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No. DR/T-1/RTI/ /2012-13 Date: 19-01-2013

To,

Sri. Nishank
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Sir,

Sub: Information sought under RTI reg....

Ref: 1. Your letter dated 24-12-2012
2. No.R/RTI Act/VI/2012 dated: 31-12-2012

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With reference to the above subject, I am forwarding the information sought by you under RTI in the above referred letter is compiled by Professor & Head, Institute of Organic Farming, UAS, Dharwad. This is for your kind information.

Yours faithfully,

Director of Research

CWC to: The Registrar, UAS, Dharwad for kind information

HTC/D:\RTI Information.doc

INFORMATION ON ORGANIC FARMING ENSURES MORE PRODUCTIVITY

The information is based on the studies conducted through Network Project on Organic Farming, at UAS, Dharwad under rainfed conditions. Network Project on Organic Farming a holistic research programme was initiated at UAS, Dharwad during 2004-05 under the aegis of ICAR's Project Directorate for Farming Systems Research, Modipuram. The project is in progress at 13 centers across the country covering different agro-climatic zones/situations with diversified crops and cropping systems. The programme aims to study the productivity, profitability, suitability, quality and input use efficiency in different crops and cropping systems under organic production in comparison with conventional and integrated systems under rainfed conditions.

Dharwad Centre represents the rainfed agro-ecosystem, comes under all India Agro-climatic region XVI and Northern Transitional Zone (Zone 8) of Karnataka. The Zone receive an average annual rainfall of 780mm. The rainfall is bio-modal in its distribution and receives in two peeks one in July and another during October offers scope for double cropping. The major cropping systems of this rainfed ecosystem are groundnut-Sorghum, Soybean-Wheat, Chilli+Cotton, Cotton, Maize-Chickpea, and Potato-rabi Sorghum/chickpea.

Rainfed areas are reported to have relative advantage to go for organic farming, primarily due to low use of chemical fertilizers and pesticides, shorter conversion period and smaller yield reduction during conversion. The rainfed soils are not only considered as thirsty they are hungry too with low soil organic matter. In rainfed situations the average national productivity is hovering around 1.0 t/ha which can be enhanced to 1.5 - 2.0 t/ha. The Present yield levels of rainfed agriculture in crops like sorghum (956 kg /ha), cotton (510 kg/ha), groundnut (1268 kg/ha) and soybean (1325 kg/ha) are low. The studies at UAS, Dharwad conducted under rainfed conditions showed organic agriculture has potential to increase the productivity and overcome risks in these areas.

With the present fertilizer crisis organic agriculture has advantage in India. The study has showed that there is a great potential to substitute chemical fertilizers through organics mainly crop residues, green loppings, green manures, organic manures, sediment harvesting, oil cakes, bio-fertilizers, biological nitrogen fixation, crop rotations, animal excreta etc are many nutrional options available

under organic production system. Rainfed agriculture depends on rainfall infiltrated in the soil and green water consumption is almost 3 fold more than blue water consumed for food production. Rainfed systems are to be upgraded in a holistic way. Our emphasis should be on the water use efficiency otherwise we cannot meet the demand for food. There is a need to harness the "untapped" potentials of rainfed agriculture through conservation of soil and water *insitu*.

To achieve sufficiency in food production and maximise the crop yield productivity, there is need to accelerate efforts to halt the decline in soil productivity and to restore the productivity of degraded soils in the shortest possible time. Much of this goal can be achieved through proper management and utilization of organic material. Application of crop residues and organic manures *viz*, FYM, composts, vermicompost and green manures improve soil physical environment which has positive impacton soil aeration, water holding capacity, bulk density and aggregation that also stimulate the activity of macro and micro-organisms in the soil.

Concept adopted in the study

Ancient knowledge of Indian farming are amalgamated with modern technologies of crop production with scientific approaches to enhance the productivity and profitability. Here, understanding the agro-ecosystem health is key in determining the effective farming system and it go beyond input substitution. Nutrition management practices were aimed at feeding soil rather than crop and giving back to soil what has been taken from it. The soil macro and micro fauna-flora are responsible for sustaining life on the earth through their rich metabolic capabilities, from recycling of organic material and releasing nutrients for sustaining plants. Encouraging natural enemy complex, crop diversity good agronomy and non chemical biological management practices efficiently manage pest and diseases. As it excludes the chemical fertilizers and pesticides from the perspective of eco service management has many advantages over conventional agriculture.

Methodology of experimentation

A fixed site long term experiment was laidout in strip block design with three blocks mainly, Organic (100% organic), Integrated (50 % organic + 50% inorganic) and Inorganic (100% inorganic) were established since 2004-05 and during 2008-

09 conventional (organic + 100% inorganic) block was included as recommended package of practices. Nutrient and plant protection practices were followed as per the treatments. In organic plots integrated nutrient management practices mainly application of crop residue produced on the farm and FYM (1/3) + VC(1/3) + Gliricidia green leaf manure (1/3) were applied equivalent to recommended nitrogen in cereals and recommended phosphorus in pulses. Whenever, rock phosphate was available in legume crops the nutrients were substituted equivalent to recommended nitrogen and additional phosphorus requirement was met with application of rock phosphate. Bio-fertilizers consortia including nitrogen fixers and P solubilizers including VAM were applied through seed treatment, tuber treatment and seedling dip in different crops. Liquid organic fertilizer mainly cow urine spray @ 10% and panchagavy spray @ 3%, was done at flowering and 15 days later in all crops except in long duration crops chilli and hybrid cotton four sprays at 15 days interval was given. To over come the deficiency of nitrogen in maize, sorghum, cotton etc., 10% cowurine spray was done two or three times. In long duration crops like cotton, chilli, maize etc., gliricidia/subabul green leaf manure mulching was done as the gliricidia and subabul hedge rows were regularly pruned.

The recently released high yielding and disease resistant varieties and hybrids recommended for the zone were adopted. In groundnut, rust and tikka resistant variety GPBD 4, Soybean JS 335, Sorghum a charcoal rot resistant variety DSV 4, Maize hybrid Arjun, Chickpea wilt resistant variety A1 and JG-11, Chilli Byadgi dabbi, Cotton variety Jayadhar, Potato kufri-Jawahar and hybrid Cotton DCH32,DHH-11 and DHB915 were adopted helped to get higher productivity.

Non chemical approaches of insect pest management practices consisting of pheromone traps @ 5 per ha, hand collection of egg masses of *spodoptera litura,* trap crops, spray of NSKE 5% and other botanicals@ 10%, biopesticides mainly *Nomurea rileyi* for defoliators, HaNPV for *Helicoverpa, Verticillium lecanii* for sucking pests, Trichocards for topshoot weevil in cotton and potato etc., were followed. Seed treatment with Trichoderma in all crops, sulphur in sorghum for smut, Bhendi and Marigold as trap crops, barrier crops, cow urine spray etc., were followed. The detailed plant protection practices followed have been presented in

package of practices of these crops. These practices were found as effective as chemical control and IPM with increase in natural enemy population helped to keep pests in control.

Results of the research study

Dharwad centre has made a significant contribution by standardizing the organic farming practices in important crops of this region For six crops validation in the farmers field has been done and recommended for large scale adoption. For some more crops validation in the farmers field is in progress. The process of transfer of technology in a farmers' participatory mode for large scale adoption is in progress. The organic farming practices on scientific principles are as productive as conventional practices with greater soil health benefits, reduced cost on production and enhanced profit margins.

Project 1: Comparative efficiency of organic, integrated and inorganic management practices on crop productivity and soil health in different cropping systems.

I. Groundnut-sorghum cropping system

In groundnut-sorghum cropping system, pooled data of six years showed that, significantly higher yield of groundnut was recorded with organic practices (2975kg/ha) and integrated practices (2842 kg/ha)as compared to inorganic practices (2604 kg/ha). During *rabi*, sorghum recorded significantly higher yield (1166 kg/ha) in organic practices and integrated system (1155 kg/ha) as compared to inorganic (1043 kg/ha) practices. Similarly, the groundnut equivalent yield differed significantly among the different systems. Significantly higher groundnut equivalent yield was recorded in organic system (3549 kg/ha) and integrated system (3411 kg/ha) as compared to inorganic system (3117 kg/ha). In groundnut-sorghum cropping system the net returns and B:C ratio was significantly higher with organic (Rs. 48345 /ha and 3.24) as compared to inorganic system (Rs. 40790/ha and 3.06) but it was on par with integrated system (Rs 46090/ha and 3.16).

Table : 1 Productivity and economics of different crops during *kharif* and *rabi* as influenced by organic, integrated and inorganic system (pooled data from 2004-05 to 2011-2012)

Nutrient management	Groundnut pod yield (kg/ha)	Sorghum seed yield (kg/ha)	Groundnut Equivalent yield (kg/ha)	Net returns (Rs./ha)
Organic	3363	1213	3934	69812
Integrated	3182	1187	3752	66614
Inorganic	2764	1048	3283	63155
LSD (0.05)	220	97	109	2535

II. Soybean-wheat cropping system:

In soybean-wheat cropping system, pooled data of six years showed that, significantly higher soybean pooled yield was recorded with organic system (1769 kg/ha) and integrated system (1733 kg/ha) over inorganic system (1521 kg/ha). The wheat yield was significantly superior among the systems. Significantly higher wheat yield was recorded with organic system (1081 kg/ha) and integrated system (1062 kg/ha) over inorganic (933 kg/ha)

The soybean equivalent yield was significantly higher with organic (2496kg/ha) and integrated systems (2457 kg/ha) as compared to inorganic system (2145 kg/ha) and were on par with each other. The net returns and B:C ratio was higher with organic (Rs. 21120/ha and 2.43) and integrated (Rs. 19929/ha and 2.18) which was significantly superior over inorganic systems (Rs. 16313/ha and 2.04).

Table : 2 Productivity and economics of different crops during *kharif* and *rabi* as influenced by organic, integrated and inorganic system (pooled data from 2004-05 to 2011-2012)

Nutrient management	Soybean yield (kg/ha)	Wheat yield (kg/ha)	Soybean Equivalent yield (kg/ha)	Net returns (kg/ha)
Organic	2081	1126	2827	46168
Integrated	1911	1107	2648	43448
Inorganic	1632	941	2257	40188
LSD (0.05)	111	64	99	2784

II. Potato-chickpea cropping system

The pooled data (2004-05 -2009-10)of six years indicate that in potato-chickpea cropping system, integrated and organic systems produced significantly higher potato yield as compared to inorganic system and were on par with each other. Where as, chickpea yield was significantly superior in organic system over inorganic system but it was on par with integrated system.

During 2010-11, organic and integrated produced significantly higher potato yield (5665 and 5175 kh/ha respectively) as compared to inorganic system. Similarly, organic and integrated recorded significantly higher chickpea yield (1410 and 1322 kg/ha) over inorganic system and they were on par net returns showed similar trend.

Similarly, potato equivalent yield was significantly superior in integrated system compared to conventional but on par with organic practices. The net returns and B:C ratio was higher with integrated system fallowed by organic and conventional systems.

Table 3 Productivity and economics of different crops during *kharif* and *rabi* as influenced by organic, integrated and inorganic system (pooled data from 2004-05 to 2011-2012)

Nutrient management	Potato tuber yield (kg/ha)	Chickpea seed yield (kg/ha)	Potato Equivalent yield (kg/ha)	Net returns (Rs./ha)
Organic	4385	920	6086	26361
Integrated	4423	853	6131	26260
Inorganic	3828	787	5444	20858
LSD (0.05)	219	37	155	1522

IV. Chilli + cotton intercropping system

In chilli + cotton intercropping system, there was no significant difference among the different management practices, but higher chilli pooled yield from 2004-05 to 2007-08 was recorded with organic and integrated systems (447 and 445 kg/ha respectively) over inorganic system (427 kg/ha). The jayadhar cotton yield differed significantly among different practices. Significantly higher yield (681

kg/ha) was recorded with integrated system over organic system (622 kg/ha) which intern was significantly superior over inorganic system(559 kg/ha).

The chilli equivalent yield differed significantly among the different systems. Significantly higher chilli equivalent yield was recorded in integrated system (819 kg/ha) over organic practices (776 kg/ha) and inorganic practices (708 kg/ha) which intern differed significantly.

The net returns was significantly higher with integrated and organic systems (Rs. 19540 and 19502/ha respectively) over inorganic system (Rs.14176/ha) but were on par with each other. Similarly the B:C ratio was significantly higher with organic (2.46) over integrated (2.21) and inorganic (1.88) practices.

Table 4 : Productivity and economics of different crops during *kharif* and *rabi* as influenced by organic, integrated and inorganic system (pooled data from 2004-05 to 2008-09)

Nutrient management	Chilli (kg/ha)	Cotton (kg/ha)	Chilli equivalent yield (kg/ha)	Net returns (Rs./ha)
Organic	447	622	776	19502
Integrated	445	681	819	19540
Inorganic	427	559	708	14176
LSD (0.05)	68	51	36	1494

V. Maize-chickpea intercropping system

In Maize-chickpea cropping system from 2007-08 to 2010-11, there was no significant difference among the different management practices, with respect to yield in both maize and chickpea upto 2009-10. However during 2010-11 significantly higher maize yield was recorded in organic system (4280 kg/ha) and integrated system (3946 kg/ha) as compared to inorganic system (3077 kg/ha). Similarly, among different practices, chickpea yield did not differ significantly with management practices with highest chickpea yield was recorded in organic and integrated systems (1534 and 1488 kg/ha respectively) as compared to inorganic system (1135 kg/ha).

During the fourth year maize equivalent yield was significantly higher with organic and integrated systems (6498 and 6294 kg/ha, respectively) compared to inorganic system (5422 kg/ha). The net returns was significantly higher with organic and integrated systems (Rs. 64976 and 62943/ha respectively) compared to inorganic system (Rs.54222/ha) and were on par with each other. The highest B:C ratio was recorded in in-organic system (3.14) followed by organic and integrated systems (3.06 and 3.02 respectively) and were on par.

Table. 5 Productivity and economics of different crops during *kharif* and *rabi* as influenced by organic, integrated and inorganic systems (pooled data from 2007-08- 2010-11)

Nutrient management	Maize yield (kg/ha)	Chickpea yield (kg/ha)	Maize Equivalent yield (kg/ha)	Net returns (kg/ha)
Organic	3396	1108	6498	64976
Integrated	3308	1067	6294	62943
Inorganic	2865	913	5422	54222
LSD (0.05)	315	95	328	3281

VI. Cotton + Peas intercropping system

The studies on hybrid cotton + peas intercropping system, was started during 2009-10 on a fixed site of organic, integrated and inorganic systems established during 2004-05. Significantly higher cotton yield was recorded with organic and integrated systems (1464 and 1382 kg/ha respectively) over inorganic practices (1076 kg/ha). Similarly the peas yield differed significantly among the systems. Significantly higher peas yield (1775 kg/ha) was recorded with organic system over integrated (1481 kg/ha) and inorganic system (1097 kg/ha). Further integrated system was significantly superior over inorganic system. Similarly, the cotton equivalent yield was significantly higher (2174 kg/ha) with organic system over integrated (1975 kg/ha) and inorganic system (1514 kg/ha). Further, integrated noticed significantly higher yield over inorganic system. The net returns were significantly higher with organic and integrated systems (Rs. 78253 and Rs. 72177/ha respectively) over inorganic system (Rs. 51969/ha). Similarly B:C ratio was significantly higher with integrated and organic systems over inorganic system and they did differed significantly.

Table 6. Productivity and economics of different crops during *kharif* and *rabi* as influenced by organic, integrated and inorganic system (pooled data from 2009-10 to 2011-2012)

Nutrient management	Cotton yield (kg/ha)	Peas seed yield (kg/ha)	Cotton Equivalent yield (kg/ha)	Net returns (Rs./ha)
	2009-10 to 2001-12			
Organic	1277	1829	2015	67515
Integrated	1212	1733	1910	63593
Inorganic	910	1259	1419	41198
LSD (0.05)	170	222	160	8321

Effect on Soil Health

The nutrient management practices had significant effect on soil fertility status. The soil organic carbon was higher under organic nutrient management practice in groundnut-sorghum cropping system (0.65%) and was found superior over integrated (0.60 %) and inorganic practice (0.50 %). Initially the organic carbon content was 0.41 percent. It was increased up to 0.64 percent in organic nutrient management after 6 years (2004 - 05 to 2010 - 11) of fixed site experiment (Table 7).

The available nitrogen was higher under organic nutrient management practice (283 kg/ha) and was superior over integrated (279.8 kg/ha) and inorganic practice (259.1 kg/ha). On average available nitrogen status of soil increased from 250 kg/ha to 283 kg/ha over period of 6 years (2004 - 05 to 2010 - 11) (Table 7).

Table. 7 Effect of management practices and cropping systems on organic carbon (%) and available nitrogen (kg/ha) in the soil.

Cropping systems	Organic carbon (%)			Nitrogen (kg/ha)		
	Organic	Integrated	Inorganic	Organic	Integrated	Inorganic
Groundnut-Sorghum	0.65	0.60	0.50	281.6	279.7	267.2
Soybean-Wheat	0.64	0.56	0.51	290.2	276.9	253.5
Potato-Chickpea	0.65	0.60	0.50	281.9	270.1	251.9
Maize –Chickpea	0.63	0.57	0.51	269.3	286.3	266.6
Cotton+Peas	0.63	0.56	0.51	291.8	285.8	255.8
Mean	0.64	0.58	0.51	283.0	279.8	259.1
Initial(2004-05)	0.41			250.0		

The available phosphorus status of soil was higher in the organic nutrient management practice (33.3 kg/ha) over both integrated and inorganic systems (28.7 and 25.09 kg/ha respectively (Table 8).

Available potassium status of soil was also found superior under organic system (378.8 kg/ha) and was higher over both integrated and inorganic management practice (352.4 and 330.4 kg/ha respectively). The initial status of available potassium was 330 kg/ha.

Table. 8 Effect of management practices and cropping systems on available phosphorus and potassium (kg/ha) in the soil

Cropping systems	Phosphorus (kg/ha)			Potassium (kg/ha)		
	Organic	Integrated	Inorganic	Organic	Integrated	Inorganic
Groundnut-Sorghum	34.2	29.4	24.1	369.2	351.4	325.4
Soybean-Wheat	32.8	28.1	25.6	374.5	342.7	323.2
Potato-Chickpea	33.7	28.7	24.9	410.9	384.7	344.1
Maize –Chickpea	32.5	28.8	25.2	381.0	351.1	340.6
Cotton+Peas	33.2	27.9	22.7	358.5	332.2	318.6
Mean	33.3	28.7	24.5	378.8	352.4	330.4
Initial(2004-05)	23.0			330.0		

The Maximum water holding capacity of soil was higher under organic nutrient management practices as compared to inorganic nutrient management practices over period of 6 years (2004 - 05 to 2010 - 11) (Table 9).

The DTPA extractable copper content of soil found superior under organic and integrated nutrient management practices (1.53 and 1.47 ppm) over inorganic management practice (1.23 ppm) (Table 9).

Table.9 Effect of management practices and cropping systems on MWHC and DTPA Extractable copper content (after harvest of crop)

Cropping systems	MWHC (%)			DTPA Extractable Copper (ppm)		
	Organic	Integrated	Inorganic	Organic	Integrated	Inorganic
Groundnut-Sorghum	63.55	61.42	60.92	1.36	1.45	1.20
Soybean-Wheat	64.62	62.79	61.09	1.56	1.39	1.29
Potato-Chickpea	63.98	62.84	60.84	1.62	1.62	1.23
Maize –Chickpea	63.72	62.51	60.26	1.56	1.48	1.17
Cotton-Peas	63.64	62.78	60.03	1.54	1.43	1.28
Mean	63.90	62.47	60.63	1.53	1.47	1.23
Initial(2004-05)	60.00			1.00		

Soil Arthropods

In organic system recorded significantly higher population of soil arthropods compared to integrated and inorganic cropping systems during 2009-10. The major soil arthropods found were *collembolans, diplurans, oribatid mites, predatory mites* and *pseudoscorpions*. Arthropods population in organic system was almost three times more than inorganic/ conventional cropping system (Table 10).

Table 10. Mean population of below ground soil arthropods / 100 g of soil

Treatment	Collembolans	Diplurans	Cryptostigmatid Mites	Other Mites	Pseudoscorpions	Other Arthropods
Organic (A)	11.06	1.56	4.63	18.13	1.56	8.19
Integrated(B)	6.31	0.88	3.94	14.50	1.13	5.56
Inorganic (C)	2.81	0.75	1.69	7.06	0.56	3.06

Soil Microorganisms

The microbes are responsible for sustaining life on the earth through their rich metabolic activities and sustained release of nutrients. This rich metabolic activity that one has to harness in the organic farming microbial communities mainly nitrogen fixers, phosphorus solubilizers, organic matter decomposers, plant growth promoters etc., a major role in sustaining soil fertility and crop productivity. Enumeration of microbial populations at grand growth phase at flowering of the crop as influenced byorganic, integrated and inorganic management practices was done in all the cropping system from 2004-05. Gradual increase in microbial population as well as enzyme activity was observed in organic management practices followed by integrated practices as compared to inorganic practices in different cropping systems (Table 11).

Table 11: Enumeration of soil microflora and beneficial soil microorganisms as influenced by nutrient management practices

Treatments	Bacteria (cfu x 10^5/gm of soil)	Fungi (cfu x 10^4/gm of soil)	Actinomycetes (cfu x 10^4/gm of soil)	N_2- fixers (cfu x 10^3/gm of soil)	PSM (cfu x 10^3/gm of soil)
Organic					
Groundnut-Sorghum	92	21	53	45	25
Soybean – Wheat	65	26	41	31	22
Potato- Chickpea	73	22	35	22	24
Maize – Chickpea	92	18	28	21	29
Cotton + Peas	87	19	39	36	17
Mean	**81.8**	**21.2**	**39.2**	**31**	**23.4**
Integrated					
Groundnut-Sorghum	75	16	44	39	22
Soybean – Wheat	57	12	32	20	15
Potato- Chickpea	71	18	32	19	11
Maize – Chickpea	84	19	28	12	28
Cotton + Peas	79	16	22	34	13
Mean	**73.2**	**16.2**	**31.6**	**24.8**	**17.8**
Inorganic					
Groundnut-Sorghum	61	19	27	23	20
Soybean – Wheat	50	11	28	19	14
Potato- Chickpea	59	15	30	19	10
Maize – Chickpea	81	13	20	10	15
Cotton + Peas	66	18	23	27	11
Mean	**63.4**	**15.2**	**25.6**	**19.6**	**14**

Application of organic manures enhanced the soil physical, chemical and biological status of the soil and integrated application of organic manures (enriched compost (1/3) + vermicompost (1/3) + green leaf manure (1/3)) + foliar application of panchagavya, vermiwash, cow urine and jeevamrutha as source of nutrient and growth regulators at time of flowering and 15 days intervals increased the productivity of different crops like groundnut, soybean, sorghum, maize, wheat, cotton, chickpea, peas chilli, and potato.

Plant Protection

Groundnut

The groundnut variety GPBD-4 which is resistant to leaf spot and rust was used. Hence the incidence of these diseases did not cause any yield reduction. Other major pest and diseases noticed in groundnut were defoliators and *Sclerotium* stem rot. These were effectively managed by trichoderma @ 4 g/kg as seed treatment. Non chemical approach of insect pest management consisting of use of pheromone traps @ 5 per ha, hand collection of egg masses of *Spodoptera litura,* trap crops like sunflower and spray with NSKE 5%, *Nomuraea rileyi* and botanicals 10%. During *rabi* sorghum seeds were treated with sulpur @ 2g/kg seed for management of smut and *Verticillum lecani* @ 2 g /l and NSKE 5% for management of aphids and plant bugs. These practices were found as effective as chemical control and IPM with increase in natural enemy population.

Soybean

Organic plant protection found as effective as chemical and IPM. Organic or non chemical approach of plant protection comprising of use of *N.rileyi* @ 1 g / 1 (10^{11} conidia/ha), NSKE 5%, bio-digester spray 10% and Panchagavya 3% spray. In soybean ecosystem *N. rileyi* infected cadavers were more abundant than others.

Chilli + Cotton

In chilli + jayadhar cotton intercropping system the non-chemical approach of pest management includes, maize as a barrier crop for sucking pests and marigold as trap crop for management of fruit borers. Further, *verticillium lecanii* @ 2 g/l, NSKE @ 5% and sulphur @ 3 g/l, will help in management of sucking pests and mites in chilli. HaNPV @250 le/ha, *N.rileyi* @2 g/l and bio-digester (10%) spray were effective for management of fruit borer. There was no significant difference between all the three systems in the management of pests. In general organic system noticed higher predatory mites, spiders and other natural enemy population. Marigold is very effective trap crop for management of helicoverpa and Bhendi is very good trap crop cotton shoot weevil.

Cotton

Organic/non - chemical approach of plant protection in cotton was as effective as IPM and conventional/ insecticidal approach. Organic plant protection module consist of use of marigold and Bhendi as trap crops, pheromone traps for *Helicoverpa* monitoring @ 5/ha and Pink Boll worm management by PBW traps @

5/ha,. release of *Trichogramma* 10 times at weekly interval @ 50,000/ha, HaNPV 500 LE / ha, *Verticillum lecanii* @ 2 g /l, NSKE 5%, cowurine and bio-digester spray 10% as and when required for sucking pests. Natural enemies like *Chrysoperla, Coccinellids, Spiders,Geocoreids* and *Trichogramma* were more abundant in organic system. All the three systems were found on par with respect to boll damage. Intercropping of lucerne as green manure crop encouraged many natural enemies in cotton ecosystem compared to other green manuring crops.

Chickpea

Organic plant protection consisting of setting up of pheromone trap @ 5/ha, use of sorghum as sprinkle crop to attract birds, HaNPV @ 250 LE/ha, NSKE @ 5% and bio-digester spray @ 10% found as effective as IPM and insecticidal spray. There was no significant difference in pod borer damage among three systems. In organic chickpea plot we could observe bird predation by cattle egret and *Campoletis chloride* a larval parasitoid of *Helicoverpa* were more abundant compared to other two methods of plant protection.

Maize

In maize organic plant protection consisting of Ha NPV 250 LE /ha, *N. rileyi* 1 g/l (10" conidia/ha), *Verticillum lecanii* @ 2 g /l, NSKE 5 % and *Trichogramma* @ 50,000/ha per release for 3-4 times found effective in management stem borer, cob borer and aphids in maize. Natural enemies *viz., coccinellids, syrphids* were found abundantly feeding on aphids. *Apanteles sp, Nomuraea* and *Tachinids* found on stem borer and *H. armigera.*

Professor & Head
Institute of Organic Farming
UAS, Dharwad-5.

(11) ORGANIC PRODUCTION TECHNOLOGIES DEVELOPED IN CROPS

GROUNDNUT – ORGANIC PRODUCTION

Groundnut is a one of the important oilseed crops of the country grown over an area of 5.40 million ha and production of 5.43 million tones with a productivity 910 kg/ha. Sustained groundnut production and higher profitability can be managed organically by on-farm management of resource with low external inputs. Based on eight years of experimentation under Network Project on Organic Farming the organic package has been developed.

Details of Varieties

Varieties	Zone/situation	Time of sowing	Duration (days)	Special features
GPBD-4	Zone 8 rainfed	June-July	105-110	Resistant to leaf spot and rust diseases. High yielding and higher oil content
JL 24	All zones	June-July	110-120	Big size pods.
TAG-24, DH-86	All zones	Dec-15 to Jan 15 (Summer)	90-95	Resistant to bud necrosis

Management practices: Inputs required per hectare

a) Seeds : GPBD-4	125.kg
JL 24,TAG-24, DH-86	150 kg
b) Organic manures (equi to RDP)	
Enriched compost	3.00 t
Vermicompost	2.40 t
Green leaf manure	5.00 t
Neem cake	250 kg
Seed treatment with bio-fertilizers and bio-fungicides	
Rhizobium	1000 g
PSB	1000 g
Trichoderma harzianum	750 g

Sowing: Early sowing of *kharif* crops during June I FN. Apply FYM/compost and green leaf manures10-15 days before sowing and vermicompost at the time of sowing. Treat the seeds with the *Trichoderma* @ 4-5 g/kg seed and biofertilizer. Sow the seeds at a spacing of 30cmx10 cm.

Gygpsum application: Apply gygpsum @ 500 kg/ha at 35-40 days after sowing, to the plant rows and earthing up will be done.

Weed management: Intercultivation at 25 and 40 DAS and hand weeding at 30 DAS.

Foliar Application: Foliar application of cow urine @ 10 % and Panchagavvya spray @ 3% as a source of nutrient and growth promoter at 45 and 60 DAS.

Plant protection measures

- Setaria or bajra as intercrop at 7:1 and castor as trap crop for S. *litura* management.
- Use of pheromone traps @ 5 per hectare for monitoring of *S. litura.*
- Collection of eggmasses of S. *litura* in groundnut as they lay eggs on upper surface of leaves.
- Neem seed kernel extract @ 5% or custard apple leaf extract @ 5% + *Nomuraea rileyi* 10^{11} conidia/ha @ 1 g/lit as a foliar spray at 45 and 60 DAS against management of defoliators.

Yield: 30-35 q/ha of pod yield and 35-40 q/ha of haulam yield will be obtained.

.Note: The package given may be updated with the development of new technologies and location specific information available.

SOYBEAN – ORGANIC PRODUCTION

Soybean is an important oil seed crop of country grown over an area of 9.95 million with a production of 12.57 million tones with productivity of 1264 kg/ha. Based on eight years field experiments carried out at MARS, Dharwad, the package of practices for organic production of soybean has been developed.

Details of Varieties

Varieties	Zone/situation	Time of sowing	Duration (days)	Special features
JS-335	1,2,3 and 8 *kharif*	May -15 to June end	85-90	Shattering resistant for 8-10 days after maturity resistant to bacterial pustules and leaf spot diseases.
JS 9305	1,2,3 and 8 *kharif*	May -15 to June end	80-85	Early maturing variety.
DSb 21	1,2,3 and 8 *kharif*	May -15 to June end	85-90	Resistant to rust disease

Production practices: Inputs required per hectare

a) Seeds	75 kg
b) Organic manures (Equi. RDP)	
Enriched compost	3.33 t
Vermicompost	2.66 t
Green leaf manure	5.33 t
Neem cake	250kg
c) Bio-fertilizers	
Rhizobium	1000 g
PSB	1000 g
Trichoderma harzianum	500 g

Sowing: Prepare land to a fine tilth by cultivating and harrowing. Optimum time of sowing is during May 15 to June end. Apply organic manures FYM compost and green leaf manures at 10-15 days before sowing. Sow the seeds at 30 cm x 7.5 cm spacing. Treat the seeds with *Trichoderma harzianum* @ 4g /kg seed followed by *Rhizobium* and *Phosphate solubilizing bacteria*. Apply vermicompost at the time of sowing in a row and sow the treated seeds on the same day. Sow the crop as early as possible from May-15th to June end. Delay in sowing cause reduction in yield due to attack of pest and diseases.

Weed management: Inter cultivation at 20 and 40 days after sowing (DAS) followed by two hand weeding at 25 and 45 DAS will effectively control the weeds.

Foliar Spray: Foliar application of cow urine @ 10 % and panchagavya @ 3% at 30 and 45 days after sowing improve the yield and quality of soybean. It helped to retain more flowers, better pod development and seed filling and induced resistance to diseases.

Plant protection measures

- Collection of eggmasses/early instar larvae from infected plants.
- Pheromone traps@ five / ha for monitoring of S. *litura.*
- Application of neem seed kernel extract @ 5% + *Nomuraea rileyi* 10^{11} conidia/ha (@ 1 g/l) as at 45 and 55 DAS against management defoliators.
- Botanicals @ 5% spray at 65 DAS as a bio-pesticide for defoliators and pod borer.

Yield: 20-25 q/ha

Note: The package may be updated as and when the location specific research is being carried and new technologies developed.

SORGHUM – ORGANIC PRODUCTION

Sorghum is an important cereal crop of Northern Karnataka. This is grown both during *kharif* and *rabi* seasons were as quality is good from rabi crop. The yield depend upon soil fertility, rainfall varieties, pest and diseases. Based on eight years experimentation under Network Project on Organic Farming the organic package has been developed. The organic practices were followed as per NSOP standards.

Varieties	Zone/situation	Time of sowing	Duration (days)	Special features
M-35-1	1,2,3 and 8 both rainfed and irrigated	September 15 to October 15	120-125	Tolerant to drought and resistant to shoot fly.
DSV-4	1,2,3 and 8 both rainfed and irrigated	September 15 to October 15	115-120	Resistant to charcoal rot disease.

Production practices: Inputs required per hectare

a) Seeds	7.5 kg
b) Organic manures	
Enriched compost	2.00 t
Vermicompost	1.70 t
Green leaf manure	3.30 t
Neem cake	250 kg
c) Bio-fertilizers	
Azospirillum	500 g
PSB	500 g

Sowing: From September second fort night to October second fort night is optimum for sowing. Apply organic manures mainly FYM/compost and green leaf manures 15 days before sowing. Before sowing soak the seeds in cow urine @ 25% solution, improves the germination and induce drought hardiness. The soaked seeds are treated with biofertilizers. Sow the seeds in 45 cm row spacing 15 cm apart to a depth of 5-7 cm.

Weed management: Intercultivation at 25, 50 and 60 DAS and hand weeding at 30 DAS to manage the weeds.

Foliar Spray : Foliar spray of cow urine @ 10% and Panchgavyya @ 3% spray at 30 and 45 DAS as a source of nutrients and growth promoters improve the yield and help to overcome the nitrogen deficiency.

Plant protection measures

- Neem seed kernel extract @ 5% spray at 25 DAS help to manage shoot fly and sucking pests.
- To manage aphids foliar application of *Verticillium lecanii* @ 2 g or Botanical mixture @ 10% spray or NSKE5% as foliar spray.

Yield : 12-15 q/ha grain yield and 4 tonn/ha fodder yield can be obtained.

Note: The package given may be updated with the development of new technologies and location specific information available.

WHEAT RAINFED – ORGANIC PRODUCTION

Wheat is an important crop of Northern Karnataka. Three species *viz., Triticum astivum, Triticum durum* and *Triticum dicoccum* are grown extensively in the state. Based on eight years experimentation under Network Project on Organic Farming the organic package for rainfed durum wheat has been developed.

Details of Varieties

Varieties	Zone/situation	Time of sowing	Duration (days)	Special Features
DWR-2006	1,2,3 and 8 under rainfed	October month	105-110	Resistant to leaf blotch disease.
Bijaga yellow	1,2,3 and 8 under rainfed	October month	105-110	Resistant to leaf blotch disease.

Production practices: Inputs required per hectare

a) Seeds	50 kg
b) Organic manures	
Enriched compost	2.00 t
Vermicompost	1.70 t
Green leaf manure	3.30 t
Neem cake	250 kg
c) Bio-fertilizers	
Azospirillum	500 g
PSB	500 g
d) Trichoderma	250 g

Sowing: October is suitable for sowing. Before sowing soak the seeds in water for 2-3 hrs and treat the seeds with Trichoderma @ 4 g/kg seed and Azospirillum and *Pseudomonas fluorescence* biofertilizers. Apply organic manures 15 days before sowing and sow the seeds in 30 cm rows.

Weed management: Intercultivation at 20 and 40 DAS and hand weeding at 30 and 50 DAS will help to manage weeds.

Foliar Spray :Foliar application of Panchgavya @ 3% spray and 10% cow urine at 30 DAS and at boot leaf stage as a source of nutrient and growth promoter enhance yield of wheat.

Plant protection measures

- Use rust resistant varieties.
- To manage aphids and sucking pests use NSKE @ 5% or botanical mixture @ 10% spray or *Verticillium lecanii* @ 1g of water as a bio-pesticide.
- For management termites apply Calatrophis leaves to soil at the time of sowing.

Yield: 12-15 q/ha grain and 28-30 quintals of bhusa (fodder) can be obtained.

Note: The package given may be updated with the development of new technologies and based on location specific information available.

COTTON – ORGANIC PRODUCTION

Cotton is an important commercial crop of Karnataka. Yield is mainly depend upon on duration of crop, rainfall, varieties and pest and disease management. Jayadhar cotton the herbaceum group is extensively grown as a relay intercrop in chilli and as a sole crop under rainfed situations.

Varieties	Zone/situation	Time of sowing	Duration (days)	Special Features
Jayadhar	Zone 3 and 8	July, August sole crop August - September Intercrop	200 days	Suitable for intercropping and for rainfed situations. Drought resistance variety. Resistant to pest and diseases.

Production practices: Inputs required per hectare

a) Seeds	3 kg
b) Organic manures	
Enriched compost	3.30 t
Vermicompost	2.70 t
Green leaf manure	5.30 t
Neem cake	250 kg
c) Bio-fertilizers	
Azospirillum	500 g
PSB	500 g

Sowing: Apply all the organic manures 15 days before sowing. Soak the seeds in 25% cow urine solution and air dried. Before sowing treat the seeds with biofertilizers. Sow the seeds at a spacing of 60cm x 30 cm during July-August as sole crop. Dibble two cotton seeds per hill between two chilli plants in a row in a intercropping system.

Weed management: Intercultivation at 25, 35 and 50 DAS and hand weeding at 30 and 55 DAS.

Foliar spray : Use of Panchgavya @ 3% and cow urine @ 10 % spray at 60 and 75 DAS as a source of nutrient and growth promoter.

Plant protection measures

- Use marigold and bhendi as trap crops for management of bollworm and shoot weevil.
- Maize as border crop
- Use of pheromone traps @ 5 per ha for monitoring of *H.armigera.*
- Yellow sticky trap for management of whiteflies @ 10 /acre.
- Botanical @ 5% spray at 30 and 60 DAS as a biopesticides for sucking pest management.
- Release of trichocard @ 1 card/acre at weekly interval 8-10 times after square formation.
- Neem seed kernel extract @ 5% spray at 90 and 105 DAS as a bio-pesticide for bollworm management.

Yield : As a Sole crop 10-12 q/ha as intercrop 5-6 q/ha.

CHILLI – ORGANIC PRODUCTION

Chilli is an important commercial crop of Northern Karnataka, grown over an area of 2 lakh/ha. The chilli is extensively grown as a sole crop, relay intercrop with cotton, onion, garlic and coriander. The crop is extensively grown in Haveri, Dharwad, Gadag, Belagavi, Bellary, Koppal and Raichur districts of Karnataka. It is mainly grown as dry chilli and has export potential as whole chilli, chilli powder and oleorecin. Based on eight years experimentation under Network Project on Organic Farming the organic package has been developed.

Varieties	Zone/situation	Time of sowing	Duration (days)	Special Features
Byadagi Kaddi Byadagi dabbi Dyvanur	Zone 3 and 8 rainfed	June -July	180-200	Special features suitable for rainfed situations drought to lerant fruit are 12-15 cm in length, less pungent, dark red colour, high in oleo-resin content, wrinkles on the surface and good keeping quality.

Production practices: Inputs required per hectare

a) Seeds	3 kg
b) Organic manures	
Enriched compost	4.20 t
Vermicompost	3.30 t
Green leaf manure	6.70 t
Neem cake	250 kg
c) Bio-fertilizers	
Azospirillum	250 g
PSB	250 g
Trichoderma	10 g

Seed bed preparation: prepare 15 raised beds of size 7.5 m length x 1.20 m width x 10 cm height. Add 50 kg FYM and 25 kg VC to the beds. Sow the seeds at 8 cm rows and water the beds once in two days and stop watering 2-3 days before planting. Plant the seedlings after one month in well prepared field.

Planning : Apply all the organic manures 15 days before sowing. Seedlings are planted at row spacing of 60cm x 60cm during June-July.

Weed management: Intercultivation at 30, 45 and 60 DAS and hand weeding at 35 and 50 DAS.

Foliar spray : Spray Panchagavvya @ 3% and cow urine @ 10% at 45, 60 and 75 DAS as a source of nutrient and growth promoter helps for flowering and pod development.

Plant protection measures

- Barrier crop of maize or jowar 4-6 rows all along the border of chilli field to prevent sucking pest like thrips and mites and encourage natural enemies.
- Plant one row of marigold for every 15 rows of chilli as trap crop for *H.armigera* management.
- Use Pheramone traps @ 5/ha for monitoring of *H.armigera.*
- Foliar spray NSKE 5% or *verticillium lecanii* @ 2g/l + cow urine 10% at 30 and 45 days after transplanting (DAT) for management of sucking pests.
- Use yellow sticky traps @ 10/acre for management of sucking pests.
- NSKE 5% or botanical @ 5% spray or chilli+garlic extract @ 2% at 60 and 90 DAT as a biopesticide to control fruit borer.
- For management of anthracnose and fruit rot foliar spray of *Pseudomonas fluorescence* @ 5 g/l of water.

Yield: 7.5-10 q/ha dry chilli yield.

POTATO– ORGANIC PRODUCTION

Potato is a one of the important commercial crops of Karnataka. It is being grown in Northern Karnataka during *Kharif* season and it can also be grown during of *rabi* season if assured irrigation is available. Based on eight years experimentation under Network Project on Organic Farming the organic package has been developed.

Varieties	Zone/situation	Time of sowing	Duration (days)	Special Features
Kufri Jawahar	Zone 8	June month	60-75 days	Medium size round tubers. Resistant to late blight disease.

Production practices: Inputs required per hectare

a) Seeds/tubers	1000 kg
b) Organic manures	
Enriched compost	4.20 t
Vermicompost	3.30 t
Green leaf manure	6.70 t
Neem cake	250 kg
c) Bio-fertilizers	
Azospirillum	1kg
PSB	1kg
Trichoderma	4 kg

Tubers selection : Use disease free certified seeds for planting. Use tubers with viable sprouting buds and big tubers can be cut in to pieces with at least two buds which weighs 35-40 g.

Sowing: Prepare land to fine tilth by deep ploughing and harrowing. Apply all the organic manures 10-15 days before sowing. Apply vermicompost +250 kg neem cake at the time of planting. June is suitable for *kharif* planting. Prepare land into ridges and furrow with 60 cm rows and plant seed tuber at 20 cm apart on the ridge. After 30 days earthing up can be done this increase the number of tubers and protect the tubers from disease.

Weed management: Intercultivation at 20 and 45 days after planting (DAS) and 2 times hand weeding at 25 and 50 DAS.

Foliar spray : Foliar application of cow urine @ 10% panchagavvy @3% at 30 and 45 days after planting.

Plant protection measures

- Dip the tubers for 10 minutes in a *Trichoderma* solution prepared in 50 litre of water with 4 kg of *Trichoderma.*
- Release of Trichocard @ 1 card/acre @ weekly interval 3 to 4 times after noticing the shoot borer incidence @ 25/ha for mass trappinp set up shoot borer pheromone traps.
- Mechanical removal of infested shoots.
- Use of wettable sulphur @ 3g/lit if mite infestation is noticed.
- NSKE @ 5% spray at 45 DAS as a biopesticide
- Neem seed kernel extract or botanicals @ 5% or *Nomuraea rileyi* @ 1 g /ltr of water for management of *Spodoptera litura.*

Yield: 50 q/ha

CHICKPEA – ORGANIC PRODUCTION

Chickpea is an important pulse crop of Northern Karnataka. The *Desi* type chickpea contribute to around 80% and the *Kabuli* type around 20% of the total production. India is the largest producer of this pulse contributing to around 70% of the world's total production.

Details of Varieties

Varieties	Zone/situation	Time of sowing	Duration (days)	Special Features
Annigeri-1,	Zone 3 and 8	October-November	90-95	Resistance to drought
JG-11	Zone 3 and 8	October-November	90-100	Bold seeded resistant to wilt and high yielding

Production practices: Inputs required per hectare

a) Seeds	50 kg
b) Organic manures (Equi. RDP)	
Enriched compost	1.00 t
Vermicompost	8.0q
Green leaf manure	1.70 t
Neem cake	250kg
Trichoderma	2.50 g
c) Bio-fertilizers	
Rhizobium	1000 g
PSB	1000 g

Sowing: Prepare land to a fine tilth, apply, FYM /Compost and green manures 15 days before sowing and apply vermicompost at the time of sowing to seed row. Soak the seeds @ 25% cow urine solution for two hours, air dried and treat them with biofertilizers before sowing. Sow the seeds at 30 x 10 cm row the spacing.

Weed management: Intercultivation at 30 and 45 days after sowing (DAS) and hand weeding at 35 DAS will help to manage the weeds efficiently.

Clipping : At 35 – 40 DAS clip the apical vegetative shoot to increase branching.

Foliar spray: Foliar spray of cow urine 10 % and panchagavvya @ 3% at 30 and 45 DAS as a source of nutrient and growth promoter.

Plant protection measures

- Intercropping of coriander at 4:1 row ratio help to reduce pod borer.
- Monitoring of *Helicoverpa* by pheromone traps @ 5/ha.
- For attraction of birds, sprinkle puffed rice or cooked rice with turmeric powder in the morning or evening hours.
- Use Ha NPV @ 250 LE/ha +Neem Seed Kernel Extract @5% or chilli + garlic extract @ 2% at 30 and 45 DAS for management of pod borer.
- Barrier crop of sorghum all along the border of chickpea reduce rust incidence.

Yield: 12-15 q/ha

MAIZE – ORGANIC PRODUCTION

Maize is a one of the most important coarse cereal food and fodder crop .In India, maize is grown over an area of 8.33 million ha with an annual production of about 16.68 million tonnes and an average productivity of about 2002 kg ha^{-1}. In Karnataka, maize occupies an area of 1.07 million ha with an annual production of about 3.03 million tonnes and an average productivity of 2833 kg ha^{-1}. In the state it is grown under rainfed as well as irrigated conditions. Based on eight years experimentation under Network Project on Organic Farming the organic package has been developed.

Varietals details :

Varieties/hybrids	Zone/situation	Time of sowing	Duration (days)	Special Features
EH-434042 (Arjun) or other hybrids	3 and 8 rainfed/irrigated	June-July	110-115	High yielding

Production practices: Inputs required per hectare

a) Seeds	15 kg
b) Organic manures	
Enriched compost	4.20 t
Vermicompost	3.30 t
Green leaf manure	6.70 t
Neem cake	2250 kg
c) Bio-fertilizers	
Azospirillum	1000 g
PSB	1000 g

Sowing: Prepare land by ploughing and harrowing to a fine tilth Apply FYM/compost and green leaf manures 15 days before sowing and in corporate into the soil. Apply half of the vermicompost at the time of sowing to seed row. Soak the seeds in water for 8 hrs air dry and treat them with biofertilizers. Sow the seeds by hand dibbling at a spacing of 60 cm x 30 cm during June 1st FN. Apply remaining half dose of the vermicompost at 30 days after sowing (DAS) and ensure sufficient moisture at the time of application.

Weed management: Intercultivation at 20 and 40 DAS two and hand weeding at 25 and 45 DAS will manage weeds efficiently.

Foliar Spray : Panchagavvya @ 3% and cowurine @ 10 % spray at 30 and 45 DAS as a source of nutrient and growth promoter.

Plant protection:

- Plant NB 21 grass on the bunds as a trap crop for management of stem borer of maize.
- Release of *Trichogram* @ 50000/ha (1 card/ha) at weekly interval 3 to 4 times to control stem borer.
- *N. rileyi* @ 1g/l spray or HaNPV 250LE/ha for management of cob borer
- Neem seed kernel extract @ 5% or Botanicals @ 10% spray at 45 and 60 DAS as a bio-pesticide to control aphids and stem borer.
- To control armyworm spray NSKE 5% and *Nomuraea rileyi* @ 1 g /l of water.

Yield : 30 - 35 q/ha grain yield and 5.0 tonne of fodder yield.

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