Plant Archives Vol. 14 No. 1, 2014 pp. 597-604 ***ISSN 0972-5210***

Review Article

UTILIZATION OF UNUSED BIO-WASTE FOR AGRICULTURAL PRODUCTION - A REVIEW

Munendra Pal, Munish Kumar[1]*, G. R. Gupta[1] and K. N. Dwivedi[2]

Department of Soil Conservation, C.C.S. (P.G.) College, Heonra - 206 002, Etawah (U.P.), India.
[1]Department of Soil Conservation, C. S. Azad University of Agriculture & Technology, Kanpur-208 002 (U.P.), India.
[2]Department of Soil Science & Agril. Chemistry, C. S. A. Univ. of Agricult. & Tech., Kanpur-208 002 (U.P.), India.

Introduction

Food security of India remains at risk due to continued population growth, stagnation in farm level productivity in intensive farming areas and globalization poverty, low income, under nourishment and gradual deterioration of agri-environments. Despite frequent surplus food stocks in recent times, there is a need to produce more. This additional quantity will have to be produced from same or even shrinking land due to increasing competition for land, water and other resources by non-agricultural sector. National Academy of Agricultural Sciences (1997) projected that 30-35 Mt of fertilizer nutrient would be required to meet food grain demand by 2020. The all India fertilizer nutrient demand projections for food grain production targets during 11th five year plans are given in table 1.

The greatest challenges facing mankind in the 21st century is to produce the basic necessities of food, feed, fuel, fibre, fruits and raw materials from 0.14 ha or less land per caput, while the use of mineral fertilizers is the quickest and surest way of boosting crop production, their *cost* and other constraints frequently deter farmers from using them in recommended quantities and in balanced proportions. As a consequence of this and other constraints there seems to be no option but to fully exploit potential alternatives sources of plant nutrients. Indiscriminate use of chemical fertilizers and pesticides for maximization of yield has created several problems, which are associated with the soil health, crop management and environment. The necessity of having an alternative agriculture method, which can function in an eco-friendly method in sustaining and increasing the crop productivity is realized now. Thus, it is a system, which encompasses the natural resources *i.e.* bio-wastes utilization for maintaining the soil health including quality and fertility for eco-friendly agriculture.

****Author for correspondence:*** E-mail: munish.csa@gmail.com

Concept

India has become self reliant in food production after independence due to the green revolution technology which enabled a nearly four fold increase in food production in the last fifty years, but this achievement has been followed by browning and loud protests concerning the environmental effects. The excessive use of fertilizers and insufficient use of organics has led to a decrease in soil fertility and health. Agricultural chemicals including pesticides, hormones and antibiotics leave residues in soil that eventually get into the food chain causing the health and environmental problem. Fertilizer nutrient costs are increasing day by day beyond small and marginal farmers are detrimental effects posed by imbalanced use of fertilizers. The continued high analysis NPK fertilizer has led to occurrence of sulphur and micronutrient deficiencies. Thus, conservation and efficient use of natural resources such as organics through agricultural wastes are the means to achieve sustainable high yields in food and nutritional security as well as environmental safety. Some projections on availability of organic resources for agriculture in India during 2000-25 are given in table 2.

As estimated, about 25% of the nutrient needs of Indian agriculture can be met by utilizing various organic resources (table 3).

Availability of Agricultural Bio-wastes:

The success of organic agriculture depends upon the development and the integration of various activities of farm in a way that availability of organic resources for recycling nutrients is not a constraint. Organic materials are valuable by products of farming and allied industries, derived from plant and animal resources. The importance

Table 1 : All India demand projections of fertilizer nutrients ('000 tonnes).

Eleventh five year Plan (2011-12)	N	P_2O_5	K_20	Total
2007-08	14347	7432	2266	24045
2008-09	14783	7855	2351	24989
2009-10	15231	8303	2441	25975
2010-11	15693	8780	2534	27007
2011-12	16171	9284	2630	28085

Source: Fertilizer Statistics 2000-01, FAI, New Delhi.

Table 2 : Some projections on the availability of organic resources for agriculture in India during 2000-2025.

Generators	2000	2010	2025
Human population (million)	1,000	1,120	1,300
Livestock population (million)	498	537	596
Food grain production (million t)	230	264	316
Nutrients (theoretical potential)[1]			
Human excreta (million tN+P_20_5+K_20)	2.00	2.24	2.60
Livestock dung (million t N+ P_20_5+K_20)	6.64	7.00	7.54
Crop residues (million t. N+ P_20_5+K_20)	0.21	7.10	20.27
Nutrient (considered tapable)[2]			
Human excreta (million tN+ P_20_5+K_20)	1.60	1.80	2.10
Livestock dung (million t N+ P_20_5+K_20)	2.00	2.10	2.26
Crop residues (million t N+ P_20_5+K_20)	2.05	2.34	3.30
Total	5.05	6.24	7.75

1. All data pertaining to nutrients in dung and in residues are counted twice to the extent these are fed to the animals.
2. Tapable = 30% of dung 80% of excreta, 33% of crop residues

Source : Tandon (1997)

Table 3 : Organic sources required to meet 25% of India's nutrient in 2000 and 2050.

Resource	2000	2050
FYM (Mt)	200	400
Crop residues (Mt)	30	50
Urban/Rural wastes (Mt)	10	15
GM (Mt)	25	50

Source: Tandon (1997).

of agricultural solids wastes in general and agro-industrial wastes in particular has been recognized during the recent years.

Organic resources

India has vast potential of bio-waste as major manurial resources

1. **Live Stock Wastes**

    Cattle-shed wastes such as cattle and buffalo dung (FYM and compost)

    Other Live stock

2. **Crop residues, tree wastes and aquatic weeds**

    Crop Waste of cereals, pulses and oilseeds (wheat, paddy, bajra, jowar, gram, moong, urd, cow pea, pigeon pea, lentil, groundnut and linseed).

    Stalks of corn, cotton, coffee, tobacco, sugarcane, trash leaves of cotton, jute, water hyacinth and forest litter.

3. **Green manure**

Sunhemp, dhaicha, cluster beans, senji, cowpea, horse gram and berseem.

4. **Agro-Industrial products**

    Oil cakes

    Paddy husk and bran

    Bagasse and press mud

    Fruit and vegetable wastes

    Cotton wool and silk wastes

    Tea and tobacco wastes

    Fruit, Vegetables produce and plantation crop wastes

    Fermentation Industry wastes

Potential of agricultural solid wastes

Farm Yard Manure (FYM)

FYM is important source of plant nutrients, composed of dung urine, bedding and straw. It contains approximately 5-6 kg N, 1.5-2 kg phosphorus and 5-6 kg potash ton^{-1}. It builds up the soil health considerably. It is obvious from the table 4 that BD, total porosity, organic carbon available N and P of soil are affected by the application of FYM and augment the soil fertility status of the soil.

Compost

Compost manures are the decayed refuse likes leaves, twigs, roots, stubble, *bhusa,* crop residue and hedge clippings, street, refuse collected in towns and villages, water hyacinth, saw-dust and bagasse. A large number of soil micro-organisms feed on these bio-wastes and convert it into well-rotted manure. .

Low-cost technology for enrichment of compost

Experiments conducted at IARI have shown that inoculation with *Azotobacter chroococcum* and phosphate solubilizing microorganism improved the manorial value of compost. The results indicated that 31.5 per cent carbon was decomposed in control during the first month whereas, the loss in different treatments ranged between 33.3 to 41.5 per cent. This was further

Table 4 : Physical and chemical properties of the surface soil as affected by FYM.

Nutrient sources	BD (Mgm³)	Total porosity (%)	Organic carbon (%)	Available NC Kgha⁻¹)	Available P (Kgha⁻¹)
Control	1.41	46.79	0.98	35.80	19.30
FYM @ 500 g/plant	1.28	51.70	1.05	42.70	25.70
VC@200 g/plant + FYM @ 250 g/plant	1.24	53.21	1.21	43.10	25.90
CD 5%	0.006	1.65	0.005	6.05	5.75
Initial	1.38	47.90	1.05	42.10	23.40

Source: Chaudhary *et al*. (2003).

Table 5 : Addition of plant nutrients through green manuring.

Crops	Average yield of GM Mt ha⁻¹	N %	N added (kg ha⁻¹)
Sunhemp	9.96	0.48	75.0
Dhaicha	9.40	0.42	68.9
Green Gram	3.76	0.53	34.6
Covvpea	7.05	0.49	50.4
Guar	9.40	0.34	55.0
Berseen	7.29	0.43	54.0

Table 6: Changes in Soil Physico-chemical properties of the experimental soil after cropping

Cropping	Organic carbon (%)		available nitrogen		Ca (%) (Kgha⁻¹)		Mg(%)	
Alley Cropping	**BC**	**AC**	**BC**	**AC**	**BC**	**AC**	**BC**	**AC**
Green leaf manuring	0.36	0.75	182	410	0.89	1.05	0.42	0.55
No green leaf manuring	0.36	0.78	182	385	0.85	0.98	0.39	0.48
Sole Cropping								
Green leaf manuring	0.28	0.74	180	378	0.81	0.96	0.39	0.47
No green leaf manuring	0.38	0.65	180	321	0.76	0.96	0.37	0.47

Table 7: Crop residues available for utilization in India

Crops	Total available crop residues (Mt)	Crop residue available for utilization (Mt)	Total NPK (Mt)	Nutrient potential available for utilization (Mt)
Rice	119.2	39.7	2.59	0.86
Wheat	93.9	31.3	1.71	0.57
Sorghum	* 19.9	6.6	0.41	0.14
Sugarcane	28.0	28.0	0.52	0.52
All pulses	17.9	6.0	0.59	0.19
Others	76.7	58.3	1.62	0.76
Total	355.6	169.9	7.44	3.54

Source : Hegde and Sudhakarbabu (2001).

increased during second month showing maximum loss of 52.4 per cent of organic carbon in rock phosphate, and P-solubiliser inoculated series. In mis treatment C N ratio was reduced to 14.1 and 12.0 during 1st month and 2 month after inoculation, respectively.

Green Manuring

Green manuring with leguminous crops is a well accepted practice for augmenting nutrient supply, particularly with the nitrogen and organic matter, under the use of agricultural solid wastes, the practice is widely utilized for not only improving the nutrient and organic matter content, but also to manage weeds and pests. Improvements in soil properties and productivity due to the incorporation of green manure crops are observed in soils under the different agro-ecological zones. The most commonly grown green manure crops are *sesbania aculeata* (Dhaicha) and *Crotolaria juncea* (Sunhemp) having the potential to provide 4-5 t ha^{-1} of try biomass and 80-100 kg of N ha within 50-60 days of plant growth (table 5).

Data presented in table 6 indicate that the physico-chemical properties of soils changed after incorporation of green manure in soil, it improves the soil organic carbon and available nutrients like nitrogen, calcium and magnesium etc. The application of GM and various organic manures are very useful practice for reclamation of salts affected soils. Besides source of plant nutrients produced favorable effects on soil physical properties. It counteracts the unfavorable effects of exchangeable sodium. Decomposition of organic materials improves soil permeability and bacteria present in it.

Water hyacinth

Water hyacinth (*Eighhornia crassipes*) is a free floating weed plant, which grows luxuriantly in ponds, lakes and water reservoirs. It is estimated that total acreage under this weed is about 292,000 ha in Bengal, Bihar, Assam, Eastern UP, Andhra Pradesh, Tamil Nadu, Orissa and Kerala. The adverse effects of such uncontrolled growth on agriculture, fisheries, transport and human health are obvious and the necessity for its collection and consequent disposal are needed.

Source of mulch and manure

Water hyacinth can be used as soil mulch, green manure and compost. Efforts have been made to use water hyacinth for biogas production without loss of plant nutrients. Water hyacinth is used as mulch in tea gardens during dry season for conservation of soil moisture and regulation of temperature.

Forest-litter manure

It is estimated that about 15 million tonnes of compost can be obtained from forest -litter annually without in any way adversely affecting the natural regeneration of the forests. If a portion or the surface litter is removed in a regular manner, the manurial value of forest-litter is as good as from compost. Fifteen million tonnes of forest litter manure may contain 0.075,0.03 and 0.075 million tonnes of N, P_2O_5 and K_2O, respectively.

Garbage

It is household wastes, road sweeping and vegetables market wastes and all other dry wastes from shops and offices etc. Application of city garbage has resulted into beneficial effect in improving the yield of many crops besides improving soil properties. It decreases bulk density, WHC increases from 70 to 150%. Compost of garbage provides slow release N for several years after application. More than 80% garbage is indigestible. Compost from city garbage contains 0.8%N, 0.3% P_20_5 and 1.5% K_20 with the garbage collection of 12 mt from Indian cities every year. It is possible to progress 4 to 4.3 mt compost containing 32000 t N, 120001 P_2O_s and 60000 K_20 for the use as manure in agriculture.

Effect of organic manures on properties of soils

Organic manures influence physical, chemical and biological properties of the soil.

Physical effects

The addition of compost improves soil structure, texture and tilth. The better soil structure provides better environment for root development and aeration. The water holding capacity of the soil increases as compared to soil receiving no manure which provides protection to the crops against drought. Compost has been found to be very useful in control of soil erosion. Several studies on the impact of organic manures on improvement in soil structure were reviewed.

Chemical effects

Organic manures add nutrients to the soil thus reducing total dependence on fertilizers. The humic substances increase P availability as they have a very high cation exchange capacity. Humus enhances the utilization of fertilizer nutrients by plants and helps in reducing leaching losses by promoting greater water retention

Biological effects

Organic manures contain a very large population of bacteria, actinomycetes and fungi. The application of organics helps the microorganisms to which build up better soil structure N-fixation and P-solubilisation is also increased due to improved microbiological activity in organic matter-amended soil. Besides, the above effects, role of compost in the control of plant nematodes and in mitigating the toxic effect of pesticides have also been documented. Benefits of adding organic matter:

- Improves tilth, condition, and structure of soil, providing better aeration
- Increase in soil-organisms
- Improves ability of soil to hold water and nutrients
- Helps dissolve mineral form of nutrients
- Maintains a steady supply of plant nutrients
- Helps recycle organic wastes, thus keeping them out of landfills and waterways
- Cheap energy source, replacing manufactured nitrogen

Crop residues recycling

Crop residues are the plant parts or crop remains left after-harvesting and or processing of the produce. These are tremendous natural resources having diverse effect on soil quality. Nearly 355 million tonnes (table 7) of crop residues are annually available in India of which 180 million tonnes can be utilized to supply 3.54 m tonnes of plant nutrients.

Rice, wheat and sugarcane are potential crops, which ensure availability of large amount of crop residues. Crop residue in rice and wheat crops as such is not the problems, however, in the event of mechanization; large amount of crop residues is left in the field during the course of harvesting and needs to be properly managed. A good sugarcane crop, leaves about 6-8 t ha^{-1} of trash. A rice and wheat crops in sequence leave about 10-12 t ha^{-1} of crops residues in the mechanically harvested field. These residues can be used as fuel, feed or recycled as compost or used as mulch or incorporated in soil.

Crop residues and soil quality

Physical quality

Crop residues act as perfect cover and may protect soil or land from being physically degraded through wind/ water erosion. It is reported that crop residues @ 2.01 ha”[1] applied as mulch reduced soil loss by 75% through wind erosion in arid conditions and incorporation of rice and wheat residues in soil led to lowering of bulk density from 1.4 g cc^{-1} in residue removed plot to 1.44 g cc^{-1} in residues incorporated plot and increased infiltration rate for 37.1 mm ha”[1] in residue removed plot to 39.4 mm ha”[1] in residue incorporated plot. Das *et al.* (2001) reported that incorporation of wheat and rice straw @ 5 t ha^{-1} lowered soil bulk density, improved water holding capacity and organic matter content of the soil.

Chemical quality

Incorporation of residues in rice - wheat crop sequence improved soil organic matter from 0.43 to 0.48%. From long term experiment on rice-wheat crop residues management concluded that residue incorporation improved OC, available N, P, K over residue removed or burned (table 9).

Burning of residue led in complete loss of nitrogen, 20% loss of P, 20% loss of K and 90% loss of S. It may not be prudent, therefore, to burn the huge quantities of crop residue, which could otherwise be converted to value added manures like; co-composting of poultry litter/ manure, phospho-compost etc or other with bio-degradable wastes effective methods to conserve the nutrients for commercialization of indigenous organic residue for the organic farming (table 10).

Biological quality

Crop residues have tremendous effect on soil biological health. Study of the effect of crop residues on microbial population observed that fungal, bacterial population and soil water content decreased immediately after residues burning. It is observed that earthworm population increased from 0.3 to 1.8 million ha^{-1}, when banana leaves were used as mulch. Studies made at IISR, Lucknow revealed that sugarcane trash used as mulch exhibited higher soil microbial population (table 11).

Crop yield

Crop yield is another important index of soil health. Several workers indicated that incorporation of crop residues improved, the crop growth and yield of both rice and wheat crops grown in sequence (table 12).

Limitations of crop residue incorporation

- o Physical removal of crop residues is not cost effective.
- o Burning of crop residues leads to loss of nutrient, environment poll ution and damage to soil bio-life.
- o Incorporation of crop residues improves soil physical, chemical and biological conditions.
- o It leads to nutrient immobilization, accumulation of toxic substance, harboring of pests, hinder in sowing / transplanting of crop,
- o Incorporation of crop residues in to deep soil layer needs use of fceavy machines,
- o Residues from legume are fast decomposing and have little or no lock up period.

Agro-Industrial wastes

Agro-industries are based not only on crops, such as rice, sugarcane, jute, tea, coffee, fruits and vegetables but also based on forest products (non-edible oilseeds, wood, lac, etc). Agro-industries wastes are available in substantial quantities at processing sites whereas, animal wastes and crop residues are available at forms and in a scattered way.

Rice Milling Industry wastes

Rice husk and rice bran

Rice husk is the largest product of the rice milling industry comprising 20 to 25 per cent of paddy. Paddy yields about 5 to 7 per cent bran. The availability of rice husk is about 15 Mt annually. A typical paddy husk sample contains 42.6 per cent cellulose, 20.1 per cent Iignin, 18.6 per cent pentosans and 18.7 per cent ash. ft is a poor source of manure and its N content varies from 0.3 to 0.4 per cent, P_2O_5 0.2 to 0.3 per cent and K_2O 0.3 to 0.5 per cent. There is a problem of its disposal in certain areas. It is used as fuel and for improving physical conditions of saline and alkali soils. It can be used as bedding material for animals and in composting.Rice bran yield is about 2.5 Mt annually. It has limited scope as fertilizer since this is exploited for production of rice bran oil.

Sugar milling industry wastes

The chief byproducts of sugar industry are bagasse, pith, molasses and presumed a multi ingredient and vital source of macro and micro nutrients, matrix for microbes, source of phytosteroides and protectinstoriodes.

Bagasse

The fibre content of Indian sugarcane is 12 to 17 per cent and 33 per cent is bagasse. About 5.3 million tonnes of dry bagasse is annual produced. The bagasse produced in the country is almost entirely used as fuel in boilers of sugar factories. Recent investigations have shown that

Table 8 : Effect of residue management for seven years in rice- wheat rotation on chemical properties of a sandy loam soil.

Treatment	pH	Bulk density ($g\ cc^{-1}$)		Hydraulic conductivity ($cm\ hr^{-1}$)	Water holding capacity (%)	OM (%)
No residue	5.5	1.43	1.53	9.58	36.76	1.21
Wheat straw ($5tha^{-11}$)	5.4 .	1.34	1.44	11.66	50.60	1.47
Rice residue($5t\ ha^{-1}$)	5.5	1.33	1.49	11.99	51.06	1.47
CD (P = 005)	NS	0.03	0.02	0.59	3.07	0.04

Source: Das *et al.* (2001).

Table 9 : Effect of residue management for seven years in rice-wheat rotation on chemical properties of a sandy loam soil.

Parameters	Residues		
	Incorporated	Removed	Burnt
pH	7.7	7.6	7.6
EC (mmhos.cm”^{l})	0.18	0.13	0.13
Organic C (%)	0.75	0.59	0.69
Available N (ppm)	154	139	143
Available P (ppm)	45	38	32
Available K (ppm)	85	56	77
Total N (ppm)	2501	2002	1725
Total P (ppm)	1346	924	858
Total K (ppm)	40480	34540	38280

compost pits. The approximately composition of each charge is 80 per cent cellulosic materials (bagasse), 12 per cent animal dung, 5 per cent bone meal or super-phosphate and 3 per cent calcium carbonate with moisture of about 70 per cent. The aerobic decomposition is allowed for 5 days by blowing compressed air resulting in rise of temperature to 60-80°c followed by anaerobic digestion for methane production on dry basis, spent slurry contains 1.5-1.8 per cent N, 1.0-1.3 per cent P_2O and 0.6-0.8 per cent K_2O. About 200 cu metre of biogas are obtained per tonnes of organic matter contained in agricultural wastes.

Pressmud

About 3.2 m tonnes of pressmud are produced annually from the sugar factories; it contains about 1.25 per cent N, 2.5 per cent of phosphorus, 2% K and 2.0 to 2.5 per cent organic matter. Compost prepared from pressmud contains 1.4 per cent nitrogen and 1 to 1.5 per cent P_2O_5. Since, it is very high in lime (up to 45 per cent), its application is useful in acidic soils.

Table 10: Composition of manures prepared from Co-composting of Poultry litter with rice straw

Treatments	N (%)	C/N ratio	Total mineral N (ppm)	Total P205 (%)	Citrate soluble (P) (gkg^{1})
T_1: Poultry waste (PW)	1.85	12.05	2.15	2.55	17.03
T_2: PW + Rock Phosphate (12:5% WAV) + Pyrites (10% W/W)	2.46	16.00	4.95	4.95	13.21
T_3: PW + Rice residue + Water hyacinth 1:0.5:0.5 ratio)	2.0	11.80	2.75	2.75	18.0
T_4: T_3 + Rock Phosphate (12.5% W/W) + Pyrites (10% W/W).	2.0	13.40	4.35	4.25	14.0
T_5: PW + Rice residues + Water hyacinth (1:2:2)	1.75	11.80	2.75	2.75	18.0
T_1: T_3 + Rock Phosphate 12.5% W/W) + Pyrites (10% W/W)	2.15	12.50	3.50	3.25	14.19

bagasse is a valuable material for production of pulp paper, boards etc. However, a portion of bagasse could be utilized as both for fuel and manure if it is processed through biogas plants. The nitrogen and P_2O_5 per cent of bagasse is approximately 0.25 per cent and 0.12 per cent and compost produced out of it will have a nitrogen of 1.4 per cent and 0.4 per cent of P_2O_5. It is estimated that about 1.4 million tonnes of organic manure per year can be produced from this by product.

A pilot plant is in operation at the National Sugar Institute, Kanpur which utilizes bagasse and sugarcane trash for production of biogas. A composted fertilizer/ manure is obtained within 40 to 45 days by this anaerobic process against longer period, normally required in

Vegetable and fruit processing industry wastes

Vegetable and fruit wastes

India produces around 33 million tonnes of fruit and 50 million tonnes of vegetable annually. It is estimated that roughly 10 to 15 % of total produce is available either as residues or bio-degradable wastes for recycling in agriculture. In addition, the processing of fruits and vegetable results in production of around 5 million tonnes of solid wastes. Most of these wastes are ligriocellulosic

Table 11 : Effect of residue management for seven years in rice-wheat rotation on chemical properties of a sandy loam soil.

Microbes	Population/ g soil	
	No trash	Trash mulch
Bacteria	21±6	43±10
Fungi	23±4	36±10
Actinomycities	65±10	72±15
Azotobactor	4±2	25±6
Azospirilum	2±1	25±8

Source: IISR, 1995.

Table 12 : Effect of wheat crop residue on rice crop yield.

Treatment	Rice grain yield (q ha^{-1})	
	Jorhat	Bareilly
No residue incorporated	23.8	4.70
Residue incorporated	28.3	51.4
CD at 5%	1.4	2.6

in nature and contain macro and micro-nutrients. If we manage the waste of plantation crops, it will provide 165 thousand tonnes of $N+P_2O_5+K_2O$, which will definitely provide help for using indigenous materials for maintaining sustainable agriculture. There is a wide scope for utilization of these wastes as fertilizer. The total quantity available from this industry is more than 25,000 tonnes from mango, pineapple, citrus fruits, apples, green peas, tomato etc annually. It is estimated that about 10,000 tonnes of compost could be produced out of these wastes.

Cotton mill wastes

Cotton wastes/byproducts

Cotton is an important commercial fibre crop of India. The present area under the crop is about 8 million hectares and production is about 6.5 million bales, valued at about rupees 800 crores. The main products of cottonseed are oilcake or meal, linters and hulls. Out of these, cotton oilcakes can be used as feed and fertilizer and the main wastes/byproducts arising from cotton are (1) cotton stalks, (2) cotton linters and hulls (3) cotton leaves and other plant parts (4) cotton dust, Rainfed cotton crop yields two-and-a-half tonnes of cotton-stalks per hectare and under irrigated crop the yield of cotton stalks is about 5 tonnes ha"[1]. The necessary technology for converting it into manure should be developed.

Cotton dust

Cotton textile mills mainly in their blowing rooms produce a large quantity of this waste, *textile* mills in India are expected to produce 30-33" tonnes waste per year.The chemical analysis of the cotton dust in per cent is given below: Moisture 8% organic matter 70, carbon 41, nitrogen 1.4, P_2O_5 0.6, K_2O 1.2 and pH 6.2. This material is ideally suited for composting and application to soils.

Tea industry

During the course of tea production, processing and storage, about 10 million kg of tea waste becomes available in the form of fluffs, stalks and sweepings. It is an important for extraction of coffein. The decaffeinated tea wastes can be used as manure or an animal feed. Spent tea waste has 0.28 to 3.5 per cent N, 0.4 per cent P_2O_5 and 1.5 per cent K_2O with C N ratio of 9 to 11.

Tobacco wastes and tobacco seed-cake

It is estimated that out of total of about 62,000 tonnes of such waste available annually, nearly 41,000 tones are used for manurial purposes. The tobacco wastes used for manuring contain 0.5 to 1.0 per cent N, 0.8 per cent P_2O_5 and 0.8 K_2O. About 10,000 tonnes of tobacco seed-cake is also available for manurial purposes and it contains 4 to 4.5 per cent N, 7 to 15 per cent P_2O_5 and 5 to 5.5 per cent K_2O.

Jute sticks

The total quantity of jute sticks produced in India is about 2.5 Mt. It is generally used for thatching, hedging and for fuel purpose. Cellulose content of jute stick is quite high as compared to bagasse, rice and wheat straw. It may be utilized in biogas after pretreatment or by chopping it to smaller size.

Marine algae and sea weeds

Marine algae and sea weeds form a good source of organic manures amounting to about 10,000 to 15,000 tonnes annually. A sea weed contains 1 to 2 per cent P_2O_5 and 2 to 7 per cent K_2O and a number of trace elements. It can be used as source of organic matter for soil amendmends.

Fermentation industry wastes

India has made rapid progress in the production of drugs and other chemicals through fermentation processes of different substrates. After production of useful products, the left out materials contain large amount of organic matter and mineral in solids and liquid form. It is estimated that one kg of antibiotic produced through fermentation, there is generation of around 7000 to 8000 litres of waste water with solid content ranging between 40-50 g L^{-1} and BOD load about 30000 to 60000 mg L^{-1}. For commercialization of indigenous organics *i.e.* fermentation industry wastes should be used for enriching the compost or other bio-solids like crop residue and agro-industry wastes to make value addition manures.

Challenges and oppotunities

Collecting and transporting agricultural solid wastes poses many serious challenges. For agro-industries unable to compost their residues on-site due to limited space or resources, they need to be able to transport their materials to-an independent composting facility off site. Feasibility for this depends on the haulers. Companies that haul residuals and compost need to have the right equipment, a dense route of industries located within a short distance of each other and a nearby composting facility. Composting fees need to be lower than alternative disposal options, although in many cases they are not. However, there are still limited markets and available land space for using composted materials in land application, Facilities are often forced to landfill a large percentage of the by products they composted because they have no where else to place them. Degraded soil ecosystems need organic matter supplements to stimulate microbial populations, which in turn will be able to support higher plant growth and reduce erosion from bare soils. Recycling them back into the soil directly or as compost is an effective and fairly safe way to restore soil ecosystem balance.

Conclusion

Agricultural solid wastes can be used an alternative sources of fertilizers to save the national economy.

Organics as agricultural solid wastes utilization improves not only its physical condition but also maintains soil health including quality and fertility.

Replacement of O.M. within a soil is a means of amending degraded soils.

Organics obtained from agricultural wastes stimulate microbial populations that are essential to the stability and resilience of the soil ecosystem as a whole

Organics also help in soil re-vegetation and erosion control.

These wastes help to achieve sustainable high yields in food, nutritional security and environmental safety.

References

Chaudhary, R. S., Anchal Das and U. S. Patnaik (2003). Organic farming for vegetable production using vermi compost and FYM in Kakriguda watershed of Orissa. *Indian J. Soil Cons*., **31(2)** : 203-06.

Das, K., D. N. Meadhi and B. Guha (2001). Recyling effect of crop residues with chemical fertilizes on physico-chemical properties of soil and rice (*Oryza sativa*) yield. *Indian J. Agron*., **46** : 640-53.

Hegde, D. M. and S. N. Sudhananbabu (2001). Nutrient management strategies in Agriculture-A future & look. *Fertili News*, **46(12)** : 61-77.

Mahajan, A. and R. D. Gupta (2009). Integrated nutrient management in a rice-wheat cropping system. @ Springer Science + Business media B.V. 2009. Pp. 101-105.