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DISTRIBUTED BIO-FERTILIZER PRODUCTION - A WAY TO HUGE ENERGY SAVING, STRUGGLE FOR EXISTENCE OF MANKIND AND PRACTICE THE PHILOSOPHY OF "LIVE AND LET LIVE".

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ABSTRACT

Increasing application of chemical fertilizers per hectare per year is necessary in order to ensure sufficient yield and supply of food grains to the gigantic and rapidly enhancing population of India. It might cause lack of vital energy and micro nutrients in food grains if the application of fertilizers is non-judicious and imbalanced in the field. If the quality of food grains is not maintained at the standard level due to excessive and non-judicious use of chemical fertilizers, it might cause higher cost of agriculture inputs on one hand and deficiency of micro nutrients in the food-grains on the other hand. Higher cost of inputs, lower minimum support price and lower cost of imported food-grains might put the poor farmers in financial bondage. This situation was the major cause of committing suicide to some of the farmers in some regions of India having less agronomic facilities. In order to put an end to this situation application of balanced, judicious and appropriate chemical fertilizers mixed with bio-fertilizers is essential. In order to achieve this, active participation of plants, animals, insects, earthworms, micro-organisms, etc in agronomic activities is imperative for mutual benefit of both human beings and the eco-system and based on the principle of "Live & Let Live." If all the biomass - food, fodder etc are processed through human beings, animals, earthworms etc. and with the incorporation of composting, Vormi-composting and bio-methanation processes, not only bio-fertilizers but also biogas - a good fuel gas is produced. Involvement of bees as pollinator enhances the crop production appreciably. Production of bio-fertilizer in the farm yard itself saves lot of commercial energy which is consumed in the manufacture of NPK, and its transportation, distribution and application of the same in the field. According to a case study production of one ton urea consumes energy equivalent to 27.66 Giga Cal which is equivalent to around 19 barrel of crude oil. Its mode of transportation and distance of use varies on case to case basis and consumes 120 Mega cal per km (23.28 kWh) and 480 Mega cal per km (93.11 kWh) through rail and road transport respectively where 5.15 Mega Calories is equivalent to one kWh. The energy consumption for manufacture of 1 ton of nitrogenous fertilizer is about nine times that of phosphorus and about 15 times that of potassium. Under the circumstances it has become inevitable to promote preparation of bio-fertilizers through various composting methods preferably NADEP and Vermi-composting, wherever it is not possible to convert the biomass into biogas through biogas plants. Out of 8 million landholders in M.P. around 5million landholders are marginal and small farmers. They could be involved first in the manufacture of bio-fertilizers. This could be done in a phased manner if in the first year 20% marginal and small farmers are motivated to do so and each farmer produces about 9 tons compost by NADEP and 1ton by Vermi-compost method, around 9 million ton compost and 1 million ton Vermi-compost could be produced per year. This could be a better substitute to 0.50 million ton of Nitrogenous fertilizers and could save 0.5x19= 9.5 million barrel of crude oil plus additional commercial energy consumed in its transportation per year a part from improving the fertility of the soil.

Key Words: *Chemical fertilizers, Vormiculture, Nadep Compost, Biomass, Food, Fodder, Fuel, Bio-fertilizer.*

1.0 INTRODUCTION

India is the second largest consumer and third largest producer of chemical fertilizers in the world. Indian population, presently around 1220 million, is continuously increasing at a fast rate and making provision of adequate supply of food grains to this gigantic population seems to be a herculean task when there are constraints of proportionate increase in the agricultural land, irrigation facilities in rain fed areas and excessive use of chemical fertilizers. India has taken the challenge of feeding its more than 1.2 billion people through indigenous food-grain production as far as possible. This could be achieved only through further increase in yield, involving adequate, balanced and appropriate use of chemical and bio-fertilizers, reducing adulteration in chemical fertilizers, addition of additional irrigation facilities in rain fed areas and converting wasteland into agricultural land as far as possible and also with the appropriate application of genetic engineering.

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Consumption of chemical fertilizers in India is more than its indigenous production. Mainly urea, DAP and potassium chloride (MOP) are imported in our country but almost all the requirement of MOP is met through imports only as it is not manufactured so far in India due to non-availability of natural potash deposits. During 2011-12 mono ammonium phosphate (MAP) and potassium sulphate (SOP) were imported only in small quantities. Quantum of imported MAP and SOP was around 65000 and 10500 tons respectively. As against total fertilizer production of 12.16 and 4.36 million tons respectively of N and P_2O_5 in India, total consumption of N, P_2O_5 and K_2O in 2010-11, remained 16.85, 8.04 and 3.4 million tons respectively. In the same year MOP import was 3.34 million tons. [21] Distribution of this mammoth quantity of fertilizers requires a huge supply chain management. If some of the suppliers adopt malpractices and supply sub-standard fertilizers might ruin the region and many of the poor, small and marginal farmers might be in the trap of money lenders or bankers.

Just one year earlier to green revolution in India that is in the year 1966-67, NPK consumption was around 1.1 million tons. In 2011-12 it had reached the level of 27.70 million tons. Average consumption of fertilizers was reported to be 105.5 kg/ha in 2005-06 and the same had achieved the level of 144 kg/ha in 2011-12. Though this consumption level of chemical fertilizer was higher than the world average 107 kg/ha of 2007 yet it was lower than Pakistan (205) and China (396) in the same year. Further, very high variation was observed among various states across India and among various crops. [1]

In 2011-12 quantity of chemical fertilizer used per hectare in Andhra Pradesh and Punjab was very high and was 266.11 and 243.56 kg/ha respectively as compared to Madhya Pradesh where it was 88.36 kg/ha and world average was 105 kg/ha in the same period. [1] In India price of urea is much lower than that of other fertilizers as it is decided administratively whereas rates of other fertilizers are market based and generally on higher side. Lower rates of urea in many cases were responsible for its non-judicious and excessive use and distortion and deviation in the norms of the use of fertilizers. This necessitated the balanced use of fertilizers in the interest of peasants and agronomy as a whole and government introduced Nutrient Based Subsidy (NBS) policy from April 2010.

Balanced use of fertilizers input is supposed to ensure adequate availability of nutrients in the soil to meet the requirement of plants at critical stages of growth. This is only possible when soil sample is tested first and based on the deficiencies noticed in test report of the soil, balanced and judicious use of appropriate chemical fertilizers in conjunction with bio-fertilizers are promoted and applied in the field so that purpose of addition of nutrients to sustain and improve soil health and its productivity is achieved. Further, lack of awareness about soil testing and intensive agriculture is leading to widespread deficiency of micronutrients such as zinc, iron, manganese and boron in the soil. Similarly, imbalanced NPK application, rising multi nutrient deficiency and lack of application of organic manure are leading to reduction in carbon content in the soil. Soil Organic Carbon (SOC) is central to soil health as it influences soil structure, water retention, microbial activities, soil aeration and nutrient retention. Depletion of soil organic carbon is leading to poor fertilizer use efficiency (FUE) of the soil which on an average is estimated to be 33% for N; 15% for P; 20% for K and micro-nutrients as against 50% for N; 30% for P and 50% for K with the best management practices.

Though the agricultural production was more or less sustained due to increased use of fertilizers yet it also increased the cost of production of agricultural produce. In some states where consumption of chemical fertilizers was more than the average consumption of India, this cost of production was higher than the minimum support price (MSP) of the produce. The situation was further aggravated because of globalization of economy and WTO agreement, as lot of agriculture produce were poured in at lower prices from other countries and many small and marginal formers of various states of our country had to commit suicide. In the year 2004 alone nearly 10,000 farmers had to commit suicide. Out of these 10000 farmers, 3000 were from Andhra Pradesh where per hectare use of N+P+K is highest in India and around 267 kg/ha. Introduction of customized fertilizers on the basis of soil testing and the agronomic multi-location trials which are crop specific and area specific is recommended. Promotion of Integrated Nutrient Management (INM) which includes soil test based balanced and judicious use of chemical fertilizers in conjunction with bio-fertilizers, and organic manures like Farm Yard Manure (FYM), NADEP Compost, Vermi-compost, Green Manure, Fruit and Vegetable Waste Compost, Municipal Solid Waste (MSW) Compost etc.

This work is being focused on Madhya Pradesh as on one hand the wheat of this state is being sold at highest price in Mumbai, Pune, and Bangalore etc. because of superior quality and on the other hand it is reported that the state is one of the toppers of the Indian State Hunger Index. In 2011-12 agricultural growth in M P was highest in India. With 18% growth rate in agriculture and highest production of pulses and oil seeds and record production and purchase of wheat on minimum support price MP won “The Agriculture Leadership Award 2011-12” from Central Government. In M P where number of land holders is around 8 million in which small and marginal farmers’ number around 62% i.e. around 5 million farmers who could gradually and easily switch over to production of bio-fertilizers and ultimately to organic farming as the state government has already taken initiative in this direction and marching ahead with farmers.

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2.0 MAIN CONSUMERS OF FOOD, FODDER AND FUEL RESOURCES

2.1 Indicators (2010–11) Source: M P Government Dairy Vital Statistics

Description	**India**	**Madhya Pradesh** Table- 1 [3]
Area in Sq.km	3287263	308245 (9.38% of India)
Population*	1,210,193,422	72598000 (5.88%)
Urban	388,524,900	20060000
Rural	821,668,522	52538000
BPL	-	5300000
Male	623,724,248	37613000
Female	586,469,174	34985000
***Census 2011**	100%	Census 2011 6%

2.2 Total Number of Livestock and Poultry—2007 Livestock Census

S No.	**Species**	**Madhya Pradesh**	**All India** Table-2 [19]
		Figs. in Thousands	Total in Thousands
1	**Cattle**	**21915**	**199075**
2	**Buffaloes**	**9129**	**105343**
3	**Sheep**	**390**	**71558**
4	**Goat**	**9014**	**140537**
5	**Pigs**	**193**	**11134**
6	**Horses**	**27**	**611**
7	**Mules**	**3**	**137**
8	**Donkeys**	**20**	**438**
9	**Camel**	**4**	**517**
10	**Yaks**	**-**	**83**
11	**Mithun**	**-**	**264**
12	**Total**	**40695**	**529697**
13	**Poultry**	**7384**	**648830**

From the data depicted in the above tables, it is clear that Madhya Pradesh has around 308 thousand square kilometer land area including forest, agricultural land, wasteland etc to produce food and fodder and other biomass, 72.60 million people, about 40.7 million live stock and 7.39 million poultry birds to consume food, fodder and other biomass as fuel and produce night soil, droppings, manure along with forest, farm, domestic and other waste etc.

2.3 Total Operational Land Holding of Madhya Pradesh

As on the national level, all the land holding farmers of Madhya Pradesh have also been classified into five categories- marginal (below 1 Ha.), small (1 to 2 Ha), semi-medium (2 to 4 Ha), medium (4 to 10 Ha), large (10 Ha and above) farmers with land holding limits given in the following brackets. Number of marginal and small farmers represents 62% and other remaining farmers 38% of the total farmers. These 62% farmers (marginal & small farmers around 5 million) hold only 22% of the total land area and other 38% farmers possess 78% land area. If these 5 million farmers are properly encouraged to produce bio-fertilizers and practice organic farming, the production of quality food grains would be enhanced with reduced cost of inputs and lot of energy saving to the nation. [3]

3.0 LAND USE, CROPPING PATTERN, FOOD-GRAINS AND BY-PRODUCT PRODUCTION

3.1 Cropping Pattern in India

Table-3 [1] **Area** (in Million Hectares) **Years →**	1990-91	2003-04	2009-10
Total Area Under Crops	185.74	189.67	192.20
Net area sown	143.00	140.71	140.02
Cropping Intensity (percent)	129.89	134.80	137.26
Area under Food Crops	141.03	142.12	141.06
Area under Non-Food Crops	44.71	47.55	51.14
Net Irrigated area	48.02	57.05	63.26
TOTAL/Gross Irrigated Area	63.20	78.04	86.42

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3.2 Land Use in Madhya Pradesh v/s India

Description (2012-13)	Madhya Pradesh	India Table-4 [3]
Agricultural Area as per village papers	23134000 ha	182.46 million ha (55.5%)
Net Area Sown	15223000 ha	140.02 million ha (42.6%)
Gross Sown Area	22149000 ha	
Net Irrigated Area	7140000 ha	
Gross Irrigated Area	7421000 ha	
Rain fed Area	13340200 ha	
Area under Forest	**94690 Sq. KM**	**70 million ha (21.2%)**
Cultivable Wasteland	1072000 ha	12.86 million ha (3.9%)
Number of land holdings	**7.908 Million**	
Area of land holdings	15.994 Million ha	
Average Size of Land Holdings	2.2 ha	

3.3 Food Grains Production in 2010 -11 in Madhya Pradesh

Food Grains Production in 2010 -11 in Madhya Pradesh Figures Published in State Govt. Diary 2012-13 Table-5	
Type	Quantity in Million Tons
Soybean	6.281
Total Oil Seeds Including Soybean	7.640
Sugar Cane in terms of Jaggery/Gur	0.196
Cotton (Lakh Bags of 180kg each)	0.961
Average Yield of Principal Crops in kg per hectare (2010 – 11)	
Paddy (Rice)	1182
Wheat	2073
Jawar	1416
Gram	785
Soybean	1109
Sugar Cane (in terms of Jaggery/Gur)	4069
Cotton	926

3.4 Production of Major Crops during the Recent Years in India [1]

Crop Table-6 Million tons or bales	**Season**	**2007 -08**	**2008 -09**	**2009 -10**	**2010 -11**	**2011-12 Final Estimates**	**2012-13 2nd Adv. Estimates**
Rice	Kharif	82.66	84.91	75.92	80.65	92.75	90.69
	Rabi	14.03	14.27	13.18	15.33	12.56	11.11
	Total	96.69	99.18	89.10	95.98	105.31	101.80
Wheat	Rabi	78.57	80.68	80.80	86.87	94.88	92.30
Coarse Cereals	Kharif	31.89	28.54	23.83	33.08	32.46	28.51
	Rabi	8.86	11.49	9.72	10.32	9.58	9.96
	Total	40.75	40.03	33.55	43.40	42.04	38.47
Total Cereals	Kharif	114.55	113.45	99.75	113.73	125.21	119.19
	Rabi	101.46	106.45	103.70	112.52	117.02	113.37
	Total	216.01	219.90	203.45	226.25	242.23	232.56
Pulses	Kharif	6.40	4.69	4.20	7.12	6.06	5.48
	Rabi	8.36	9.88	10.46	11.12	11.03	12.09
	Total	14.76	14.57	14.66	18.24	17.09	17.57
Food grains	Kharif	120.96	118.14	103.95	120.85	131.27	124.68
	Rabi	109.82	116.33	114.15	123.64	128.05	125.47
	Total	230.78	234.47	218.10	244.49	259.32	250.15
Oilseeds	Kharif	20.71	17.81	15.73	21.92	20.69	19.45
	Rabi	9.04	9.91	9.15	10.56	9.11	10.01
	Total	29.75	27.72	24.88	32.48	29.80	29.46
Sugarcane		348.19	285.03	292.30	342.38	361.04	334.54
Cotton*		25.88	22.28	24.02	33.00	35.20	33.80
Jute & Mesta**		11.21	10.37	11.82	10.62	11.40	11.13

*** (Million bales of 170 kg each), ** (Million bales of 180 kg each)**

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3.5 Biomass Production from various Forest & Agriculture Resources

S No.	Type of Land Table-7 [6]	Land Area in million ha	Biomass Production million tons
1	Arable Land	163	900
2	Pastures and Grazing Land	13	45
3	Forest	66	262
4	Others	84	42
5	Total	326	1249
Source – Proceedings of Bio-energy Society of India, 1st Convention, 1985			

3.6 Seasonal Availability of Various Agricultural Residues/Biomass per Year

S No.	Table-8 [6]	Quarterly Availability in Million Tons			
	Agricultural Residues/by-products	**First**	**Second**	**Third**	**Fourth**
1	Crop Residue	21.50	24.50	26.70	221.10
2	Cereals	3.60	3.60	3.60	3.60
3	Pulses	-	-	2.90	88.60
4	Plantation Crops	8.60	8.60	8.60	8.60
5	Fibre Crops	0.60	0.60	11.30	14.90
6	Fruits	0.50	1.13	1.13	0.50
7	Vegetables	0.30	0.30	0.30	0.30
8	Agro-industrial by-products	-	-	-	-
9	Rice Husk	-	-	-	18.0
10	Jute Mill Waste	0.12	0.12	0.12	0.12
11	Cotton Dust	0.08	0.08	0.08	0.08
12	Cotton Linters	0.03	0.03	0.03	0.03
13	Sugar Cane Bagasse	1.75	1.75	-	1.75
14	Molasses	0.70	0.70	-	0.70
15	Sawdust	0.50	0.50	0.50	0.50
16	Animal and Poultry Waste	-	-	-	-
17	Wet Cattle Dung	215.00	215.00	215.00	215.00
18	Cattle Urine	9.25	9.25	9.25	9.25
19	Sheep and Goat Waste	11.25	11.25	11.25	11.25
20	Poultry Waste	0.25	0.25	0.25	0.25
21	Fisheries and Marine Waste	0.36	0.36	0.36	0.36
22	Community Waste	37.50	37.50	37.50	37.50
23	**Total**	**314.89**	**315.52**	**318.87**	**446.69**
24	**Grand Total of all Four Quarters = 1395.97 Million Tons***				
25	**Source – Proceedings of Bio-energy Society of India, 1st Convention, 1985**				

*** As the production of food grains is increasing proportionately crop residue is also increasing.**

Assuming that out of around 1400 million tons of biomass / residue produced if about 10% waste residue is made available for the preparation of bio-fertilizers then around 200 million tons compost could be easily made by adopting NADEP method of composting.

4.0 FERTILIZER APPLICATION

4.1 Consumption of Fertilizes in Selected Countries in 2007 & 2008 (Kg Per ha) Table-9 [15]

Country	Nitrogen (N)		Phosphate P_2O_5		Potash K_2O		Total ($N+P_2O_5+K_2O$)	
	2007	2008	2007	2008	2007	2008	2007	2008
USA	11480.0	10906.0	3840.6	3072.0	4219.0	2531.4	19539.6	16509.4
China	**33111.8**	**33236.7**	**11569.8**	**10500.0**	**6480.0**	**4685.0**	**51161.6**	**48421.7**
India	**14419.1**	**15090.5**	**5514.7**	**6506.2**	**2636.3**	**3312.6**	**22570.0**	**24909.3**
Pakistan	2925.3	3035.0	629.9	629.9	27.0	25.0	3582.2	3689.9
France	2402.7	2098.9	631.3	295.6	794.2	390.4	3828.2	2784.9

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4.2 Yearly Food Grain Production versus Fertilizer Consumption from 2003 to 2012 Table-10 [15]

Item	2002 -03	2003 -04	2004 -05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12
Food grain Production	**174.78**	**213.19**	**198.36**	**208.6**	**217.28**	**230.78**	**234.47**	**218.20**	**244.49**	**259.32**
Fertilizers Consumption in Nutrients	**16.094**	**16.799**	**18.398**	**20.34**	**21.652**	**22.570**	**24.909**	**26.086**	**28.122**	**27.743**

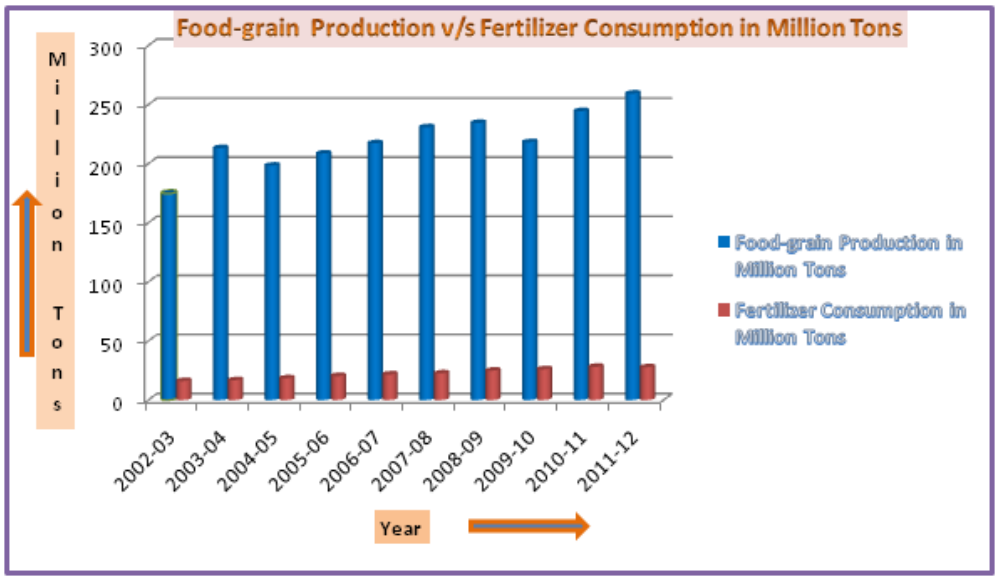

Figure -1

From the data given above and graph depicted in fig.1, it is clear that as the production is increasing correspondingly consumption of chemical fertilizers is also gradually increasing and proportionately agricultural residue production is also enhancing up for consumption of livestock and as fuel or composting material.

4.3 Fertilizer Consumption in Some States of India in kg/ha during 2009-10 Table-11 [15]

S. No.	State/Union Territory	Per Hectare fertilizer Consumption in Kg*			
		N	P_2O_5	K_2O	Total
1	Gujarat	89.59	38.75	16.72	145.06
2	Madhya Pradesh	45.94	29.21	5.63	80.79
3	Chhattisgarh	58.83	34.07	12.17	105.07
4	Maharashtra	64.81	44.44	25.60	134.85
5	Haryana	145.42	42.43	9.25	197.10
6	Punjab	165.74	46.69	9.20	221.63
7	Uttar Pradesh	114.77	39.41	11.36	165.53
8	Uttarakhand	93.18	20.34	5.40	118.92
	All India	78.92	35.96	18.34	133.22

** Estimated (Based on 2007-08 Gross Cropped area)*

Fertilizers - Huge population and livestock of our country are increasing at a fast pace. In order to fulfill the needs of this gigantic population for food, fodder, fibre and fuel, fertilizers play an important role and are supposed to be the major contributors in food grain production.

Application of chemical fertilizers is rising year by year from 9.4 kg/ha in 1978-79 to 62.7 kg/ha in 2006-07. This increase was around 6.7 times. Major growth had been observed in the consumption of nitrogenous and phosphorus fertilizers due to the shift in cropping pattern from food grains to oilseeds and growth in irrigation facilities. In the year 2011-12 average fertilizer consumption of India has reached to the level of 144kg/ha.

4.4 Year-wise Fertilizer Consumption in Madhya Pradesh (kg/ha)

Period	N	P	K	N+ P+K Total Table-12
1978-79	5.79	2.91	0.70	**9.40**
1988-89	17.42	12.33	1.56	**31.31**
1998-99	25.88	18.27	2.17	**46.33**
2006-07	37.58	21.32	3.39	**62.70**

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2009-10	43.78	28.15	5.29	**77.21**
2010-11	47.67	35.39	6.13	**89.19**
2011-12	49.54	35.03	3.71	**88.28**
2012-13	42.07	27.34	2.73	**72.15**
Source: Department of Agriculture, Govt. of M. P.				

4.5 Installed Capacity of Various Fertilizer Plants in India

Product	No. of Units	Total Installed Capacity in Million Tons per Annum Table-13 [15]
Urea	31	21.084*
DAP	12	7.299
Complexes	19	5.222
SSP	80	7.713
**At present operational capacity is 20.030 Million Tons since FACT-Cochin and DIL Kanpur are under shut down. In the absence of domestic natural resources, complete requirement of potash is imported;*		

4.6 Production of Various Fertilizer Plants from 2002-03 to 2009-10

Production of Urea, DAP and Complexes in Million Tons Table-14 [15]

Product/Year	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10
Urea	18.730	19.200	20.260	20.100	20.310	19.860	19.920	21.112
DAP	5.236	4.734	5.184	4.628	4.852	4.212	2.993	4.246
Complexes	4.859	4.511	5.363	6.764	7.464	5.850	6.848	8.038

4.7 Sector-wise Production of Complex Fertilizers from 2002-03 to 2009-10 in Thousand tons Table-15 [15]

Sector	Annual Inst. Cap.	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-2010
Public Sector	2134.5	1641.8	1513.7	1454.5	1602.8	1291.2	928.6	1076.3	1261.5
Coop. Sector	1635.4	860.2	901.8	1182.2	1862.8	2004.5	1805.3	2448.6	2749.7
Private Sector	1452.5	2357.2	2095.6	2726.9	3298.6	4168.5	3116.1	3323.5	4027.1
Total	5222.4	4859.2	4511.1	5363.4	6764.2	7464.2	5850.0	6848.4	8038.3

Location Map of Fertilizer Factories Source: http://business.mapsofindia.com/

4.8 Imports of Major Fertilizers from 2002-03 to 2009-10 (In million tons) Table-16 [15]

Year	Urea	DAP	MOP
2002-03	0.00	0.371	2.533
2003-04	0.143	0.734	1.841
2004-05	0.641	0.644	3.409
2005-06	2.056	2.828	4.529
2006-07	4.719	2.875	3.448
2007-08	6.928	2.990	4.420
2008-09	5.667	6.192	5.672
2009-10	5.209	5.889	5.286
Source: Department of Fertilizers, Ministry of Chemicals & Fertilizers			

4.9 Port-Wise Import of Fertilizers from 2006-07 to 2009-10 in Million Tons Table-17 [15]

Port	2006-07			2007-08			2008-09			2009-10		
	Urea	MOP	DAP	Urea	MOP	DAP	Urea	MOP	DAP	Urea	MOP	DAP
Bhavnagar	0.054	0.037	0.000	0.022	0.016	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Channai	0.202	0.342	0.063	0.320	0.287	0.012	0.144	0.223	0.093	0.080	0.290	0.039
Cochin	0.000	0.075	0.000	0.028	0.025	0.000	0.070	0.079	0.000	0.084	0.000	0.000
Cuddalore	0.000	0.000	0.000	0.048	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Dharamtar	0.024	0.248	0.053	0.000	0.199	0.000	0.030	0.198	0.012	0.000	0.016	0.000
Haldia	0.095	0.295	0.018	0.017	0.361	0.000	0.000	0.388	0.000	0.000	0.133	0.000
Kakinada	0.467	0.340	0.000	0.501	0.532	0.000	0.519	0.745	0.564	0.578	0.540	0.264
Kandla	0.678	0.538	0.527	1.783	1.035	0.848	1.452	1.338	2.161	1.116	1.223	2.321
Karwar	0.046	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Krishnaputnam	0.000	0.000	0.000	0.000	0.000	0.000	0.061	0.000	0.000	0.531	0.215	0.077
Mormugad	0.000	0.209	0.000	0.000	0.261	0.000	0.000	0.275	0.000	0.000	0.000	0.000
Mumbai	0.000	0.026	0.019	0.000	0.023	0.004	0.000	0.000	0.000	0.000	0.000	0.000
Mundra	0.533	0.142	0.800	0.719	0.124	1.113	0.612	0.264	1.380	0.741	0.257	1.272
New Mangalore	0.516	0.321	0.100	0.345	0.330	0.290	0.316	0.303	0.130	0.228	0.338	0.235
Paradeep	0.089	0.175	0.000	0.128	0.127	0.007	0.173	0.340	0.000	0.080	0.157	0.073
Rozy	0.063	0.000	0.609	0.313	0.016	0.212	0.187	0.000	0.539	0.083	0.043	0.527
Tuticorin	0.275	0.281	0.107	0.601	0.397	0.059	0.466	0.523	0.509	0.337	0.678	0.245
Vizag	1.292	0.419	0.580	1.720	0.597	0.440	1.193	0.931	0.806	0.752	1.055	0.751
Pipavava	0.385	0.000	0.000	0.383	0.000	0.000	0.395	0.000	0.000	0.396	0.207	0.081
Mbpt	0.000	0.000	0.000	0.000	0.047	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Gopalpur	0.000	0.000	0.000	0.000	0.045	0.000	0.049	0.050	0.000	0.000	0.031	0.000
Gangavaram	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.203	0.000	0.000
Goa	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.100	0.096	0.000
Grand Total	**4.719**	**3.448**	**2.876**	**6.928**	**4.421**	**2.724**	**5.627**	**5.672**	**6.192**	**5.209**	**5.286**	**5.888**

4.10 Consumption of Fertilizers in Terms of NPK Nutrients in India in Million Tons Table-18 [1]

1	**Consumption of Fertilizers**	1991-92	2000-01	2005-6	2009-10	2010-11	2011-12
	Nitrogenous (N)	8.046	10.920	12.723	15.580	16.558	17.302
	Phosphatic (P)	3.321	4.215	5.204	7.274	8.050	7.915
	Potassic (K)	1.361	1.567	2.413	3.632	3.514	2.525
	Total (N+P+K)	**12.728**	**16.702**	**20.340**	**26.486**	**28.122**	**27.743**
2	**Consumption of Fertilizers** kg/ha	69.840	89.630	105.500	135.760	144.140	144.350
	Source: State Governments						

4.11 Consumption of Fertilizers in India in Million Tons Table-19 [1]

S No.	**Consumption of Fertilizers**	**1991-92**	**2000-01**	**2005-6**	**2009-10**	**2010-11**	**2011-12**
1	**Urea**	14.004	19.186	22.297	26.673	28.112	29.565
2	**DAP**	4.518	5.884	6.764	10.492	10.870	10.191
3	**MOP**	1.701	1.829	2.731	4.634	3.932	3.029
4	**NPK Complex**	**3.221**	**4.780**	**6.694**	**8.025**	**9.764**	**10.395**
5	**SSP**	3.165	2.860	2.756	2.651	3.825	4.746
	Source: State Governments						

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5.0 QUALITY CONTROL OF CHEMICAL FERTILIZERS

Quality control is the process of checking the quality of the material under test against the standard set by the organizations, if the material does not match the standards/parameters then the material is said to be below standard and the prescribed steps will be taken against the persons who are found to be involved in degrading the material to substandard.

5.1 Quality Control of Fertilizers

In order to check the quality of the fertilizers sold in India, at present there are 74 Fertilizer Quality Control Laboratories functioning under the control of various State Governments. Since quality testing is a statutory requirement under the Fertilizer Control Order, 1985, it is imperative to maintain and run these labs in an efficient manner so that poor farmers do not get deceived by the sub-standard supply and use of chemical fertilizers. Further, there should be adequate FQTL (Fertilizer Quality Testing Laboratory) in order to ensure that all the dealers in the country are covered for quality checks and fertilizer samples could be tested in as many numbers as possible. [21]

5.2 The Product-Wise Details of Non Standard Samples Found during 2011-12; Table: 20 [21]

S No.	Source of Samples	Analyzed	Non-standard	% Non-standard
1	Urea/AS/Amm. Chloride	1.0	0.0	0.00
2	MOP	-	-	0.00
3	DAP	7.0	1.0	14.30
4	SSP/TSP	25.0	10.0	40.00
5	NPK Complex	14.0	6.0	42.80
6	NPK Mixture	18.0	9.0	50.00
7	MNF	40.0	5.0	12.50
8	100%W.S. Complex	6.0	3.0	50.00
9	Sulphur	4.0	0.0	0.00
	Total	115.0	34.0	29.60

The product-wise analysis indicates that 50% NPK mixtures and Water soluble Complex Fertilizers, 42.8% NPK Complex, 40% SSP/TSP, 14.3% DAP and 12.5% MNF samples were found non-standard during 2011-12.

5.3 Sub-Standard Samples

On all India basis 11.3% of SSP followed by 10.2% of MNF, 7.9% NPK Mixtures, 7.1% NPK Complexes, 6.2% DAP and 1.4% MOP/SOP samples were found non-standard during 2001-02, but its magnitude varied from State to State. The non-standard **Single Super Phosphate (SSP)** varied from only nil in Assam, Jharkhand, H.P., Kerala, Pondicherry to **36% in M.P.** Similarly the non-standard fertilizer mixtures varied from only Nil in H.P. and Pondicherry to **33% in M.P. and 42% in Bihar.** The percentage of sub-standard samples on all India level is floating or hovering around 5.5% ever **since last 5 years.** However, it varied from state to state as **29.9 % in M.P**., 15.8% in West Bengal, 8-10% in U.P. & Orissa, 3-5% in Chhattisgarh, Punjab, & around 1.1% in Gujarat, H.P., J&K, Kerala, and Andhra Pradesh. This does not seem to be the ground reality as the supply chain system of fertilizers in India is one of the largest systems in the world and corruption now-a-days is on peak. As such there is urgent need to adopt organic farming as well as checking adulteration of chemical fertilizers so that judicious use of mix of chemical and organic fertilizers could be ensured. In percentages given above maximum number of samples found non-standard were from Madhya Pradesh and Bihar.

6.0 ENERGY CONSUMPTION IN AGRONOMIC ACTIVITIES

6.1 Share of Various Commercial Energy Inputs in the Farm Requirement for Wheat

S No.	Agricultural Inputs	% Share of Commercial Energy to Total Inputs in Agriculture Table-21 [7]
1	**Direct**	
	1.1 Diesel	40.50
	1.2 Electricity	06.50
2	**Indirect**	
	N	44.30,
	P_2O_5	04.90, i.e. N+P+K = 50%
	K_2O	00.80
3	**Chemicals**	00.60
4	**Machinery**	02.00
Source: Pathak and Bining [1985]		

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6.2 Average Energy use in Manufacturing Various Fertilizers and production of Crops

S. No.	Table-22 [7] Fertilizer	Average Energy Input (GJ)/MT of the Nutrient		
		N	P_2O_5	K_2O
1	Urea (Prilled)	79.5	-	-
2	Ammonium Nitrate (Prilled)	73.4	-	-
3	Ammonium Sulphate	60.0	-	-
4	TSP (Granular)	-	9.4	-
5	DAP (Granular)	57.2	8.6	-
6	SSP (Granular)	-	8.5	-
7	MOP (Granular)	-	-	4.8

NPK Consumption Ratio - Optimum Consumption Ratio of NPK is 4.0: 2.0: 1.0 [15]

Though the share of Nitrogen reduced from 89% in 1950-51 to about 66% in 1970-71, it floated around that level during seventies and the ratio of NPK was reported 4.6:2.0:1 and 4.3:2.0:1 in the year 2008-09 and 2009-10 respectively. Thus N contributed two-third of the total fertilizer consumption in India.

Nitrogen also played a major role in the energy consumption in agriculture. The average energy consumption of N, P_2O_5 and K_2O through different fertilizer materials is shown in Table-22.

The energy consumption for the manufacture of 1 ton of nitrogenous fertilizer is about nine times that of phosphorus and about 15 times that of potassium. This shows the extent to which nitrogenous fertilizers are contributing to the total energy consumption in agriculture.

Among the nitrogenous fertilizers, consumption of urea is the highest of all. In India the share of urea in the total nitrogen consumption is approximately 90%. Therefore, the energy input study was done with focus on urea as the main fertilizer.

6.3 Energy Input-Output Relationship – A Case Study of Indian Farmers Fertilizers Cooperative (IFFCO) Limited

IFFCO is a cooperative sector organization involved in manufacturing and marketing urea and complex fertilizers throughout the country. Urea and ammonia are manufactured at Kalol (Gujarat) and Phulpur (Utter Pradesh) and complex fertilizers at Kandla (Gujarat).

The urea that is manufactured at Phulpur plant is included in the present analysis. Naphtha is used as basic feedstock and fuel oil, High Speed Diesel and coal as fuel materials in this plant.

The energy input in the form of fertilizers involves the consumption of energy at the stages of manufacturing fertilizers and packing material, baggage, transportation and application in the fields**.** The estimation of energy consumption in manufacturing of ammonia and urea at one of the plants of IFFCO is presented below;

6.3.1 Energy Consumption in the Manufacture of Urea

Various materials that are consumed in the manufacture of ammonia and urea at Phulpur plant of IFFCO are shown in Table: 23. The quantity of consumption per ton of urea was calculated by taking the average consumption during the year, July 1984 to June 1985. These materials were converted into energy units and the total energy consumed for the manufacture of one ton of urea was calculated as 12.25 G cal.

Energy Consumption in the Manufacture of Urea at Phulpur Plant
(Average during the year July,84 to June'1985) Table:23 [7]

S No.	Material Used	Consumption Per Ton of Urea	
		Quantity in kg	**Energy Units in (G cal)**
1	Naphtha	559.31	6.3220
2	Fuel Oil	101.17	1.0800
3	HSD	6.88	0.0700
4	Coal	748.60	4.7160
5	Power	76.20	0.0658
Total Energy Consumption per Ton = 12.25 G cal			**12.2538**

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6.3.2 Energy for Packing, Transportation and Application

It had been estimated that the industrial average for manufacture of polyethylene bags is 0.148 G cal per 20 bags, each of the capacity of 50 kg and 0.100 G cal of energy for the bagging of one ton of the material. The energy consumed for the application of the fertilizer was estimated at 0.14 G cal/ton. (Table-24)

Case to case variation is generally experienced in the distance and mode of transportation of fertilizers from factories to field via dealers. Under this case study it was estimated that **120000 k cal** (0.0822 barrel of crude oil) of energy is at least needed for the transportation of fertilizers per ton per km by rail and **480000 k cal** (0.329 barrel of crude oil) by trucks. [7]

The equivalent energy consumed is shown in the total energy input in the form of fertilizers is thus, calculated as under;

S No.	**Process/Item**	**G. cal/T of Urea** Table: 24 [7]
1	Manufacturing	12.250
2	Bags	00.148*
3	Bagging	00.100*
4	Application	00.140*
5	Transportation	00.086
	Total	12.724
* Source An Illustrative Model for Fertilizer Complex and New Product Pattern (1985) S. K. Mukherjee		

The total energy consumed for per ton of nitrogenous fertilizer would work out to be 27.66 G cal.

6.3.3 Energy Conversion Equivalent Units

1 kilowatt-hour (kWh) = 3.6 x 10^6 J,
1 Calorie (mean) = 4.1900 J,
Therefore 1 kWh = 5155131.265 Calorie = 5155131.265 / 1000 = 5155.131265 **Kilo calorie**
Therefore 27.66 G Cal = [(1/.0051551)*27.66] kWh = **5365.53 kWh would be consumed to produce 1 ton of nitrogenous fertilizer**
1 barrel of crude oil = 6.12 G J = [6.12* (1/4.19)] GC = 1.46 GC
27.66 GC is equivalent to 27.66/1.46 = 18.94521 barrel of crude oil **would be consumed to produce 1 ton of nitrogenous fertilizer**
Since 1.46 GC = 1 barrel crude oil (BCO), Therefore 1GC = 1/1.46 BCO = 0.685 BCO
Or, 1x 10^6KC = 0.685BCO or, 120000 KC/km = 0.082 barrel crude oil/km by rail and 0.329 barrel/km by road for transportation of chemical fertilizers per ton.

7.0 ORGANIC FARMING

Excessive use of chemical fertilizers and reduced or nil use of bio-fertilizers are the main causes of deficiencies of certain vital components in food grains. Though the yearly production of food grains is increasing with increased input of fertilizers yet the quality of food is deteriorating gradually and food prepared out of these food grains, is acting as filler in the stomach for subsiding hunger with less or very less or no vital energy and micro-nutrients. Another impact of the excessive use of chemical fertilizers and pesticides in agriculture is having its own devastating effects on the environment, especially land and water in this case.

While the use of fertilizers in Madhya Pradesh is much less as compared to other states of India and hence its negative effects are yet to appear in full force, we take evidence both from other states and from Madhya Pradesh to caution on the ever increasing use of chemical fertilizers, adulterated chemical fertilizers emphasize that use of organic fertilizers and organic farming is a fairly viable and environmentally sound alternative. The benefits of organic produce in terms of health and nutrition are well known. Bringing more farmers/farmers' groups under organic farming, production of on-farm organic inputs and proper organic management of such farms need to be encouraged to increase the quantity and quality of the produce and bring down its prices, save huge quantum of energy and also bring down the cost of other inputs of agriculture in the interest of farmers and the nation. **Production of bio-fertilizers in various states of India from 2003-04 to 2009-10 is given below;**

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7.1 Zone-wise Production of Bio-fertilizer in India

Production of Bio-fertilizer in India (In Tons) South Zone								Table - 25 [15]
S. No.	Name of State	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10
1	A & N Island	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	Andhra Pradesh	205.00	2019.50	2246.43	4500.62	4515.81	168.14	1345.28
3	Daman & Diu	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	Karnataka	1083.40	1135.86	612.00	341.64	2841.27	11921.06	3695.50
5	Kerala	54.85	213.25	8.34	261.75	814.45	1187.00	1987.45
6	Lakshadweep	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	Pondicherry	22.62	0.00	7.78	1827.78	471.29	561.79	452.79
8	Tamil Nadu	1845.50	1564.94	2207.58	1770.29	3466.97	4687.82	3732.59
South Zone Total		3211.37	4933.55	5082.13	8702.08	12109.78	18525.80	11162.61
Production of Bio-fertilizer in India (In Tons) West Zone								TABLE – 26 [15]
S. No.	Name of State	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10
9	Chhattisgarh	86.95	0.00	0.00	0.00	0.00	0.00	0.00
10	Gujarat	1034.85	943.00	1371.60	1250.63	1263.30	1149.70	1309.20
11	Goa	0.00	0.00	0.00	3.50	0.00	0.00	0.00
12	**Madhya Pradesh**	**1300.45**	**1333.94**	**823.07**	**1204.76**	**1884.87**	**848.448**	**1587.68**
13	Maharashtra	3035.00	3049.98	2098.96	2425.96	2486.41	1249.87	1861.33
14	Rajasthan	590.01	30.64	430.59	339.75	302.30	353.67	805.57
15	D & N Haveli	0.00	0.00	0.00	0.00	0.00	0.00	0.00
West Zone Total		6047.26	5357.56	4724.60	5224.60	5936.88	3601.68	5563.76

Production of Bio-fertilizer in India (In Tons) North Zone								TABLE – 27 [15]
S.No.	Name of State	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10
16	Delhi	0.00	1.36	1.23	0.00	168.84	1165.10	1021.85
17	Chandigarh	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18	Haryana	22.54	20.16	23.48	30.22	8.89	14.25	6.20
19	Himanchal Pradesh	9.48	10.30	9.59	0.00	56.21	0.00	8.50
20	Jammu & Kashmir	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21	Punjab	2.95	0.37	2.27	2.00	1.70	1.14	301.23
22	Uttar Pradesh	115.98	130.27	486.30	212.78	250.06	885.52	962.64
23	Uttarakhand	0.00	0.00	0.00	0.00	0.00	48.23	32.00
North Zone Total		150.95	162.46	522.87	245.00	485.70	2114.23	2332.42
Production of Bio-fertilizer in India (In Tons) East Zone								TABLE – 28 [15]
S.No.	Name of State	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10
24	Bihar	0.00	15.00	41.00	36.90	168.84	1165.10	1021.85
25	Jharkhand	0.00	0.00	9.00	205.62	201.68	15.00	15.00
26	Orissa	59.31	32.62	65.97	280.54	331.94	405.03	289.87
27	West Bengal	226.53	74.30	194.60	1406.48	922.34	241.24	256.50
East Zone Total		285.84	121.92	310.57	1929.54	1475.96	661.27	561.37
Production of Bio-fertilizer in India (In Tons) North East Zone								TABLE – 29 [15]
S. No.	Name of State	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10
28	Arunachal Pradesh	0.00	0.00	0.00	0.00	00.00	0.00	0.00
29	Assam	88.50	25.20	107.60	8.465	70.901	129.36	121.04
30	Manipur	0.00	00.00	00.00	00.00	00.00	0.00	0.00
31	Meghalaya	0.00	00.00	00.00	00.00	00.00	0.00	0.00
32	Mizoram	1.14	0.000	0.000	1.68	3.58	1.996	2.50
33	Nagaland	2.950	0.370	17.03	10.65	13.98	16.01	18.25
34	Sikkim	0.00	0.00	0.00	0.00	0.00	0.00	0.00
35	Tripura	5.80	00.00	00.00	23.25	14.27	14.68	278.402
North **East** Zone Total		103.47	25.20	124.63	44.04	102.73	162.04	420.19
Grand Total		**9798.89**	**10600.69**	**10764.42**	**16145.26**	**20111.05**	**25065.03**	**20040.35**

Source: DAC - National Centre of Organic Farming (NCOF), Ghaziabad

From the figures of bio-fertilizer production particularly of Punjab, Haryana, Maharashtra and Madhya Pradesh given in the above table and use of chemical fertilizers being done currently (given in table-11) by the same states, one can easily infer why quality of food-grains produced has deteriorated in Punjab and Haryana and why the per hectare production of food-grains is going down in Maharashtra.

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7.2 Biogas and Bio-fertilizer from various By-products/Components of Jatropha Curcus

When 4444 J. curcus plants are grown per hectare through the saplings, at least one year old, grown in the site nursery, these plants generally bear fruits from second year of its plantation and the economic yield stabilizes from the fifth year onwards. Seeds become mature when the schizocarp capsule changes from green to yellow and then dark brown. The brown fruits are dried in the shade and de-hulled to separate the hulls from the seeds. J. curcus plants yield about 1 kg seed per plant per year in a relatively poor soil from fifth year onwards. Generally 3 seeds were obtained from a single fruit and the seeds had oil content of 25 – 35%. The seeds are de-shelled to separate the shell and kernel or used as such for oil extraction. [11]

Production of J. Curcus Plantation on Rain Fed Dry Lands at a Density of 4444 Plants per Hectare and Energy Flow

Table-30 [11]	Name of Plant Component	Biomass		Associated Energy	CH_4 Potential in M^3
		Total Solids	Volatile Solids		
(A)Total Biomethanation Route	Pruned Leaves	1.10 ton	0.97 ton	13 GJ	230 M^3
	Fruit Hulls	1.10 ton	1.00 ton	14 GJ	309 M^3
	Seeds	4.05 ton	3.85 ton	91 GJ	2349 M^3
	Duration 105 days at 35^0C			**118 GJ**	**Total 2888 M^3**
(B)Bio-diesel & Biomethanation Route	Seeds	4.05 ton	3.85 ton		
	Oil Yield	1.42 ton			
	Trans-esterification Using 14kg KOH and 170 kg Methanol				
	Biodiesel yield	1.35 ton /Ha / year		53GJ	
	Glycerin	156 kg/ Ha/year			
	De-oiled Cake	**2.63 ton**	**2.35 ton**	**34 GJ**	**541 M^3**

If 20 ha waste land is provided to the project so that petro-crop plantation could be done as suggested above.

1. If (A) Route is followed, the following products would be produced per year;
   1.1 Biogas = 2888 *20 = 57760 M^3 biogas = 57760 kWh of electricity and
   1.2 Bio-manure = 6.25*20*40/100 = 625*8/100 = 5000/100 =50 ton bio-manure (dried)

2. If (B) Route is followed the products would be produced/year as follows;
   2.1 Bio-diesel = 1.35*20 = 27.00 ton
   2.2 De-oiled Cake = 2.63*20 = 52.60 ton = 541*20 = 10820 M^3 = 10820 kWh
   2.3 Bio-manure = 52.60*40/100 = 210.40/10 = 21.104 t (Dried Bio-manure)
   2.4 Glycerin = 156*20 kg = 3120 kg =3.12 ton,

This Glycerin could also be used as feed material for biogas plants if not otherwise utilized for cosmetic or medicinal purpose due to lack of refining. It is assumed that at least 40% bio-manure would be recovered from the effluent slurry produced from the biogas plants.

7.3 Comparison of Bio-diesel Production from Algae and Oil Seeds Plants

The project team associated with agronomic development of the state would also keep watch on the National & International developments of micro algae production and oil extraction research during the implementation and commissioning of the project so that we could switch over to aquatic products in order to meet our growing energy demand through environment friendly manner and we could implement the model in the regions where waste land is not available in plenty along with production of bio-fertilizers.

In remote villages of M.P. where availability of waste or barren land is still in plenty, development of various types of biomass for energy and bio-fertilizer production is a promising alternative which could sustainably manage energy supply and demand of the villages in an economically and eco-friendly manner. Processing of biomass through biogas plants as far as possible is one of the better options as we not only get energy but also good bio-manure which could help a lot in nutrient recycling of the soil and reduce the use of chemical fertilizers that ultimately could save huge amount of money and energy used in the production and movement of Chemical fertilizers. Growing aquatic biomass such as water hyacinth, blue green algae, micro-algae (mono-cell or multi-cell) etc. require very less land (under water) and time period for production of per kg of aquatic biomass as compared to terrestrial biomass. This is clear from the data depicted in the Table-31 given below;

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Comparison of Bio-diesel Production from Algae and Oil Seeds Plants [12],[13],[14] Table-31		
Item	**Bio-diesel Produced from Algae**	**Bio-diesel Produced from Plants**
Technology	Cell Bioengineering, Automatically Produced in a Pilot Plant	Agriculture in Farm
Production Period	5 -7 days for a Batch Cultivation	Several Months or Years
Oil Content	More than 40 -50 % in whole cells	Less than 20 % in seeds or fruits
Land Occupied	0.010 -0.013 hectare for Producing 1000 L Oil[a]	2.24 ha for Producing 1000 L Oil[b]
Cost	$2.4 per liter micro algal Oil	$0.6 -0.8 per liter plant seeds oil
Performance	Unlimited (Work just beginning)	Limited (Many works have been done
a. Based on Projected area of Bioreactor in Pilot Plant **b.** Based on Soybean Cultivation in farmland		

7.4 Other Options/ Features of Jatropha Curcus

In the "Annual Report of 2005-2006" of Sardar Patel Renewable Energy Research Institute **(SPRERI)** it is reported and suggested that in place of mass plantation of J. Curcus farmers should be encouraged to plant it on field boundaries and small patches of land **not under crops.** The harvest (seed) should be processed in the village level expeller and oil cleaning units. The de-gummed and de-waxed oil should be blended with diesel to operate diesel engines and tractors in the villages, the oil cake used to enhance gas generation in biogas plants or as bio-fertilizer, Jatropha fruit shell and seed husk used as fuel and the surplus oil supplied to the bio-diesel manufacturing plants, resulting in a complete utilization of the harvest. **The ash of Jatropha fruit shell is exceptionally rich in potash and it could be used as fertilizer.** [10]

7.4.1 Jatropha De-oiled Cake: The de-oiled cake is rich in nitrogen compared to other commonly available organic manures. However, because of its toxicity, it cannot be used as an animal feed, but it is a good fertilizer.

7.4.2 Nitrogen, Phosphorus and Potassium Contents of Jatropha Curcas De-oiled Cake Compared to other Bio – fertilizers

Table-32 **Bio –fertilizer**	**Nitrogen %**	**Phosphorus %**	**Potassium %**
Jatropha Curcas De-oiled Cake	**4.44**	**2.09**	**1.68**
Cattle Manure	**0.97**	**0.69**	**1.66**
Poultry Manure	**3.04**	**6.27**	**2.08**
Duck Manure	**2.37**	**2.10**	**1.09**
Compost of Water Hyacinth	**1.43**	**0.46**	**0.48**
NADEP Compost	**0.5 -1.5**	**0.5 – 0.9**	**1.2 – 1.4**
Vermi-compost	**2 –2.5**	**1 – 1.5**	**1 – 1.5**

The latex of J. Curcas has been used in local Ayurvedic pharmacopoeia. According to Botany laboratory, BARC-East Beltsville, Maryland, USA, the active principal in its latex, Jatropha has shown anticancer properties. The green tender leaves are useful feed for Tasar silk worms and the plant holds promise to sustain a small-scale silk industry in rural India. The petro-plant, plantation is also good for Bee-keeping. It is good and is in the interest of bees and the petro-crops.

7.5 Mineral and Ash Contents of Banana Pseudo-Stem Flour

S. No.	Name of Mineral	Table- 33 [20]Mg/100gm Dry Sample*
1	Sodium	444.12 ± 4.08
2	Potassium	944.12 ± 1.41
3	Calcium	1335.33 ± 14.11
4	Magnesium	255.00 ± 2.83
5	Phosphorus	137.82 ± 1.89
6	Iron	3.31 ± 0.05
7	Zinc	8.05 ± 0.05
8	Manganese	1.27 ± 0.11
9	Ash (%)	6.75 ± 0.34
* Values are expressed as mean ± standard deviation, n = 3		

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7.6 Biogas and Bio-fertilizer from Cotton Micro-dust

7.6.1 Snap Study on Generation of Micro-dust in Various Mills

Mills Code No.	Average Consumption of Cotton Fibre/Month in Kg	Average Micro-dust Generation per Month in Kg Table-34 [9]
A	165000	1600
B	215000	850
C	159900	1759
D	497000	2125
E	92000	1400
F	256402	2820
G	543972	4896
H	312256	3590
I	34514	517

7.6.2 Generation of Energy/Fuel from Cotton Micro-dust

S No.	Description	Quantity Table-35 [9]
1	Micro dust generated in Indian Textile Industry	21.0 Million Kg
2	5 Kg of Micro-dust will produce (approx.)	1 M^3 of Biogas
3	1 M^3 of Biogas is equivalent to	0.71 Liters of Petrol
4	1 M^3 of Biogas is equivalent to	0.433 Kg of LPG
5	11.5 Kg Micro-dust is equivalent to	1.0 Kg of LPG
6	7.0 Kg of Micro-dust is equivalent to	1.0 Liter of Petrol

7.6.3 Results of Cotton Micro-dust Sample Tested to Analyze Mineral Content

S No.	Content	Percentage (%) Table- 36 [9]
1	Potassium	46.30
2	Phosphorous	5.60
3	Calcium	13.60
4	Aluminium	4.80
5	Manganese	6.00
6	Iron	6.80
7	Sodium	8.00
8	Copper	7.60
9	Others in minute quantities	1.60

7.7.0 Comparative Data on Individual Input to Biogas Plant [6]

Characteristics Table- 37	Cow Dung	Banana Stem	Eucalyptus Leaves	Water Hyacinth	Congress Grass*	Chido	Dharo	Tandal
1: Physical								
A – Moisture, % of wet wt.	79.21	94.79	14.58	92.87	73.02	64.50	63.04	67.81
B –Total Solids, % of wet wt.	20.79	5.21	85.42	7.13	26.98	35.50	36.96	32.19
C–Volatile solids, % of wet wt.	60.85	83.49	93.26	81.63	79.02	80.68	86.04	79.87
D – Ash, % of wet wt.	39.15	16’51	6.74	18.37	20.98	19.32	13.96	20.13
E – Specific Gravity	1.01	0.50	0.80	0.25	0.80	N.E.	N.E.	N.E.
2: Chemical								
A) Elemental Analysis								
i. Carbon, % of wet wt.	53.00	36.66	49.67	32.51	N.E.	27.22	32.53	36.82
ii. Hydrogen, % of wet wt.	N.E.	4.99	6.10	4.22	N.E.	3.16	3.97	4.74
iii. Nitrogen, % of wet wt.	2.70	1.45	1.26	1.78	N.E.	N.E.	N.E.	N.E.
iv. Carbon to Nitrogen Ratio	19.7:1	25.3:1	39.4:1	18.3:1	N.E.	N.E.	N.E.	N.E.
3: Biogas Production								
a. Liter /kg of wet wt.	32.00	32.70	163.40	53.50	57.6	55.00	49.00	69.50
b. Liter /kg of dry wt.	154.00	627.64	191.33	750.61	213.49	154.93	132.59	20.89
c. Liter /kg of VS.	253.00	751.72	205.14	919.24	270.17	192.04	154.09	170.32
4: Methane in Biogas, %	54.7	66.7	74.0	78.0	66.0	67.3	64.7	80.0
5: Retention Period, in Days	30	40	45	35	35	N.E.	N.E.	N.E.
6: Digester Volume to Daily Gas Production Ratio	2:1	7.5:1	7:1	6.5:1	10:1	N.E.	N.E.	N.E.

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* Parthenium hysterophorus L or congress grass – This is considered as one of the most devastating weeds of the world and is a major biological pollutant to our environment. In spite of many issues raised by general public against its ill effect and spread where ever it got the chance to introduce, no effective check have been observed in effected fields and

the weed is continuing to spread its tentacles almost in all parts of India. Since its inception into the Indian flora, this alien/foreign species has been captivating the attention of people in most of the states mainly because of its potential threat to the farm lands, native flora and fauna of the region and, above all, to the human beings. Once introduced, it occupies vast tracks of lands to the exclusion of the previously existing plants, gradually becoming the dominant plant of the area. We can utilize the huge biomass produced by this weed for generation of biogas and bio-fertilizer which is reported to be very useful for grapes crop as was revealed by Padmashree T G K Kutti Menon, Ex- Director, Kasturba Gandhi Kendra, Kasturba Gram, Indore in one the conferences attained by the author.

7.7.1 Potential Biomass Resources and their Yield Potential [6]

S. No.	**Species**	**Production Potential** Table-38 [6]
1	**Leucaena/Leucocepphale-** Acacia sp, Calliandra sp., Sesbania sp., Eucalyptus sp., Casuarina sp.,	When grown on reasonably good soil 50 Cubic M/ha/yr; many species yield 20M^{3}of wood/ha/yr
2	**Hydrocarbon Plants-** Euphorbia lathyrus, Euphorbia tirucalli	Semi-arid land 17barrel/ha/yr; 36barrel/ha/yr
3	**Oil Producing Species-** Soybean, Sunflower, Groundnut	Can grow on wide range of soils, climatic conditions; fuel for diesel engines or as blend
4	**Sugar/Starch** Sugarcane, Sweet sorghum, Cassava	50t of sugarcane /ha/yr can yield 120 t /ha (Hawaii) giving yield of 3600 liter alcohol/ha. 45t/ha/yr can yield 3500 liter alcohol/ha. Poor soils 10-12t/ha/yr can yield of 2160 liter alcohol/ha
5	**Other Crops Corn**	6 t/ha -2200 liter alcohol/ha
6	**Green Herbaceous Plants Tropical Grass, Elephant Grass (Napier grass)**	High cellulose content, not good for alcohol, could be useful for charcoal, feed stock for gas or liquid fuel
7	**Imperate Cylindrica (Asia)**	---------- ,, ----------
8	**Aquatic Crops Water Hyacinth, Duckweed, Seaweeds, Sea/ kelps***	Animal feed/energy use Biogas and fertilizer, 50 t/ha /yr (dry matter), Source of food; can be used for energy as well as for fuel; 90t/ha For biogas. According to an estimate, in sea each ha of kelp could yield 10 m kcal of food

* Kelp has a high rate of growth and its decay is quite efficient in yielding methane, as well as sugars that can be converted to ethanol. It has been proposed that large open-ocean kelp farms could serve as a source of renewable energy. Unlike some bio-fuels such as corn-ethanol, kelp energy avoids "food v/s fuel" issues and does not require irrigation. Energy content and nutritious values of various components of Seaweed – Kelp are given below;

7.7.2 Seaweed, Raw Kelp, - Nutritional Value per 100 g (3.5 oz)

S No.	Component	Value	S No.	Component	Value Table-39
1	Energy	180 kJ (43 kcal)	12	Vitamin C	3 mg (4%)
2	Carbohydrates	9.57 g	13	Vitamin E	0.87 mg (6%)
3	Sugars	0.6	14	Vitamin K	66 µg (63%)
4	Dietary Fibre	1.3 g	15	Calcium	168 mg (17%)
5	Fat	0.56 g	16	Iron	2.85 mg (22%)
6	Protein	1.68 g	17	Magnesium	121 mg (34%)
7	Thiamine (vit.B_1)	0.05 mg (4%)	18	Manganese	0.2 mg (10%)
8	Riboflavin (vit. B_2)	0.15 mg (13%)	19	Phosphorus	42 mg (6%)
9	Niacin (vit. B_3)	0.47 mg (3%)	20	Potassium	89 mg (2%)
10	Pantothenic acid (B_5)	0.642 mg (13%)	21	Sodium	233 mg (16%)
11	Folate (vit. B_9)	180 µg (45%)	22	Zinc	1.23 mg (13%)
Percentages are roughly approximated			Source: USDA Nutrient Database		

From the contents of Table No. 30 to 38 it is clear that cotton dust, de-oiled cake of Jatropha seeds, banana stem, Eucalyptus leaves, Water Hyacinth, Congress Grass seaweed kelp etc could not only be used for biogas production also for bio-fertilizer production.

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Various reports of Bumb (1995), FAO (1998), Hopper (1993) and others establish that one-third of the food–grain production all over the world is due to the use of chemical fertilizers and other allied materials. Particularly in Asia 50 % of yield growth of agricultural products is due to the contribution of fertilizers. The role of chemical fertilizers for increased agricultural production, mainly in many developing countries, is well established. [21] But in this process focused mainly on high yield, the ill-effects of excessive use of chemical fertilizers on quality of food grains, soil erosion, water absorbing quality of the soil and other adverse affects on environment etc. are not being taken into consideration seriously.

8.0 SOME IMPORTANT COMPOSTING FEATURES AND METHODS

8.1 Composting

It is the process by which waste biomass is converted into bio-fertilizer/compost which helps farmers to improve the productivity of soil and their income. For making compost farmers are mostly required to put in physical labor. They need not to borrow money and get into debt like they do for buying chemical fertilizers. **In order to make and utilize compost they are required to work hard either individually or collectively in groups.** Therefore fertilizers are of two types:

1. Natural fertilizer, including compost; and
2. Human-made chemical fertilizers

Throughout the world there are many options for replacing the plant nutrients lost from soil, but, in case of Madhya Pradesh where on 22 % of the arable land agriculture is done by small and marginal farmers, the best option is compost produced by human labor using the natural materials locally available to farmers and others. Good quality compost could be made from organic household, animal, forest, and agricultural waste as on farm activity in rural areas and used to grow healthy crops, fruits and vegetables etc.

8.2 Compost Formation

Composting is a method of speeding natural decomposition of biomass under controlled conditions. Raw organic materials are converted to compost by a successive action of the chain of organisms. During the initial stages of composting, bacteria increase rapidly. Later filamentous bacteria, fungi and protozoan take over to work further. After much of the carbon in the compost has been utilized and the temperature has fallen, centipedes, millipedes, sow bugs, earthworms and other organisms continue the decomposition.

As microorganisms decompose the organic materials, their body heat causes the temperature in the pile to rise dramatically. The center of a properly made heap should reach a temperature of 110 to 140 degrees Fahrenheit in four to five days. At this time the pile will begin "settling," which is a good sign that the pile is working properly. The pH of the pile will be very acidic at first, at a level from 4.0 to 4.5. By the time the process is complete, the pH should rise to approximately 7.0 to 7.2. [16], [17], [18]

The heating in the pile would kill some of the weeds seed and disease organisms. However, this happens only in areas where the most intense temperatures develop. The organisms that break down the organic materials require large quantities of nitrogen. Therefore, adding nitrogen fertilizer, or other materials that supply nitrogen, is necessary for rapid and thorough decomposition.

8.3 Materials Useful for Composting

Many types of organic materials can be used for compost. Sod, grass clippings, leaves, hay, straw, weeds, manure, chopped corncobs, corn stalks, sawdust, shredded newspaper, wood ashes, hedge clippings and many kinds of plant refuse from the forest, garden etc are some of the possibilities. Though some seeds are killed during composting yet those that survive might create an unnecessary weed problem. [27]

8.4 The composting process

The length of time necessary for the composting process depends on several conditions:

1. Carbon-to-nitrogen ratio
2. Surface area of particles /size / dimensions of the biodegradable matter
3. Aeration
4. Moisture
5. Temperature

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8.5 The Contributions of Different Compost-Making Materials -A Good Balance of Carbon & Nitrogen

Both carbon and nitrogen are needed to make good compost, are used by the micro-organisms to grow, multiply and to get energy. Some of the carbon is converted to carbon dioxide, and this escapes to the atmosphere. Most of it remains and forms humus, and the nitrogen turns to nitrates. Methane is not produced if there is a good supply of air to the organisms carrying out the decomposition process. A carbon to nitrogen ratio of about 30:1 is ideal for the activity of the microbes in the compost. [16, 17, 18]

Materials with good nitrogen content help in making good compost, but their quantum or proportion should be less than the carbon-containing materials. Carbon-containing materials should always be more than those containing high nitrogen. A good balance of carbon and nitrogen is needed to make good compost. Table-40 gives the carbon to nitrogen balance for some types of composting materials.

The nitrogen and carbon content of some selected composting materials Table- 40

	Type of Composting Material	Nitrogen Content (%)	Carbon-to-Nitrogen ratio (C:N)
1	Urine	15-18	0.8:1
2	Blood	10-14	3:1
3	Horn	12	Not found
4	Bone	3	8:1
5	Poultry Dropping	3-6	10-12:1
6	Sheep Dropping	3.8	Not found
7	Horse & Donkey Manure	3.8	25:1
8	Manure in General	1.7	18:1
9	Manure from Animal Pens	2.15	14:1 (Farm Yard Manure0
10	Maize Stalks and Leaves	0.7-0.8	55-70:1
11	Wheat Straw and Chaff	0.4-0.6	80-100:1
12	Fallen Leaves	0.4	45:1
13	Young grass hay	4	12:1
14	Grass clippings	2.4	20:1
15	Straw from peas and beans	1.5	Not found
16	Pig manure	-	5 to 7:1
17	Corn Stalks	-	60:1
18	Vegetable wastes		12 to 20:1
19	Coffee grounds		20:1

Sources: Dalzell and Riddle-stone (1987), Gershuny and Martin (1992)

8.6 Quality Compost with Animal Dung and Urine

1. Animal dung contains water, nitrogen, phosphorous and potassium, as well as micro-nutrients.
2. Animal dung and urine are very necessary to prepare good quality compost – urine especially is high in potassium and nitrogen.
3. Both dung and urine help to produce **a high temperature** so that the materials decompose into compost easily.
4. Urine, in particular, accelerates decomposition.

Air- Including dry materials in the compost, e.g. fallen old leaves and stalks, provides space for air to circulate inside the compost. Air is needed because the soil organisms need oxygen.

Heat- Decomposition of organic wastes produces heat. Compost needs to be kept hot and moist so the plant and animal materials could be broken down quickly and thoroughly. Heat destroys most of the weed seeds, fungal diseases, pests and parasites.

There are many composting methods but NADEP and Vermi-composing are very popular and environment friendly. These methods are explained below so that waste biomass could be processed properly for making bio-fertilizers where it is not possible to process it through Biogas Plants.

8.7 Vermi-composting

It is the process of converting organic waste or any biodegradable matter into bio-manure through the involvement of earthworms. Practically almost all kinds of bio-waste could be consumed by earth worms. These worms consume biodegradable matter equal to their own weight and approximately same amount of manure per day is produced by them in the form of castings. It is the need of the hour that we should adopt vermi-compost or organic farming so that agricultural sustainability and economic prosperity of farmers could also be ascertained. The level of nutrients in compost depends upon the source of the raw material and the species of earthworm. A fine worm cast is rich in N P K

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besides other nutrients. Nutrients in Vermi-compost are in readily available form and are released within a month of application. [4], [30]

Nutrient Analysis of Vermicompost [30]

S No.	Parameter	Content	S No.	Parameter	Content
1	pH	6.80	6	Available N (%)	0.50
2	OC%	11.88	7	Available P (%)	0.30
3	OM%	20.46	8	Available K (%)	0.24
4	C/N ratio	11.64	9	Ca (%)	0.17
5	Total Nitrogen (%)	1.02	10	Mg (%)	0.06

Figure: 2

By following Vermi-composting process 1000 tons of moist bio-degradable matter could be converted into 400 tons of high value bio-fertilizer. After consumption of waste biomass earthworms release the digested matter which is known as excreta or castings rich in nutrients and bacterial and filamentous bacteria population.

The Potential Benefits of Vermi-composting Include: Elimination or reduction of objectionable odor, harmful microorganisms and ill effects of variety of organic waste and produce saleable bio-fertilizer, increases fertility, bacterial activity, micro grains, aeration and water absorption capacity of the soil, plant resistance to pests, fungus and other diseases, income generation to farmers, production of aqua life, birds and animal food or even human food by drying earthworms etc. [4]

Doses

The doses of Vermi-compost application depend upon the type of crop grown in the field or nursery. For fruit crops, it is applied in the tree basin. It is added in the pot mixture for potted ornamental plants and for raising seedlings. Vermi-compost should be used as a component of integrated nutrient supply system. [30]

Crops Dose/rate

1. **Field crops** 5-6t/ha, 2. **Fruit crops** 3-5 kg/plant, 3. **Pots** 100-200g/pot

8.8 The NADEP method produces nitrogen-rich compost using the least possible amount of cow dung. The system also minimizes problems from pests and diseases, and does not pollute the surrounding area because the compost is made in a closed tank with honey-combing i.e. holes in the walls of the tank for aeration. The Nadep method of composting actually enables the farmer to get around the difficulty of generation of biomass and to increase the quantity of compost rapidly within a given time frame and without any significant additional expense.

The **NADEP** method of making compost involves the construction of a simple, low cost, rectangular brick tank, with enough spaces maintained between the bricks (partial honeycomb pattern) to provide for necessary aeration as depicted below. The recommended size of the tank is of the order of 10 ft (length) **x** 6 ft (breadth) x ***3*** ft (height). If more material is available for composting, then the length should be increased. However, the breadth should never exceed six feet. The tank can be erected with bricks and with the use of mud mortar. Cement and reinforcement may also be used throughout but this is not necessary. The system permits conversion of approximately 1 kg of animal dung into 40 kg of rich compost which can then be applied directly to the field.

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Figure: 3

Raw materials / Biomass required for filling NADEP tank:

- Agricultural/Dairy/Garden/Forest/other waste materials (Dry & green) – 1350-1400 kg
- Cattle dung or biogas effluent slurry – 98 to 100 kg
- Fine sieved local soil/ clay preferably silt gathered by cleaning the local ponds/ tanks – 1675 kg
- Water – 1350-1400 litres preferably waste water or spent wash from cattle sheds
- It is a must and important in the preparation of NADEP compost that entire tank should be charged in one go, within 24 hours and should not go beyond 48 hours, as this would affect the quality of the compost.

Before filling, the tank is painted by dilute cattle dung slurry to facilitate bacterial activity from all the four sides. It is charged or filled in definite sequence of set of layers. Each set consists of the following sub layers;

Sub-layer-1:
4 to 6″ thick layer of fine sticks, stems, (To facilitate aeration) followed by 4 to 6″ layer of dry and green biomass.

Sub-layer-2:
4 kg Cow dung is mixed with 100 litres of water or spent wash from cattle sheds and sprinkled thoroughly on the agricultural waste to facilitate microbial activity.

Sub-layer-3:
60 kg of fine dry soil is spread uniformly over the soaked biomass for moisture retention and acts as a buffer during biodegradation.

Thus the proportion of organic materials for each layer is 100 kg organic biomass: 4kg Cow dung + 100 litres water+60 kg soil. In this way, approximately 10 -12 layers are filled in each tank.

After filling the tank, biomass is covered with about 3″ thick layer of soil and sealed with cow dung + mud plaster as depicted below;

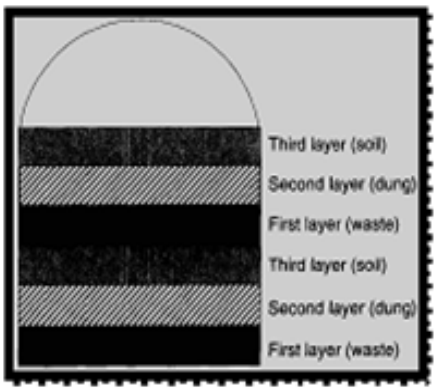

Figure 4

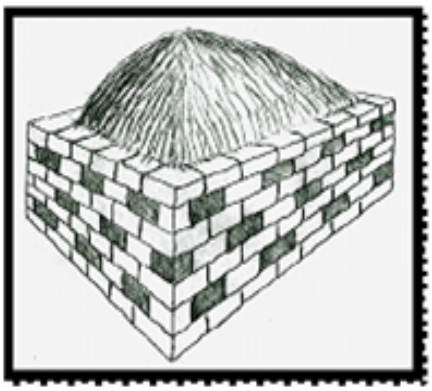

Figure 5

After the NADEP tank has been filled with compost making materials and sealed, it is left for the decomposition process to take place without any further handling until the mature compost is required.

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Production from one Unit /Tank

About 3 t of compost is produced per tank per cycle. In a properly constructed and strengthened **NADEP** tank about 9 tons of bio-fertilizer could be produced in one year. Benefits;

- Reduction in cash expenses on chemical fertilizer, improved soil fertility, increased crop yield,
- supports organic crop production, reduced dependence on outside inputs,
- NADEP tank could produce approximately 2.5 -3 tons of compost within 90-120 days.
- The use of compost reduces the need for mineral fertilizer thus reducing production costs and outside dependence. [27], [29] Large quantities of organic manure or compost are made available through the **NADEP** process. The compost, worked into the soil prior to the planting of seeds, has a remarkable impact on the growth of the plants, improves the condition of the soil and increases the ambient environment to enable proliferation of soil micro-organisms, including earthworms. The **NADEP** method is particularly useful in those areas where soils are eroded and where it is difficult for farmers to purchase plant nutrients from the market.

The compost method is also fairly successful among those farmers who have eschewed the use of chemical fertilizers due to various problems faced in the use of such chemical inputs.

9.0 BEEKEEPING/APICULTURE

An entrepreneur interested in beginning or expanding a beekeeping enterprise for utilizing the bees as pollinators for crops or for the income generation from their products, producers need to be aware of their states' apiary laws concerning inspection, registration, and permits, as well as labeling and marketing standards. When used as pollinators bees could enhance the production of a crop to a wonderful level. Farmers of Murena district of Madhya Pradesh have seen the wonderful results of bees' pollination in mustard crop. The yield of the crop was found to be very encouraging. This news was prominently displayed in a leading news paper "Dainik Bhaskar." [28]

An example of bees used as pollinators is under observation in Vidyapeeth Institute of Science and Technology Bhopal. Fast growth and huge number of pods on Drumstick (Moringa Oleifera) tree could be clearly seen in the picture depicted below by enlarging the same;

Figure: 6

10.0 NEED/IMPORTANCE OF THE STUDY

The importance of this study is to focus the attention of all concerned to process or consume all food and fodder, or waste biomass wherever possible, through human beings, animals and other living beings and the bio- degradable waste produced by human beings and other living beings, as far as possible either through biogas plants or composting/Vormi-composting route so that energy as well as bio-fertilizer or the later alone could be produced respectively along with huge energy saving. This is crucial for mutual survival of both human and all living beings. This might be economical, energy efficient and eco-friendly system and in line with measures to be adhered to for the existence of the mankind. With the involvement of animals, living beings, organisms etc degradation of bio-degradable matter is performed almost free or economically, faithfully and in less time with generation of energy and bio-fertilizer or with huge energy saving and production of bio-manure which also helps in recycling the micro-nutrients of the soil.

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11.0 STATEMENT OF THE PROBLEM

With the rising population demand of the food grains in India is increasing day by day and in order to fulfill this ever increasing demand of food and fodder agricultural land is being exploited heavily and per hectare average consumption of chemical fertilizers is increasing every year and as a result the percentage of micro nutrients in the soil is gradually decreasing and ultimately causing deficiency of the vital components in the food grains produced in the field. Though the agricultural production was sustained due to increased use of fertilizers yet it also increased the cost of production of agricultural produce. In some states of the country this cost of production was higher than the Minimum Support Price (MSP) of the produce. The situation was further aggravated because of globalization of economy and WTO agreement, as lot of agriculture produce were poured in at lower prices from other countries and many small and marginal formers of various states of our country had to commit suicide. This is the main problem needs special attention to be checked and nullified urgently.

12.0 OBJECTIVES

To prepare the strategy of enhanced production and use of bio-fertilizers so that cost of inputs to agriculture could be minimized and quality of food grains could be improved. Consumption of good quality food grains only could be the cause of good human health with high immunity against diseases. In Punjab due to excessive use of chemical fertilizers many persons are suffering from Cancer. A daily train from Bhtinda to Sekar carries most of the passengers suffering from cancer to Sekar Cancer Hospital. As a result this train itself is known as cancer train. This was reported in a daily News Paper “Patrika” on front page and the whole page was devoted to crushing ill effects of excessive use of chemical fertilizers and pesticides and promotion of organic agriculture. In the Western Region of the world Sir Albert Howard is regarded as the father of sustainable agriculture. He wrote in An Agriculture Testament/Evidence: “I regarded these (Indian) peasants as my professors. I learnt from them how to grow healthy crops without the slightest help from artificial manures or insecticides." Organic farming could only be successful if soil fertility, nutrient content of the soil and crop growth is regularly monitored and appropriate bio-fertilizers are timely added to the soil in order to replenish the deficiency noticed in the soil. Gradual shifting is advisable from existing general cropping practices to organic farming in the region where availability of bio-fertilizers is difficult and soil productivity is low. Above all efforts should be made so that the poor farmers do not have to depend on the high cost of external inputs. [26]

13.0 RESULTS & DISCUSSION

Huge energy saving, larger benefits and economic improvement of small and marginal farmers, free service from micro organisms, better processing of waste biomass, cleanliness in villages, quality improvement of soil as well as food-grains, better human health, regular de-silting of pond and tanks are all proportional to production of bio-fertilizers. Hence special attention of all concerned must be paid to produce bio-fertilizers in as large the quantity as possible at each level.

14.0 FINDINGS

IF one ton of nitrogenous fertilizer is substituted by equivalent quantity of bio-fertilizers energy equivalent to around 19 barrel of crude oil could be saved. If it is produced as on-farm activity a lot of energy consumed in chemical fertilizer transportation and its application in the field could also be saved. This reduces the cost of production of food grains produced and also saves foreign exchange along with sustained, eco-friendly and superior quality agriculture in which healthy food grains full of energy are produced.

15.0 RECOMMENDATIONS / SUGGESTION

Immense use of waste biomass for energy production or for saving energy accompanied by bio-fertilizer production is the need of the hour hence it should be strictly followed and adhered to if we are really interested to accelerate our action against adverse effect of immense use of chemical fertilizers to save the farmers from committing suicide.

16.0 CONCLUSION

Excessive and non-judicious use of chemical fertilizers without carrying out soil test and appropriate mixing of bio-fertilizers is harmful to sustained agriculture, quality of produce and economical growth of farmers. Gradual shifting from existing agriculture practices to organic agriculture is a must for our survival and existence in general and checking the poor farmers of our country from committing suicide in particular along with lot of energy saving.

17.0 SCOPE FOR FURTHER RESEARCH

1. From the composition data given in Table-36, 32, 33, and 39 for Cotton-dust, Jatropha De-oiled Cake, Banana Pseudo Stem Flour and Seaweed Kelp, it is clear that these materials are rich in Potassium (K) and contains 46.30%, 1.68%, 944±1.41 mg/100gm and 89mg/100g respectively. In these four items the percentage of K is gradually

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decreasing and it is highest in case of cotton-dust. It is reasonably good in case of Jatropha curcus and Banana Stem. Similarly other natural sources could be identified so that NADEP or Vermi-compost or Biogas feed could be adequately mixed with these materials and requirement of Potassium (K) could be fulfilled by getting compost or biogas slurry from these plants as whole requirement of potassium in India is met through imported potassium chemical fertilizers only. If other natural materials containing higher percentage of potassium are identified and the list is made available to field workers of agriculture, and farmers are enlightened, good substitute of imported potassium could be managed in the villages itself. Applying the same technique customized bio-fertilizers could be manufactured locally by locally carrying out soil test and knowing the defficiency of the soil composting materials could be accordingly supplimented so that soil under consideration could be enriched with this customized compost.

2. Urine is very useful for manufacture of Bio-fertilizers hence there is urgent need to develop the methods to collect the same on small, medium and large scale. Research should be initiated in this direction too.

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