day (Bana et al. 2022; Sarangthem et al. 2023). According to the economic survey of 1995 of the Central Government of India, per capita availability of pulses in 1961 was 69 gm, which reduced to 37 gm in 1995. The average availability of pulses in Gujarat is 17 gm/day (Only 20 % of the requirement). India has an area of *kharif* pulses of 130.76 lakh hectares with 80.46 lakh tones production during 2019-20. (*Kharif Pulses Prospects -2020-21*).

According to (FIBL & IFOAM – Organic international 2020)

At the global level, there are 71.5 million hectares of organic agricultural land, which accounts for 5.1% of all organic shares. Worldwide, there are around 5.71 (4.22+1.49) million ha of organically certified land. India is ranked first overall in the number of organic producers and eighth in the world for organic agricultural land. India has a 43,39,184 ha organic certified area and will produce 34,96,800 MT of goods in 2020–21. Madhya Pradesh having largest area under certification in India. Ghaziabad, Uttar Pradesh, is National Centre of Organic Farming.

Management of nutrients in natural farming systems is a challenging task, as the use of inorganic fertilizers is not permitted. Therefore, organic farmers have must to optimize a range of soil, crop, rotation and manure management to ensure a nutrient supply which will guarantee optimum crop yields and minimize losses to the environment and promote healthy soil with good physical, biological, and chemical properties.

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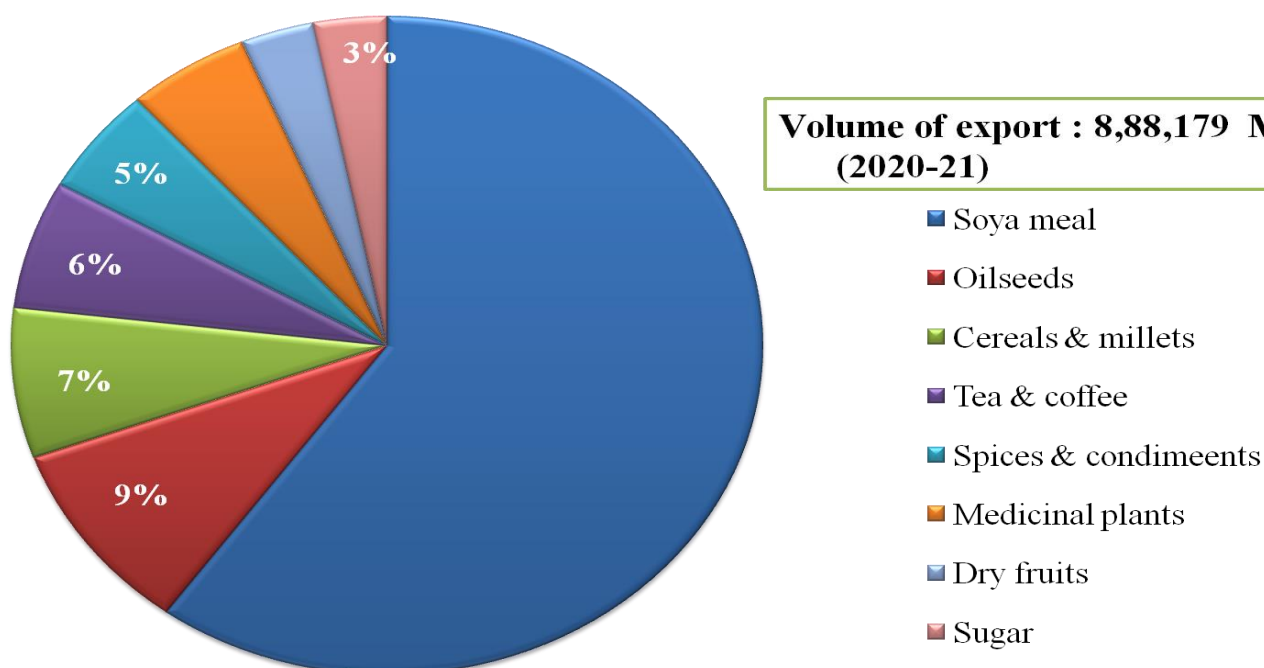


Figure 1. Total exported organic products by India

Basic concepts of organic and natural farming

The basic concepts behind organic and Natural farming are:

1. It concentrates on building up the biological fertility of the soil.
2. Control of pests, diseases and weeds is achieved largely by developing an ecological balance within the system and using bio-pesticides and various cultural techniques such as crop rotation, mixed cropping and cultivation.
3. farmers recycle all wastes and manures within a farm.
4. Enhancement of the environment so that wild life flourishes.

The objectives of organic farming by (IFOAM) are as follows

1. To produce food of high nutritional quality in sufficient quantity.
2. To work with natural systems rather than seeking to dominate them.
3. To encourage and enhance the biological cycles within farming system involving microorganisms, soil flora and fauna, plants and animals.
4. To maintain and increase the long-term fertility of soils.
5. To given all livestock, conditions of life that allow them to perform all aspects of their innate behavior.
6. To avoid all forms of pollution that result from agricultural techniques and agrochemicals
7. To maintain the genetic diversity of the agricultural system and its surroundings, including the protection of plant and wildlife habitats.
8. To consider the wider, social and ecological impact of the farming system.

Why Organic Farming and Natural Farming? (Kirchmann 2019)

Table 1. External inputs and composition (Borah et al. 2019)

Sources	Nitrogen (%)	Phosphorus (%)	Potassium (%)
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The most unfortunate impact of GRTs on Indian Agriculture

1. Imbalance in production
2. Reduction in productivity
3. Reduction in quality of the produce
4. Dependency on synthetic chemical fertilizers
5. Increase in pesticide use
6. Environmental pollution

Opportunities: To increases the productivity in organic agriculture

- Selection of crops and varieties suitable for organic agriculture
 - Selection of crops which are more responsive to OA
 - Development of varieties suitable for OA
- N –fixers and root rhizosphere
 - Basic principles i.e. host specific and native inoculants
- Agronomic practices to improve soil fertility and thus, productivity
 - To modify the soil environment for better mineralization by tillage, mulching etc.
 - Inter-culturing and crop rotation to sustain/improve soil fertility
 - Green manuring with cover crops
 - Prevents the leaching losses of nutrients from the rhizosphere

Way of nutrient losses in the farming system

1. Crop uptake
2. Crop Removal
3. Leaching
4. Volatilization
5. Immobilization
6. Chemical reaction between various components in the mixture

Bulky organic sources (manures)			
FYM	0.50	0.25	0.50
Poultry manure	3.03	2.63	1.40
Compost farm	0.50	0.15	0.50
Compost town	1.40	1.00	1.40
Vermicompost	2.00	1.00	1.20
Press mud	1.25	2.00	1.00
Night soil	5.5	4.00	2.00
Concentrated organic manures			
Safflower cake	7.90	2.20	1.90
Groundnut cake	7.30	1.50	1.30
Castor cake	4.30	1.80	1.30
Neem cake	5.20	1.10	1.50
Raw bone meal	3-40	20-25	-
Fish manure	4-10	3-9	0.3-1.5

Nutrient management strategies to reduce nutrient losses

- NM is the maintenance of soil fertility and plant nutrient supply at an optimum level to sustain the desired crop productivity and it has been considered a broad-based remedy against soil fertility decline.
- Organic and natural sources
- Application of 4R's
- Residue management
- Legume based cropping system
- Site specific nutrient management practices

- Agronomic practices (Crop rotation, Residue management, Selection of crop and variety, conservation of water, Mulching and other Agronomic Practices, STCR approach, Soil testing).

Effect on yield, quality and economics

Amareswari (2015) conducted an experiment on French bean reported that application of 8 t/ha vermicompost + Panchagavya (3%) as foliar spray which resulted in maximum benefit-cost ratio while net profit was found maximum with application of 10 t/ha straw mulch + vermicompost + panchagavya (Table 2).

Table 2. Effect of Vermicompost, Jeevamrutha, Panchagavya and Mulching on the Benefit Cost Ratio in French bean

Treatment	B:C ratio	Net profit (Rs)
T ₀ : Control-without any chemical or organic inputs	1.74	54700
T ₁ : Chemical fertilizers NPK @ 60:75:75 kg/ha	2.59	134964
T ₂ : Vermicompost @ 8 tonnes/ha	2.73	132700
T ₃ : Jeevamrutha @ 500 lts /ha	1.85	66100
T ₄ : Panchagavya @ 3% as foliar spray	2.35	103816
T ₅ : Straw mulch @ 10 tonens/ha (15 cm above soil)	2.22	96300
T ₆ : Chemical fertilizers NPK (100%) + Panchagavya (T ₁ + T ₄)	2.96	172780
T ₇ : Vermicompost + Panchagavya (T ₂ + T ₄)	3.25	179316
T ₈ : Jeevamrutha + Panchagavya (T ₃ + T ₄)	3.00	161516
T ₉ : Straw mulch + Panchagavya (T ₅ + T ₄)	2.80	146916
T ₁₀ : Straw mulch + Chem. Ferti. NPK(100%) + Panchagavya (T ₅ + T ₁ + T ₄)	2.79	167080
T ₁₁ : Straw mulch + Vermicompost + Panchagavya (T ₅ + T ₂ + T ₄)	3.22	192416
T ₁₂ : Straw mulch + Jeevamrutha + Panchagavya (T ₅ + T ₃ + T ₄)	3.06	178716

Patel *et al.* (2015) revealed that treatment receiving BC: VC: CC + Cow urine (2%) recorded significantly higher seed and yield of chickpea (Table 3). Kumbaret *al.* (2016) concluded that application of the highest levels of jeevamrutha and panchagavya recorded significantly

higher yields of French beans. (Table 4). Akhila (2017) found that significantly increased values of quality, yields and economics of green gram were found with foliar spray of 2 % seaweed sap followed by enriched banana pseudo stem sap (1%) (Table 5).

Table 3. Effect of various liquid organic manures on grain and Stover yield of Chickpea

Treatments	Seed yield (kg/ha)	Stover yield (kg/ha)
T ₁ - BC:VC:CC + panchagavya (2%)	758.81	1579.51
T ₂ - BC:VC:CC + jivamrut (2%)	764.05	1591.38
T ₃ - BC:VC:CC + cow urine (2%)	952.30	1870.55
T ₄ - BC:VC:CC + enriched sap (1%)	924.86	1638.42
T ₅ - BC:VC:CC + vermibedwash (2%)	837.47	1606.23
T ₆ - BC:VC:CC + control	706.37	1334.70
S.Em. (±)	48.09	95.22
CD@ 5 (%)	144.96	287.02
CV (%)	11.67	11.88

Note: Bio compost (BC), Vermicompost (VC) and Castor cake (CC) RDN: 25 kg/ha , clayey soil

Table 4. Yield of French bean as influenced by Jeevamrutha and Panchagavya application

Treatments	Yield (q/ha)			
	Panchagavya 0 %	Panchagavya 3 %	Panchagavya 6 %	Mean
Without jeevamrutha	83.0	104.0	112.4	99.8
Jeevamrutha1000 L/ha	91.9	107.7	120.6	106.7
Jeevamrutha1500 L/ha	104.4	117.8	122.9	115.0
Jeevamrutha 2000 L/ha	126.2	134.8	141.8	134.3
Mean	101.4	116.1	124.4	
	S. Em±	C.D at 5 %		
Jeevamrutha	1.97	5.78		
Panchagavya	1.71	5.00		
Jeevamrutha × Panchagavya	3.41	NS		

Note: Application of liquid manures by drenching at 15, 30 and 45 DAS

Table 5. Effect of liquid organic manures on quality, yield and BCR of Green gram

Treatments	Protein (%)	Carbohydrate (%)	Stover yield (q/ha)	Seed Yield (q/ha)	B:C ratio
T ₁ : water spray	17.15	56.65	22.07	9.81	2.60
T ₂ : SWS – 2%	19.01	62.70	28.65	12.21	2.69
T ₃ : SWS – 4%	17.60	58.72	23.91	10.70	1.73
T ₄ : SWS – 6%	17.00	55.12	16.86	9.09	0.99
T ₅ : EBPS – 1%	18.51	60.84	25.21	11.11	2.87
T ₆ : EBPS – 12 %	16.0	55.60	13.84	8.36	1.70
C.D. (P=0.05)	1.07	4.60	3.36	0.76	-

Note: Time of application: 15, 30, 45 DAS, SWS= Seaweed sap; EBPS= Enriched banana pseudostem sap, RDN: 20 kg/ha (NADEP compost)

Choudhary et al. (2017) revealed that significantly higher seed, straw and biological yield as well as protein content in seed and total nitrogen, phosphorus and potassium uptake in black gram was achieved with the application of 4% of panchagavya and its application at branching + flowering stages over remaining treatments. (Table 6).

Yadav et al. (2017) stated that from the solid organic manure, application of 2T vermicompost/ha whereas among the liquid organic manures, application of 3 percent of panchagavya recorded significantly higher

pod/plant, seed yield and haulm yield compared to other treatments. (Table 7). Ullasa et al. (2018) reported that application of recommended dose of FYM (7.5 t ha⁻¹) along with 100 percent N equivalent through vermicompost (2 t ha⁻¹) has recorded significantly higher dry pod and seed yields as compared to rest of the treatments. (Table 8). Haridha et al. (2020) revealed that the combined application of goat manure and vermicompost 17 t/ha showed a significantly higher yield of black gram (Fig. 2).

Table 6. Effect of doses of panchagavya and its stage of application on yield and quality of organic black gram

Treatments	Yield kg/ha			Protein in seed (%)	Total uptake (kg/ha)		
	Seed	Straw	Biological		N	P	K
Doses of Panchagavya							
Control	519	1272	1791	20.63	46.14	4.42	32.62
Panchagavya 2%	686	1512	2198	21.17	59.62	5.67	40.66
Panchagavya 4%	801	1735	2536	22.36	73.32	7.23	48.68
Panchagavya 6%	715	1534	2249	21.52	62.55	6.07	42.77
Panchagavya 8%	697	1519	2217	21.45	61.23	5.90	42.09
Panchagavya 10%	690	1505	2195	21.31	60.33	5.80	41.62
SEm±	20	59	68	0.30	1.98	0.21	1.47
C.D.5%	57	168	193	0.84	5.65	0.59	4.21
Stages of panchagavya application							
Branching	635	1470	2105	20.75	56.91	5.49	39.54
Flowering	667	1451	2118	20.99	56.55	5.44	39.18
Branching + Flowering	751	1617	2368	22.37	67.78	6.53	45.18
SEm±	13	38	44	0.19	1.29	0.13	0.96
C.D.5%	37	110	127	0.55	3.70	0.38	2.76

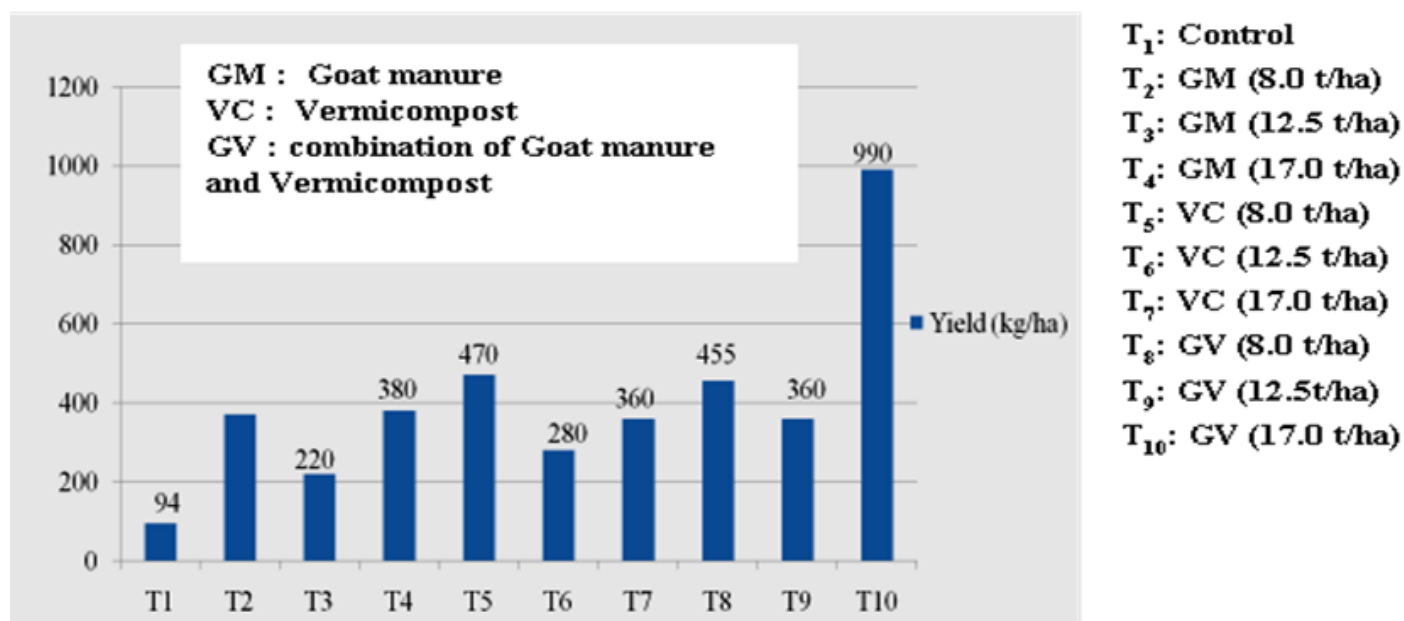


Figure 2. Effect of organic manures on yield of Black gram

Table 7. Effect of different organic manures on yield attributes and yield of chickpea

Treatments	Pods/plant	Seed yield (kg/ha)	Haulm yield (kg/ha)
Sources of organic manures			
OM ₀ : Control	45.66	1310	1900
OM ₁ : FYM 5 t/ha	48.29	1636	2578
OM ₂ : Compost 3 t/ha	49.62	1736	2853
OM ₃ : Vermicompost 2 t/ha	50.12	1916	2998
S.Em±	0.69	54	86
CD (P=0.05)	1.99	156	247
Liquid organic manures spray			
LM ₀ : Control	46.78	1371	2252
LM ₁ : Panchagavya 3 %	49.54	1888	2804
LM ₂ : Cow Urine 10 %	48.35	1556	2626
LM ₃ : Vermiwash 10 %	49.02	1783	2645
S. Em±	0.690	54	86
CD (P=0.05)	1.99	156	247

Table 8. Pod yield and seed yield of field bean as influenced by different nutrient management practices

Treatments	Dry pod yield (q/ha)	Seed yield (q/ha)
T ₁ : Recommended FYM (7.5 t/ha) + 100 % N equivalent FYM	12.70	8.75
T ₂ : 75 % N equivalent FYM	9.88	6.98
T ₃ : 100 % N equivalent FYM	10.71	7.45
T ₄ : 125 % N equivalent FYM	11.56	8.04
T ₅ : Recommended FYM (7.5 t/ha) + 100 % N equivalent vermicompost	13.25	9.32
T ₆ : 75 % N equivalent vermicompost	10.91	7.25
T ₇ : 100 % N equivalent vermicompost	11.45	7.78
T ₈ : 125 % N equivalent vermicompost	12.03	8.30
T ₉ : 50 % N equivalent FYM + 50 % N equivalent vermicompost	11.58	7.91
S.Em.±	0.32	0.20
C.D. at 5%	0.94	0.60

Declaration of interests

The authors have no conflict of interest to declare.

Data sharing

All relevant data are within the manuscript.

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