

Residue management in crops

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Importance of Residue

Plant, animal including human residues, green plant materials and municipal wastes are serve as effective source of plant nutrients and humus in soil. SOM plays an important role in maintaining proper rhizosphere for better growth of the plants. In intensive agriculture, soil often gets sickness due to continuous use of chemical fertilizers. Organic manures are used to increase efficiency of fertilizers. Jharkhand State with red & laterite soil with low organic matter P and S needs balanced input of plant nutrients to sustain and improve crop productivity.

Why crop residues?

- To maintain an acceptable environment free from excessive pollution on ground and the air
- To conserves ever scare & more costly raw material and energy cycle (in situ)

Method of Organic Recycling

- Improvements in the process of composting by reduction in the processing period and enrichment in quality.
- Utilization of available organic residues in the natural plant production
- As mulching

Estimates of the availability of some crop residues in India & their plant nutrient potential.

Crop	Residue yield 000 t	Nutrient (%)			Nutrient potential (000 t)		
		N	P ₂ O ₅	K ₂ O	Total	Utilizable	Fertilizer equivalent
Rice	1,10,495	0.61	0.18	1.38	2,398	799	399
Wheat	82,631	0.48	0.16	1.18	1,504	501	250
Sorghum	12,535	0.52	0.23	1.34	262	87	43
Maize	11,974	0.52	0.18	1.35	252	84	42
Pearl millet	6,967	0.45	0.16	1.14	121	40	20
Barley	2,475	0.52	0.18	1.30	51	17	8
Finger millet	5,351	1.00	0.20	1.00	118	39	19
Sugarcane	22,736	0.40	0.40	1.28	423	23	211
Potato	7,867	0.52	0.21	1.06	141	141	70
Groundnut pods	10,598	1.60	0.23	1.37	339	339	169
Total	2,73,629	-	-	-	5609	2470	1231

(Bhardwaj, 1995)

Nutrient potential of biological wastes.

Type of waste	Total quantity available (Mt)	Total nutrients (,000 t/yr)			
		N	P ₂ O ₅	K ₂ O	Total
Cattle dung manure	279.8	2813.3	1999.7	2069.3	6882.3
Crop residue	273.3	1283.1	1965.6	3903.9	7152.6
Forest litter	18.7	99.7	37.4	99.7	236.8
Rural compost	285.0	1431.2	861.5	1422.7	3715.4
City refuse	14.0	98.0	84.0	112.0	294.0
Sewage sludge	0.5	5.1	2.9	2.8	10.8
Pressmud	3.2	33.3	79.4	55.4	168.1

Source : Juwarkar et al. (1992)

Fertilizer equivalent of organic manures and biofertilizers.

Component	Input level	Fertilizer equivalent of input in terms of crop yield
Organic manure (FYM)	Per tonne	3.6 kg N+ P ₂ O ₅ + K ₂ O (2:1:1)
Green manure (Sesbania)	Per tonne	4.4 kg N
Green manure (Sesbania)	45 days crop	50-60 kg N for HYV rice
Cowpea intercropped with castor	Legume buried after 6 weeks	30 kg fertilizer N on castor
Leucaena loppings	88 kg N in leucaena	25 kg fertilizer N on sorghum
Rhizobium	Inoculant	19-22 kg N
Azotobacter & Azospirillum	Inoculant	20 kg N
Blue Green Algae	10 kg/ha	3-4 kg/t
Azolla	6-12 t/ha	3-4 kg/t
Sugarcane trash	5 t/ha	12 kg N/t
Rice straw + waterhyacinth	5 t/ha	20 kg N/t

Source : Tandon, H.L.S. (Ed.) FDCO Publication, New Delhi (1992)

Average nutrient content of organic manures.

Organic manure	Primary nutrients (%)			Micronutrients (mg/kg)					
	N	P	K	Fe	Zn	Mn	Cu	B	Mo
FYM	1.00	0.54	0.90	2600	57	250	2.5	2.1	0.7
Pig manure	1.88	2.13	0.67	1200	50	70	8.9		
Poultry manure	1.89	1.90	1.60	1400	90	210	7.1	5.0	
Goat/sheep manure	0.65	0.50	0.03		2570	150	61	4600	
City compost	1.50	0.50	1.00		400	560	150	15	9
Sewage sludge	2.40	1.20	0.002		2459	262	643	9	0.6
Press mud	1.20	1.96	2.20	1140	94	450			
Green manure (Sesbania)	2.25	0.37		140	17	80	3.2	20	0.2
Azolla	4.03	0.29	1.70						

Source : Katyal, J. C. (1992) PPIC Gurgaon Publ. 227-249.

Average nutrient content of animal by-product.

Type of manure	Nutrient status		
	N (%)	P (%)	K (%)
Blood meal	10-12	1.2	1.0
Meat meal	10.5	2.5	0.5
Fish meal	4.10	3.9	0.3-1.5
Horn & hoof meal	13.0	-	-
Raw Bone meal	3-4	20-25	-
Steamed bone meal	1-2	25-30	-

Source : Gaur et al. (1995)

Nutrient content of some oilseed cakes.

Oil cake	N %	P ₂ O ₅ %	K ₂ O %
Caster	5.8	1.8	1.0
Cotton seen	3.9	1.8	1.6
Karanj	4.0	1.0	1.3
Neem	5.2	1.0	1.4
Niger	4.8	1.8	1.3
Safflower	4.8	1.4	1.2
Linseed	5.5	1.4	1.2

Subblan et al. 2000

Livestock population & availability of animal residues in Jharkhand.

Manure production (kg/yr)	Livestock population (in lakh)	Estimated availability of animal wastes (lakh tonnes)
750	Cattle 73.88	55.0
650	Buffalo 10.83	6.5
80	Sheep 13.00	1.04
75	Goat 56.94	4.27
20	Pig 8.50	0.16
25	Poultry 100.66	2.50

Source : Sarkar 2002

Crop residues available in Jharkhand.

Crop	Area (*000 ha)	Production (*000 tonnes)	Total production of straw 1:1.5 ratio (*000 tonnes)	Straw available for compost preparation (*000 tonnes)
Rice	1444	1770	2655	1770
Wheat	63	71	136.5	91
Maize	122	119	178.5	119
Barley	11	8	12	8
Ragi	43	40	60	40
Other	21	11	16.5	11

Source : Sarkar 2002

Residues available for recycling in Jharkhand

- New sown are of state – 2.0 Mha
- Crop residues available – 2.4 mt
- Total residue availability - 9.0 MT
- Availability per ha of land – 4.5 tonne.

Characteristics of some natural plant residue & crop.

Residue/ Nutrient content	Rice straw	Maize straw	Lentil straw	Subabul leaves	Karanj leaves	Lantana tops	Ipomea leaves	Water hyacinth
C%	47.7	52.8	48.0	48.6	46.0	47.3	46.4	42.7
N%	0.54	0.64	1.64	3.24	2.53	1.83	2.60	2.39
P%	0.11	0.14	0.12	0.24	1.10	0.25	0.22	0.12
K%	1.68	0.94	1.68	2.54	1.06	2.65	2.77	2.89
Ca%	0.80	0.80	4.0	4.4	4.0	4.0	4.0	2.4
Mg%	0.09	0.13	0.47	0.15	1.42	0.28	0.33	0.45
S%	0.09	0.13	0.47	0.15	1.42	0.28	0.33	0.45
Zn (mg kg ⁻¹)	119	123	148	133	139	160	89	130
C/N ratio	88	85	29	15	18	26	18	18
C/P ratio	434	377	400	203	460	189	211	356

Source : Lal 1998

Factors effecting for composting.

Parameters	Value
Size of the pit	12' x 6' x 6'
Size the heap	Any length x 5' x 7'
Size of the material	2 to 5 cm
C/N ratio	30 to 40 : 1
Moisture content	60-70%
Air flow	0.8 to 1.8 M3/air/day/kg
Temperature	50-60°C
Additive	Ligno cellulolytic organisms

Source : Gaur (1992)

Factors affecting crop residues decomposition

- Quantity added
- Size of the residue
- Method of application –
 - (i) Incorporation
 - (ii) Surface application

Grain yield of maize and wheat (Q ha⁻¹) with N+PK fertilizers and crop residue management (Av. of 11 years) upto 2004.

Treatment	Grain in yield			
	Maize	% increase over control	Wheat	% increase over control
Control	11.57	-	14.51	-
Crop residue (CR)	20.00	73	18.16	25.0
50% N + CR	21.69	88	22.28	54.0
75% N + CR	28.08	143	26.73	84.0
100% N + CR	34.44	198	31.31	116
50% N	17.11	48	18.57	28
75% N	24.85	115	23.69	63
100% N	29.87	158	28.20	94

Soil properties as influenced by in situ incorporation of crop residues.

Treatments	pH (1:2.5)	Organic C (g kg ⁻¹)	Total microbial population (x10 ⁶ cells g ⁻¹)	CO ₂ evolution (g kg ⁻¹)	Microbial biomass carbon (u g ⁻¹)
After maize					
Control	5.5	4.2	128.6	0.791	128.6
Crop residue (CR)	6.0	4.9	145.2	0.879	145.2
50% N + CR	5.8	5.5	151.8	1.715	151.8
75% N + CR	5.6	5.8	167.0	2.331	167.0
100% N + CR	5.5	6.2	173.3	2.771	173.3
50% N	5.4	5.5	143.3	0.923	143.3
75% N	5.2	5.7	146.6	1.143	146.6
100% N	5.1	5.9	-	0.042	-
CD (P = 0.05)	-	0.2	-	0.042	-

Advantages of residue management on physical properties of soil

- **Soil structure** : Favour the formation of aggregates due to addition of Organic matter to the soil structural stability increase due to straw addition & better aggregate size distribution occurs due to a reduction in soil disturbance crop residues.
- **Bulk Density & porosity** : Low bulk density so incorporation of straw with FYM reduces the bulk density of soil & increase the porosity of the soils.
- **Hydraulic conductivity** : Crop residues increase hydrolic conductivity by modifying soil structure microspores & aggregate stability
- **Soil temperature** : Mulching with plant residues raised the minimum soil temp. in winter due to reduction in upward heat flux from soil & decrease soil temp. during summer due to shading effect.
- **Soil Moisture** : Reduces evaporation rate due to increase in amount of residues on the soil surface.

Advantages of residue management on chemical properties of soil

- **Organic carbon** : Increases with continuous O. M. addition
 - **Soil pH** : Increases soil pH significantly. By decarboxy lotion of organic anions, ligand exchange & addition of basic cations.
 - **C.E.C.** : Soil O.M. as reservoir for plant nutrients essential prevents leaching of lements, required for growth.
- Addition of residues increase C.E.C.**

Advantages of residue management on Biological properties of soil

- It provides energy for growth & activities of microbes & substrates for microbial biomass
- Provide suitable environment for Biological N – fixation
- Enzymes *Microbial biomass, dehydrogenase & alkaline phosphatase activities increase in sandy loam soil.
- Microbial population : Increase microbial biomass & it can enhance nutrients availability in soil as well as the microbial biomass act as sink & source of plant nutrients.

Summary & conclusion

- The importance of SOM for sustainable maximum economic production through INM can never be underestimated.
- O.M. is a dynamic material changing physical, chemical & biological properties.
- Judicious use of organic residues could bring. Considerable improvement of soil fertility & productivity.
- Organic inputs are essential for promoting organic farming.
- Therefore, it is essential to regularly monitor the changes in soil health for sustained productivity .

Thank you