Sustainable Agriculture with Low Cost Technologies (SALoCT)

(A project funded by Rural Technology Action Group - Eastern India (RuTAG - EI), IIT, Kharagpur, under DST, Govt. of India)

- ***Multi-purpose and multi-functional liquid organic products***
- ***Higher yield and higher income than chemical farming***
- ***Less labour, less water, less weeds and less investment***
- ***Better quality produces***
- ***Ideal for resource poor farmers***

School of Agriculture and Rural Development,
Ramakrishna Mission Vivekananda University
(Declared by Government of India as Deemed University under section 3 of UGC Act, 1956)
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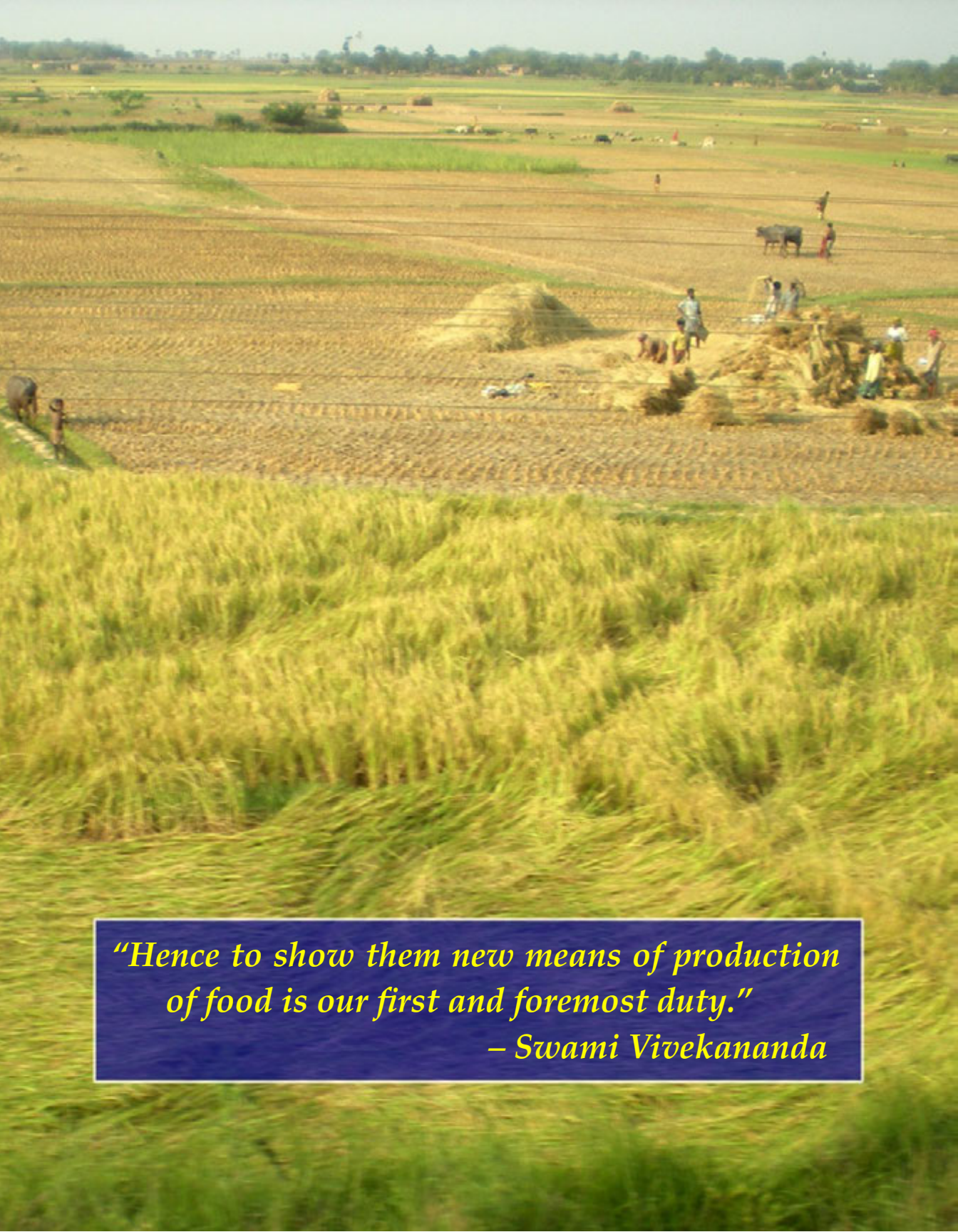

"Hence to show them new means of production of food is our first and foremost duty."

– Swami Vivekananda

Sustainable Agriculture with Low Cost Technologies (SALoCT)

Project duration: May 2008 to June 2011

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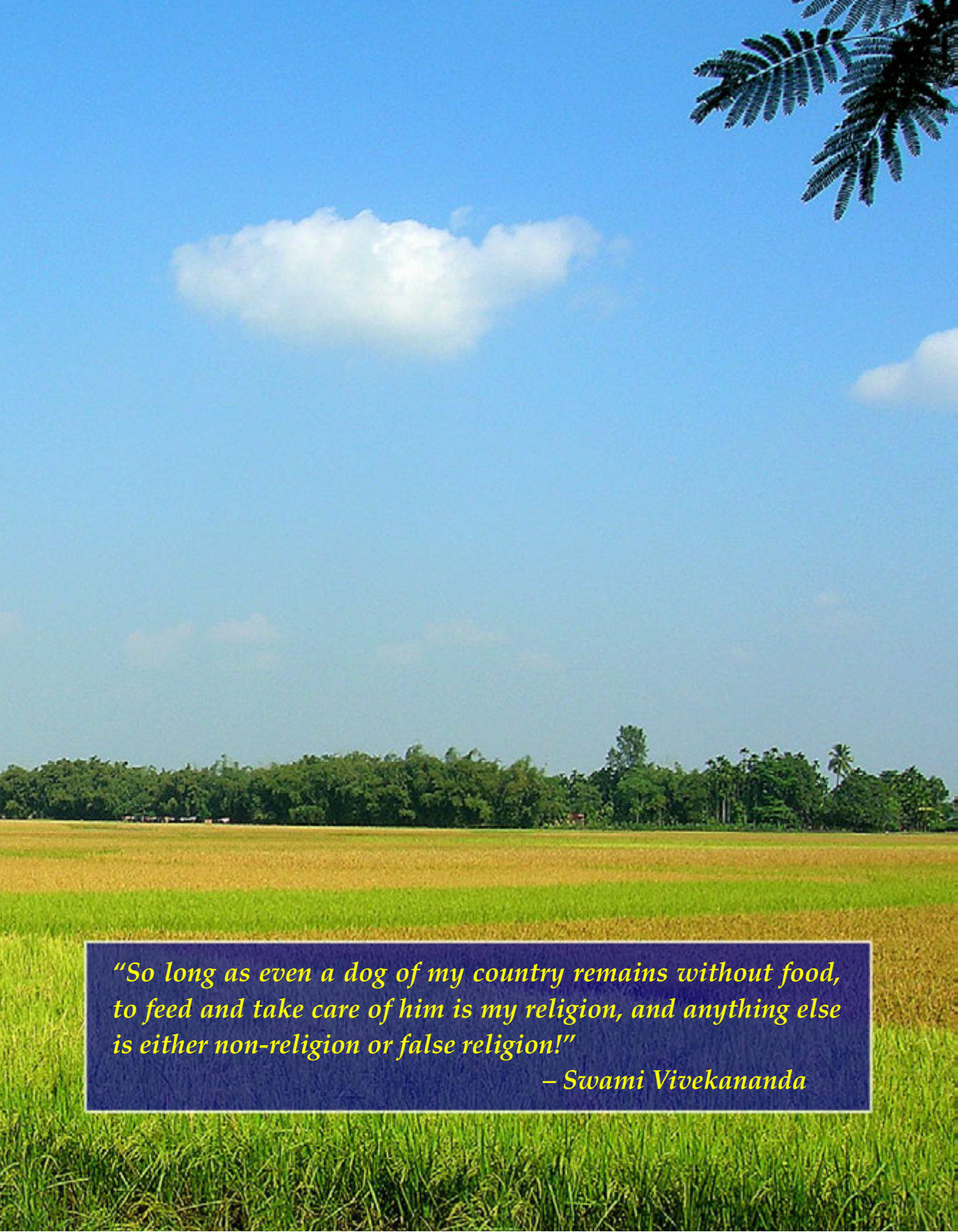

"So long as even a dog of my country remains without food, to feed and take care of him is my religion, and anything else is either non-religion or false religion!"

– Swami Vivekananda

RAMAKRISHNA MISSION VIVEKANANDA UNIVERSITY
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Foreword

A full report on the outcomes of the three year project on 'Sustainable Agriculture with Low Cost Technologies (SALoCT)' run by Ramakrishna Mission Vivekananda University, Belur Math, through its Specialized Faculty Centre for 'Integrated Rural Development and Management (IRDM)' under the 'School of Agriculture and Rural Development', is now being published. This project, funded through Rural Technology Action Group—Eastern India (RuTAG—EI), IIT, Kharagpur, by the Department of Science and Technology, Government of India, has been both a challenge and an innovation taken up and accomplished by our fledgling University and we therefore publish this report with deep satisfaction for having been able to do something positive and creative for our farmers in rural India.

In ancient India, the cultivator and the farmer has been assigned a pride of place in society almost bordering on divine dignity, agriculture having been compared to yoga, sacrifice (R.V x. 101.3-6). Cultivation has been intimately related to Vedic rituals also. (Refer 'Agriculture in the Vedic Age: A Review' published in the 'History, Science, Philosophy and Culture in Indian Civilization'). Unfortunately, the perception changed with the introduction of western education in pre-independent India and the dignity and glory associated with agriculture as a profession were lost due to lopsided vision in society, resulting in an increasing trend among farmers to shift to other professions deserting or leaving their age old traditional profession of agriculture (Ref. NSSO 2005) once looked upon as divine. Low income, insecurity, lack of dignity in the eyes of the society, etc., are the reasons for this appalling trend among farmers. In India where more

than 82% farmers belong to small and marginal category, appropriate package of low cost technologies for sustainable agriculture is essential for secured income of our resource poor farmers to achieve food security for the whole nation.

Our University in the hallowed name of Swami Vivekananda feels proud and satisfied that we could contribute our humble bit to actualizing the vision of this great soul whose heart wept for the poor, the underprivileged and the downtrodden, as articulated by him the following words:

“I do not believe in a God or religion which cannot wipe the widow's tears or bring a piece of bread to the orphan's mouth”, “First of all try to ameliorate the terrible distress that is prevailing everywhere, to still the heart-rending cry of your hungry countrymen for a morsel of food; after that come to me to have a debate on the Vedanta. To stake one's whole life and soul to save thousands who are dying of starvation—this is the essence of the religion of the Vedanta!"

We fondly hope and strongly feel that the outcomes of this project will play a pivotal role in ushering a second and ever green revolution in India to ameliorate the wide spread hunger among the poor brethren among our countrymen.

We pray to Swami Vivekananda to bless us with the strength and inspiration to transfer these standardized and recommended technologies to all farmers of India in an effort to actualize Swami Vivekananda’s vision of a hunger free India.

12 January 2012

Swami Atmapriyananda

Vice Chancellor

Index

Acknowledgement

We thankfully acknowledge the Department Science of Technology, Government of India and Indian Institute of Technology, Kharagpur for their financial and technical support.

We express our deepest gratitude to Swami Atmapriyananda, Vice Chancellor, Ramakrishna Mission Vivekananda University (RKMVU), Dr P Chidambaram, Scientific Advisor, Government of India, Dr Manas Ghosh, Dean, Faculty of 'Integrated Rural Development and Management (IRDM)', Narendrapur Centre of RKMVU, monks and all the faculty members of IRDM at Narendrapur and 'Integrated Rural & Tribal Development and Management (IRTDM)' at Ranchi, Jharkhand, for their encouragement, administrative and technical support.

Nandalal Kumar, Technical Assistant, all the students of postgraduate diploma in Agro-based Bio-technology (ABBT) for sessions 2008-09, 2009-10 and 2010-11 of IRDM Faculty Centre and the farmers of Banhooghly, South 24-Parganas district in West Bengal deserve our gratitude and thanks for their active participation and help in implementing the project.

Sustainable Agriculture with Low Cost Technologies (SALCoT): A Rural Technology Action Group—Eastern India (RuTAG-EI) Project

1. Background and Introduction

Indians have been cultivating for more than 10000 years using locally available resources in an eco-friendly way. Evolution of the concept of farming has been best described in Kautilya's *Arthashatra*, Varahamihira's *Virat Samhita*, Surapala's *Vrikshayurveda* and Parasara's *Krishi Parashara*. The sage Parasar in 'Krishi Parasar' in the 400 BC stated that the "**life of farmers is solely dependent upon the microbes present in the soil**." Kautilya preached that a king must learn agriculture. "The sage Janaka held the plough in one hand and the sacred Vedas in the other. Our sages of old were farmers" Swami Vivekananda (Ref *Life of Swami Vivekananda* by his Eastern and Western disciples, publ. Advaita Ashrama, Vol.1, p.274). Unfortunately, the perception changed with the introduction of western education in pre-independent India and agriculture profession came to be regarded as one of low dignity. Swami Vivekananda rightly said, "But these days, no sooner do the village boys read a book or two of English than they run to the cities. In the village they may have plenty of land, but they do not feel satisfied. They want to enjoy city-life and enter service. That is why the Hindus have not progressed like other races." (Ref *ibid*)Due to this lack of the feeling of love for the land as towards one's own mother as in the past

and the sense of pride and dignity towards farming as a profession, farmers started considering land as merely a 'unit of production' rather than as a sacred mother-symbol. Exploiting the land for more and more production became their objective without any consideration for the health of soil and environment.

Meeting with farmers

With the advent of modern inputs, namely, chemical fertilizers, pesticides etc. during post world war II and to meet the demand for food production for the huge population from limited land area, India too started using chemical inputs etc. during late fifties. This was the advent of 'Green Revolution' in India in 1968 with new chemical inputs and high yielding varieties of crops. Undoubtedly, this was a great stride towards self-sufficiency in food. But, the Green Revolution is now showing the second generation problems like soil fatigue due to intensive cultivation and inadequate and imbalanced fertilizer use, stagnation in yield of high yielding varieties, continuous decrease in the input use efficiency, declining soil organic carbon content, declining water table, increasing problems of soil salinity and environmental degradation, etc. The productivity of major cereal crops like wheat and rice is declining in many states. Albert Einstein in his message to the people of India had rightly said in 1948, "India should not go for mechanized farming. Soil in the U.S.A. has lost much of its fertility within a span of just three hundred years, whereas India's soil retains its fertility till today, even though farming has been going on for last 10000 years. Tractor's ploughing and use of fertilizers

will bring loss of fertility, eventually causing incalculable and irreparable harm to the country."

According to Swaminathan (1992) "Soils in India are often not only 'thirsty' but also 'hungry'. Inputs are needed for output. Therefore, what we need is a reduction in the use of market purchased chemical input and not of inputs per se. It is in this context that integrated system of nutrient supply suitable for easy adoption includes crop rotations, green manure, bio-fertilizers and bio dynamic systems that make significant use of compost and humus, will help to improve soil structure and fertility". (Refer *Report on the Inter ministerial Task force on Integrated Plant Nutrient Management Using City Compost* dated 14 January 2003). Report of the working group on 'Organic and biodynamic farming' for 10th five year plan published by Planning Commission, Government of India in 2001 also supports the above mentioned views and suggests organic and biodynamic farming principle and practices to improve the health of soil, plants, animals, men and environment.

Experimental plot at Narendrapur

It is estimated that 65% of the country's cropped area is organic by default as the small farmers have no choice but to farm without chemical fertilizers and pesticides as they cannot afford these (Muthukumaran, 2006) (Refer *Organic Agriculture and Food Industry: trends, challenges and opportunities, K Muthukumaran, CAB Calling, Oct-Dec. 2006*). Assuming the need of the organic farming and demand of organic products in

global market, the Department of Agriculture and Co-operation, Government of India has set up a task force in May, 2000 on organic farming to collect information on organic farming, assess the appropriate technologies of such farming and setting up standards. The Indian Government also established the National Institute of organic farming in October, 2003 in Ghaziabad, Uttar Pradesh. Thirty years experiment on Organic Farming vs. Chemical Farming in Rodale Institute of USA (published in 2011) also proves that organic farming is better than chemical farming in respect of productivity, profitability, sustainability, input use efficiency and energy consumption. Bio-fertilisers, bio-pesticides, enriched organic manure; growth promoters etc. which are generally recommended and produced commercially are also expensive and uncertain due to lack of adequate standard quality control mechanism facility. In India, since more than 82 % farmers belong to small and marginal farmers, and since 60% of net cultivated land fall under rain fed farming and about 37% of people live below poverty line, purchase of these costly organic inputs also become difficult for the resource poor farmers of India. Again, dependence on high cost external inputs itself is against the principle of self-sufficiency and self-sustainability of an organic farm. To address the above mentioned problems, the School of Agriculture and Rural Development of Ramakrishna Mission Vivekananda University undertook the project 'Sustainable Agriculture with Low Cost Technologies (SALCoT)' under Rural Technology Action Group—Eastern India (RuTAG-EI) of the Department of Science and Technology, Government of India, through Indian Institute of Technology, Kharagpur, with the following objectives:

Objectives of the Project

1. To standardize the proportion of different ingredients, dose and method of application of four low cost **multi-purpose and multi-functional liquid organic products** viz. *Sanjivani, Panchagavya, Shasyagavya* and *Kunapajala* for recommendations.

2. To observe the effects of these preparations on yield and yield contributing characters of different crops.

3. To analyse the bio-chemical composition of all four liquid organic products.

4. To identify beneficial microbes viz. *Rhizobium, Azotobacter, Azospirillium, Phosphate Solubilising Bacteria(PSB), Trichoderma and Pseudomonas* present in *Sanjivani, Shasyagavya, Kunapajala and Panchagavya* to explore the potentiality of these products as bio-fertilizer and bio-pesticides.

5. To measure the soil health of the experimental plots in the beginning of each cropping season to see the fertility status of soil.

6. To increase the shelf life of these products by producing carrier based preparations.

7. To explore the potentiality of these liquid organic products as standard starter solution for preparation of compost manure.

8. To explore the potentiality of these four products as rooting hormone.

9. To study the comparative productivity and profitability of organic and conventional farming (chemical).

10. To conduct demonstration in farmers' field to transfer the upgraded and standardized technology.

11. To create job opportunity for rural youths or Self Help Groups (SHGs) by production and marketing of these produces.

The details of the project and the achievements have been described in this booklet.

2. Brief Description and Preparation of four multi-purpose and multi-functional liquid organic products under study

The common characteristic features:

- The common components are cow dung and cow urine.
- These are fermented products.
- Stirring is required during fermentation.
- Unlike other solid organic manure, foliar application is possible.

Advantages of uses:

- Source of essential plant nutrients and growth promoting hormones. So, these can be used as liquid manures as well as growth promoting hormones.
- Huge source of beneficial bacteria, fungi and other microbes. Hence, these can be used as bio-inoculums for better and quicker preparation of composts.
- Could be applied as bio-fertilizer because these are rich sources of *Rhizobium*, *Azotobacter*, *Azospirillum* and Phosphate Solubilizing Bacteria.
- Could be applied as bio pesticides because of presence of entomopathogenic and antagonistic fungus and bacteria like *Trichoderma*, *Pseudomonas*, etc.

Brief description of all four multi-purpose and multi-functional liquid organic products with respect to their composition, preparation and use:

i) Sanjivani

Sanjivani is a low/no cost organic liquid manure. Cow dung, cow urine and water are mixed in the ratio of 1: 1: 2 in an earthen pot or bucket and left aerobically (stirring twice daily) for 7-9 days. Stirring with a stick atleast ten times is required every day morning and evening clockwise and anticlockwise. This is called mother solution of *Sanjivani*

Type:

On the basis of use, it is of two types:-

Bija Sanjivani: The 20% aqueous solution of *Sanjivani* is called *Bija Sanjivani*. Seeds, seedlings or any planting materials are to be dipped in *Bija Sanjivani* solution for some time and to be sown/ planted in field after drying in shade. This treatment protects the crop from harmful soil borne and seed borne pathogens during initial stages of germination and establishment. This is also used for seed enrichment to provide nutrients and growth promoting hormones during initial crop growth.

Poudh Sanjivani: The 5% and 10 % aqueous solution of *Sanjivani* is called Poudh *Sanjivani*. It is called Poudh *Sanjivani* because of its use on standing crops. Poudh *Sanjivani* of 5% and 10% are recommended for spray after sieving at initial stage (up to 30 Days after sowing) and later growth stage (after 30 Days after sowing) of crops respectively. This is to be applied twice in a month till maturity of crops. Fermented solution may be applied in field with irrigation also.

ii) Panchagavya

In Sanskrit, *Panchagavya* means the blend of five products obtained from a cow. All these five products are individually called *gavya* and collectively termed as *Panchagavya*. Mixing of five ingredients i.e. cow dung, cow urine, milk, curd and ghee in 5: 3: 2: 2: 1 and incubated for 7-9 days in an earthen pot or wide mouth plastic container. Stirring with a stick is required every day two times morning and evening clockwise and anticlockwise. It is stored in shady place with cover. *Panchagavya* of 1% and 3% are recommended for spray after sieving at initial stage (up to 30 days after sowing) and later growth stage (after 30 days after sowing) of crops respectively. This is to be applied twice in a month till maturity of crops. This promotes biological activities in the soil and makes nutrients available to crops. *Panchagavya* may be applied with irrigation water also without sieving.

iii) Sasyagavya

The ingredients in this case are: cow dung, cow urine, vegetable waste/crop residues and water. Initially, vegetable waste/crop residues are chopped. Then fresh cow dung, cow urine, chopped organic waste and water are mixed at 1: 1: 1: 2 ratio properly and allowed to ferment for 10-12 days aerobically (stirring twice in a day). After 10-12 days of preparation, the fermented Sasya*gavya* after sieving will be sprayed on standing crops as 5% and 10% aqueous solution up to 30 days of germination and 30 days after germination respectively. Also it is used for drenching soil before sowing and /or after sowing with irrigation water.

iv) Kunapajala

Sanskrit word *kunapa* means smelling like dead body, stinking and *jala* means water. So *Kunapajala* means water smelling like a dead body. It contains mainly cow dung, cow

urine, water, and any animal flesh like flesh part of fishes, poultry birds or animals. Fresh cow dung, cow urine, animal waste and water are taken in a bucket at 1: 1: 1: 2 ratios and mixed properly. Then allow this mixture to ferment in a shady place for 25-30 aerobically (stirring twice in a day). After filtration, 1% aqueous solution of *Kunapajala* is to be sprayed at 10-15 days interval on the standing crop preferably in the evening. To remove the foul smell of the products, any scented leaves like lemon, lemongrass etc. or peels of lemon, orange, sweet orange etc. are to added 1-2 days before spray.

Plants absorb through roots, leaves and stem the nutrients available in these liquid organic products. These promote biological activities in the soil also to make the nutrients available to crops.

All these liquid organic products can be enriched with molasses/rice washed water, pulse powder, ripen fruits, yeast culture etc.

Note: Additional 2 to 4 days will be required for fermentation of all liquid organic products during winter season.

"Religion is not for empty stomachs" - Sri Ramakrishna

1 part

1 part

1 part

2 parts

1 part

Ingredients of Shasyagavya

Ingredients of Sanjivani

Ingredients of Kunapajala

Mixing of Ingredients

Stirring every day during fermentation period

Pictorial representation of different steps of production of Sanjivani, Shasyagavya and Kunapajala

Adding ghee with cowdung

Adding Curd with the mixture

Adding milk with the mixture

Adding Cow urine with the mixture

Pictorial representation of different steps of production of Panchagavya

Recommended proportion of different ingredients and dose of application of four low cost multi-purpose and multi-functional liquid organic products viz. *Sanjivani*, *Panchagavya*, Shasya*gavya* and *Kunapajala* are summarized in Table 1

Liquid organic products	Composition	Fermentation Period (days)	Amount of water to be mixed with 1 litre of mother solution	Amount of mother solution for 1 acre crop
Mother Solution/Sanjivani (50%)	Cow dung -1 part, Cow urine -1 part and Water-2 part			
Bija Sanijvani (20%)	Cow dung -1 part Cow urine -1 part Water-5 part	7-9	750 ml water is mixed with 1 lt of mother *Sanjivani*	2-3 lt/kg of seed
Poudh Sanjivani (5%) for spraying on seedlings upto 30 days after germination	Cow dung -1 part Cow urine -1 part Water-20 part	7-9	4.5 lt water is mixed with 1 lt of mother *Sanjivani*	40 lt
Poudh Sanjivani (10%) for spraying in mature seedling	Cow dung -1 part Cow urine -1 part, Water-10 part	7-9	2 lt water is mixed with 1 lt of mother *Sanjivani*	70 lt
Shasyagavya (10%)	Cow dung -1 part Cow urine -1part Crop residues-1 part Water-10 part	10-12	1.6 lt water is mixed with 1 lt of mother *Sasyagavya* (1:1:1:2)	80 lt
Kunapajala (1%)	Cow dung -1 part Cow urine -1 part Animal flesh-1 part Water-100 part	25-30	19.6 lt water is mixed with 1 lt of mother *Kunapajala* (1:1:1:2)	10 lt
Panchagavya (3%)	Cow dung -5 part Cow urine -3 part, Milk-2 part, Curd-2 part, Ghee-1 part	7-9	3 kg of *Panchagavya* is to be mixed with 100 lt of water	6 kg

Table 1: Proportion of different ingredients and dose of four low cost multi-purpose and multi-functional liquid organic products

3. Effect of four multi-purpose and multi-functional liquid organic products on yield of different crops

Year	Crop Season	Crop grown	Variety	Treatment	Yield / plant or Yield / m^2 in treated plot	Yield / plant or Yield / m^2 in control plot
2008-09	Pre-Kharif	Green gram	Samrat	***Sanjivani* 10%,** *Panchagavya* 3%, control	35.8 gm/ plant	15.8gm/plant
	Kharif	Black gram	Sarada	*Sanjivani*-5%,**10%**,15%	10.92 gm/plant	6.32 gm/plant
	Rabi	Mustard	B-9	*Sanjivani* 10%,***Panchagavya* 3%,** control	1.75 gm/plant	0.45 gm/plant
2009-10	Kharif: University trial plot	Paddy	Shatabti	***Sanjivani* 10%,***Panchagavya* 3%, control	750 gm/m^2	668.88 gm/m^2
	Kharif: Farmer's field	Paddy	Khitish	*Sanjivani* 10%,***Panchagavya* 3%,** control	716.67 g/m^2	700 g/m^2
	Rabi: University trial plot	Paddy	GB-1	*Sanjivani* 10%,***Panchagavya* 3%,** control	646.66 gm/m^2	550 gm/m^2
		Mustard	Jhumka	*Sanjivani* 10%,***Panchagavya* 3%,** control	120.66 gm/m^2	60 gm/m^2
	Rabi: Farmer's field	Lady's Finger (25 pickings)	O16 hybrid	***Sanjivani* 10%,***Panchagavya* 3%, control	229 kg in 0.09 acre	205 kg in 0.09 acre
2010-11	Kharif	Paddy	Shatabti	***Sasyagavya*-20%,**	782.67 gm/m^2	567.00 gm/m^2
			Basmati	***Sasyagavya* 10%,** *Sasyagavya* - 5%,10%,20%, *Kunapajala*-1%,3%,5%,10%, Control.	445.33 gm/m^2	352 gm/m^2
		Black gram	Kalindi		110 gm/m^2	90 gm/m^2
	Rabi	Mustard	Jhumka	***Kunapajala* -1%(mustard),**3%,5%,10% ***Sasyagavya*** -5%,**10%(paddy GB1)**, 20%, control	782. 95 gm/m^2	679.33 gm/m^2
		Paddy	GB-1		803.33 gm/m^2	488.67gm/m^2

Table 2: Effect of four liquid organic products on yield of different crops

*Yield of treated plots indicates the yield of best organic treatment which is mentioned as bold characters in treatment column.

Mustard plot (Var: Jhumka) treated with 1 % Kunapajala (Rabi, 2010-11)

Paddy plot (Var: Shatabdi)treated with 10 % Shasyagavya (Kharif, 2010)

Chilli Plant (Var: Beldanga) treated with 3 % Panchagavya (Kharif, 2010)

Paddy plot (Var: Basmati) treated with 5 % Shasyagavya (Kharif, 2010)

Blackgram (Var: Kalindi) treated with 10 % Sanjivani (Kharif, 2009)

Paddy plot (Var: Gontra Bidhan) treated with 1 % Kunapajala (Rabi, 2011)

Different crops in the experimental plot at IRDM Faculty Centre, Narendrapur in different crop seasons

NB. The synoptic findings on the effects of four liquid organic products on yield contributing characters of all crops:

- Out of 11 yield contributing characters 6 characters namely numbers of spikelet/ panicle, Nos of filled grains/ spikelet in Paddy; and plant height, number of branches/plant, number of siliqua/plant, 1000 seed weight in Mustard were statistically significant.
- Higher variation was observed in number of pods/plant and 100-seed weight in case of Green-gram and Black-gram.

4a. Bio-chemical analysis of the liquid organic products and improved farm soil

Liquid organic products	pH	EC	Organic Carbon (%)	Available Nitrogen (%)	Available Potassium (%)	Available Phosphorus (%)	Total fungus	Total Bacteria
Shasyagavya (1:1:1:5)	5.32-7.78	1.78	0.33-0.73%	0.083-0.086%	0.113-0.118%	0.013%	1.01 X 10^7	7.64 X 10^{11}
Sanjivani (1: 1: 5)	7.2-7.5	3.5	0.19-0.32%	0.045-0.056%	0.062-0.088%	0.0032-0.0077%	2.53 X 10^9	1.97 X 10^{11}
Kunapajala (1:1:3:100)	7.69	4.01	0.087-0.116%	0.022-0.025%	0.0022-0.0024%	0.0015-0.0061%	1.71X 10^7	1.19 X 10^{11}
Panchagavya	5.6	4.6	>12%	0.035-0.039%	0.058-0.075%	0.0082-0.0168%	4.41 X 10^6	1.83 X 10^9

Table 3: Biochemical properties of four low cost liquid organic products
Source: IRTDM faculty Centre, Ranchi of Ramakrishna Mission Vivekananda University

4b. Identification of number of different specific microbes viz. *Rhizobium*, *Azotobacter*, *Azospirillium*, PSB, *Trichoderma* and *Pseudomonas* present in Sanjivani, Shasyagavya, Kunapajala and Panchagavya to explore the potentiality of these liquid organic products as bio-fertilizer and bio-pesticides

Parameter	*Panchagavya*	*Sanjivani*	*Sasyagavya*	*Kunapajala*
Days of fermentation	10^{th} Day	10^{th} Day	10^{th} day	24^{th} Day
Azotobacter	17 X 10^8	2 X 10^8	5.12 X 10^{11}	1.28 X 10^{11}
Azospirillum	35 X 10^8	2 X 10^8	4.66 X 10^9	3.74 X 10^{10}
PSB	34 X 10^8	18 X 10^8	4.66 X 10^9	6.22 X 10^{10}
Pseudomonas	32 X 10^8	5 X 10^8	3.04 X 10^{10}	5.8 X 10^{10}
Rhizobium	28 X 10^8	15 X 10^8	1.82 X 10^{10}	2.08 X 10^{11}

Table 4: Population of different species of microbes present in four low cost liquid organic products

Microbiology Laboratory of IRDM Faculty Centre

Transfer of inoculants in liquid media

Isolation of microbes from broth

Culture plate showing microbial colonies

Counting of microbial colony in colony counter

Molecular biology laboratory of IRDM Faculty Centre

Different Laboratory based activities at IRDM Faculty Centre, Narendrapur

4c.Bio-chemical composition of improved soil health of the experimental plots:

Particular	pH	EC (mhos/ cm)	Organic C (%)	N (%)	Available P (P_2O_5 kg / ha)	Available K (K_2O kg / ha)	Total fungus	Total Bacteria
2009-Pre- Kharif	7.2	0.30	1.1	0.11	>100	250	-	-
2009- Kharif	7.6	0.30	1.2	0.12	83	450	-	-
2009-10-Rabi	7.9	0.40	1.2	0.12	67	370	-	-
2010-Pre- Kharif	7.4	0.30	0.85	0.085	>100	390	6×10^5	3.33×10^9
2010- Kharif	7.6	0.30	0.71	0.071	60.5	275	2.8×10^6	2.7×10^{10}
2010-11-Rabi	7.7	0.16	1.27	0.12	49.50	203	1.46×10^6	2.36×10^{10}

Table 5: Soil health results of the experimental plots

Soil volume: One sq. meter upto 30 cm soil depth	Organic plots (after3years)	Adjacent Inorganic plot
Average weight(gms)	68.56	1.16

Table 5a: Mass weight of earth worms in experimental organic plot and its adjacent inorganic plot, Narendrapur

Table 3 shows that the products can be used as liquid manures as these are good sources of N P K and organic carbon whereas Table 4 indicates the uses of these products as bio-fertilisers as well as bio-pesticides due to presence of nitrogen fixing bacteria, phosphorus solubilising bacteria, *Pseudomonas* bacteria etc.

The soil health result of Table 5 shows the increase in organic carbon percentage and total microbial population of experimental plots over two years after cultivation of three crops in a year with organic package of practices only

Table 5a shows the higher earth worm mass weight in organic plots than the inorganic plots. Earthworm enriches soil by producing cast equal to its body weight every day in addition to continuous biological farming. The cast contains almost all macro and micro nutrients in addition to various beneficial microbes in soil and thus improves the physical, chemical and biological health of soil.

So, the **sustainability** of these technologies may be confirmed from the soil health record of Table 5 and 5a.

5. Increasing shelf life of liquid organic products and scope for rural employment

Days after fermentation	Sasyagavya					
	Control		Solid (Charcoal) carrier (30 ml culture/100 g of carrier)		Liquid (Glycerol) carrier (30 ml culture/100 g of carrier)	
	Fungal count ($X10^5$)	Bacterial count ($X10^9$)	Fungal count ($X10^5$)	Bacterial count ($X10^9$)	Fungal count ($X10^5$)	Bacterial count ($X10^9$)
17	101.55	76.44	75.66	102.55	8	78.66
92	2.66	15.44	8.77	26.77	2.66	0.33

Table 6: Microbial population in different treatments in Sasyagavya at different days of fermentation

Days after fermentation	Kunapajala					
	Control		Solid (charcoal) carrier (30 ml culture/100 g of carrier)		Liquid (Glycerol) carrier (30 ml culture/100 g of carrier)	
	Fungal count ($X10^5$)	Bacterial count ($X10^9$)	Fungal count ($X10^5$)	Bacterial count ($X10^9$)	Fungal count ($X10^5$)	Bacterial count ($X10^9$)
24	171.77	119.00	226.33	70.22	100.40	130.33
94	1.44	1.00	2.66	8.22	3.33	16.77

Table 7: Microbial population in different treatments of Kunapajala at different days of fermentation

Days after fermentation	*Panchagavya*						*Sanjivani*					
	Control		Solid (Charcoal) carrier (30 ml culture/100 g of carrier)		Liquid (Glycerol) carrier (30 ml culture/100 g of carrier)		Control		Solid (Charcoal) carrier (30 ml culture/100 g of carrier)		Liquid (Glycerol) carrier (30 ml culture/100 g of carrier)	
	Fun. ($X10^5$)	Bac ($X10^9$)	Fun. ($X10^5$)	Bac ($X10^9$)	Fun. ($X10^5$)	Bac ($X10^9$)	Fun. ($X10^5$)	Bac ($X10^9$)	Fun. ($X10^5$)	Bac ($X10^9$)	Fun. ($X10^5$)	Bac ($X10^9$)
8	326.33	152.00	231.33	129.66	62.60	220.00	46.66	171.33	101.33	110.00	27.66	109.66
77	3.33	1.66	144.66	136.33	242.00	200.00	0.33	4	328.33	310.00	384.00	336.00

Table 8: Microbial population in different treatments of Panchagvya and Sanjivani at different days of fermentation (Fun: Fungal count; Bac: Bacterial count)

From the findings of Table 6, 7 & 8, it is clear that the problem of longer period storage could be solved by developing the carrier based preparation which will also be very easy to produce a packaged product

Production and marketing of these produces will be a good enterprise for the rural youths or SHGs while encouraging eco-friendly technologies for sustainable agriculture.

6. Effects on composting

Parameter	Compost using Commercial decomposer 1	Compost using Commercial decomposer 2	Compost using Commercial decomposer 3	Compost using Commercial decomposer 4	Compost using *Panchagavya**	Compost using Sanjivani**
Days for composting	29	34	36	41	38	33
pH	7.96	7.95	7.9	8.2	8.08	8.1
E. C.	8.0	8.2	9.5	5.5	10.5	8.8
Org. C (%)	8.00	7.72	13.15	13	12.5	12
P (%)	3.1	2.8	4.2	6.3	4.2	4.4
K (%)	>0.13	>0.13	>0.13	>0.13	>0.13	>0.13
Total Fungus	4.67×10^5	2.67×10^5	2×10^5	1.33×10^5	2.33×10^5	3.33×10^5
Total Bacteria	9.33×10^5	7.67×10^5	5.67×10^5	3.67×10^5	6.67×10^5	8.33×10^5

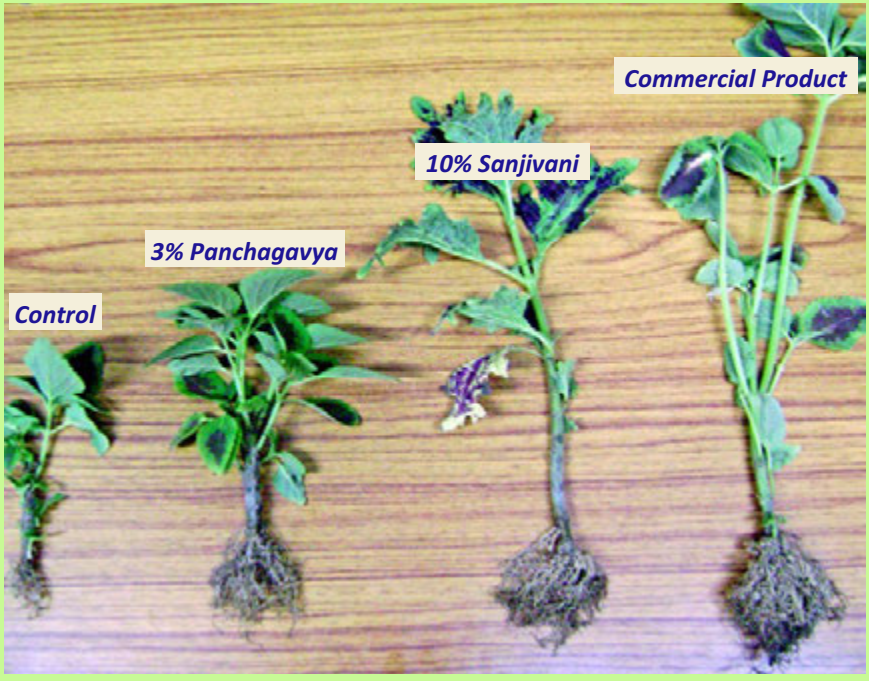
Table 9: Bio-chemical analysis and fermentation period for preparation of compost from water hyacinth with different liquid organic products .

* 3% *Panchagavya* (i.e. 3g fermented *Panchagavya* in 100 ml of water) of 500ml were mixed with in 40 kg partially decomposed organic materials.

**10% Sanjivani (i.e. Cow Dung: Cow urine: Water in 1:1:10 ratio) of 500ml were added in 40 kg partially decomposed organic materials

The above results show that *Panchagavya* and *Sanjivani* can easily replace the commercial costly decomposers used for compost preparation. Thus these reduce the cost of compost as well as dependence on external inputs.

Experiment for studying the effect of liquid organic products on composting



Experiment for studying the effect of liquid organic products on rooting

7. Effects on root development

Treatment	Root mass(gm)	Root length(cm)	Shoot mass(gm)	Shoot length(cm)
Control	0.42	2.83	2.51	7.73
3% *Panchagavya**	0.88	6.97	6.97	14.03
10% *Sanjivani**	1.86	9.73	9.57	16.77
Commercial product	2.96	12.90	15.06	27.97

Table 10: Mean of different root characters of *Coleus* plant after treating with different liquid organic products

Chrysanthemum plants at Belur

* Small earthen pots were taken with sands because of easy root initiation & elongation. After inserting of the twigs within sands, 500 ml of respective liquid organic products was spread in every pot.

Panchagavya and *Sanjivani* are having significant effect on promotion of roots in cuttings. Hence, these two can be used as cutting aids in plant propagation.

Sanjivani as rooting aid showed 85-90% success in Chrysanthemum plants cultivated at Belur Math campus of the University.

8. Low cost package of technologies for sustainable/organic farming

i. Land preparation- Raised bed technique, zero/minimum tillage

ii. Soil drenching with liquid manures for land reclamation and/manuring

iii. Appropriate crop selection according to soil type, land situation, seed and/or seedling treatment with beeja *Sanjivani*

Preparation of Sanjivani by Farmer

Straining of Sanjivani

Seed treatment

Seed bed preparation

Land preparation

Seedling treatment with Sanjivani

iv. Integrated Nutrient Management:

a) Manuring - Compost, vermicompost, bio-fertilisers in soil, on standing crops or with seeds and manures

b) Preparation and use of different liquid organic products

c) Green manuring and green leaf manuring- Culturing Azolla, ploughing down green manured plants, using green legume leaves, growing leguminous plants on bunds, borders of the field/farm etc.

d) Creating congenial environment for growth and multiplication of earthworms and beneficial microbes

v. In situ water management- Every drop of water is conserved through adoption of different soil and water conservation practices and thus reduces requirement of irrigation

vi. Mulching – Covering plots with crop residues or other biodegradable materials to control weeds, conserve moistures, add biomass etc.

vii. Integrated Organic Pest management- Bio-pesticides, botanical pesticides, organic pesticides and natural control

viii. Weed management- Furrow irrigation in raised beds, mulching, cover crops, use of well rotten cow dung manures, proper crop rotation, uprooting weeds before seed formation etc.

ix. Live fencing for protection of crops from grazing animals

x. Seed storage-Using botanical and organic preparation

xi. Appropriate crop rotation according soil and land situation.

Cultivation of crops with the above mentioned technologies reduces requirement of water, labour and less investment (due to use of low cost inputs, less weed infestation, less labour etc.).

9. Economics of cultivation

Treatment	Cultivation Cost (Rs per acre)	Yield (q per acre)	Return (Rs)	Net return per acre (in Rs)	Additional net return per acre (in Rs)
Chemical	32314	18.72	41184	8870	
Organic**	25250	15.63	34386	9136	266

**Cow dung manure @ 1 q/ acre as basal followed by 4 spraying of 3% *Panchagavya* and *Sanjivani*

Table 11: Economic Analysis of boro paddy (var Gontra Bidhan 1) cultivation: 2009-10

Treatment	Return (q per acre)	Additional return from treatment plot than control (q per acre)	Additional return from treatment plot than control (in Rs per acre)	Additional cost per acre (in Rs)	Additional net return per acre (in Rs)
Control	22.53				
Sanjivani (10%)	30.00	7.47	7470	nil	7470
Panchagavya (3%)	27.73	5.20	5200	600	4600

Table 12: Economics of Kharif Paddy (var Shatabdi) in the University Farm, 2009-10

Note: Sale price of paddy: Rs.1000 per quintal

Raised Bed Furrow method

Sowing of Lady's Finger

Mulching

Different low cost package of technologies for sustainable / organic farming

Cost Calculation of Organic and Chemical Paddy (Basmati) Cultivation (2010) Kharif

Organic paddy:

Yield per acre: 1386.5 kg and Net Return from 1 acre organic paddy = Rs 20, 025/=

Chemical paddy:

Yield per acre: 1100.5 kg and Net Return from 1 acre chemical paddy = Rs 1785/=

Cost Calculation of Organic and Chemical Paddy (Gontra Bidhan-1) (2010-11) Rabi

Organic paddy:

Yield per acre: 39331 kg and Net Return from 1 acre organic paddy = Rs 42600/=

Chemical paddy

Yield per acre: 18330kg and Net Return from 1 acre chemical paddy = Rs 42200/=

(Labour Cost @ Rs. 100.00 /day and Paddy@ Rs 22/kg selling price for seed purpose). From the first year itself organic paddy gives more net return than the chemical paddy for all the three varieties grown in different seasons in a year. Local Scented variety (Basmati) respond very positively giving more than 10 times higher income than the conventional system of chemical farming. The result is seemed to be absurd than the reality. However, we have to confirm the result through further study.

10. Multi-locational trials and demonstrations

Name of the Farmers:

a. Abani Pal, **Address of the farmers:**

b. Bhadu Ramanik, **Vill.Kachharipara, P.O. Banhooghly,**

c. Santishi Majhi **District 24 Paraganas (South), West Bengal**

i) **Kharif Crop: Paddy:** Paddy was grown in the field of above mentioned three farmers to see the effects of *Panchagavya* - 3% and *Sanjivani* - 10% on morphology of the plants, yield and quality of produce. The growth and yield of crop in the treated plots were encouraging.

Kharif paddy at farmers' plot at BanHooghly, S-24 Parganas

Yield in *Panchagavya* treated plot was the highest

ii) **Lady's finger (O16 hybrid):** After harvest of paddy, lady's finger was cultivated to show the effects of *Panchagavya* and *Sanjivani*. Though initially there was an attack of mite infestation (due to long spell of hot) and semilooper in all the plots i.e.

Lady's Finger at farmers' plot at BanHooghly, S-24 Parganas

chemical and organic plots. After rains mite was controlled automatically and semilooper with botanical pesticides and chemical sprays in organic and chemical plots respectively. Twelve percent higher yield was obtained in treated plots than the control.

Similar results were observed for other crops grown in other agro-climatic regions also.

i)

a) Cereals like Paddy, wheat, maize, finger millet;

b) Pulses like gram, green gram, lentil, pea, pigeon pea;

c) Oilseeds like mustard, linseed, sunflower and

d) almost all types of important vegetables have been cultivated in the University farm at Narendrapur, West Bengal (Lower Gangetic Plains Region) and Ranchi, Jharkhand(Eastern Plateau and Hills Region) for last four years in all seasons organically using organic manures, liquid organic products like *Sanjivani*(fermented product of cow dung and cow urine), *Sanjivani* (fermented product of cow dung, cow urine and crop residues), *Panchagavya* (fermented five products of cow), *Kunapajala*(fermented product of cow dung, cow urine and animal residues) etc. and adopting organic package of low cost technologies mentioned earlier in serial no 8 i.e. Low cost package of technologies for sustainable/organic farming.

Organic Flower Garden at Belur Math

Organic Sesame Plot, IRTDM, Ranchi

Organic Flowers, Belur Math

Organic Mustard, IRTDM, Ranchi

Organic Dianthus, Belur Math

Organic wheat plot, IRTDM, Ranchi,

Trial at Belur Math on Flower and on different field crops at IRTDM, Ranchi.

ii) **Effect of furrow irrigation and mulching on Weed Infestation in Rabi season of 2007-08(A comparative study), RKMVU Farm at Narendrapur:**

Sl No.	Name of the treatment	Average count (including all types of weeds) per 9.6 sq.mt bed of cabbage
1.	Raised bed furrow + Straw mulching	22
2.	Raised Bed + no mulching	34
3.	No raised bed + no mulching	300

Table 13: Effect of mulching on weed infestation

Significant positive effect of mulching and raised bed furrow irrigation on weed control was observed in this experiment.

iii) Flower garden with all important seasonal and permanent flowers, decorative plants have also been maintained organically using all the above mentioned liquid manures in the headquarters of the University at Belur Math, West Bengal for last four years.

iv) No chemical fertilizers or pesticides are used in the crops of two faculty centres of the University viz. **Narendrapur**, West Bengal (Gangetic alluvial zone) and **Ranchi**, Jharkhand (Chotanagpur plateau region) and its headquarters at **Belur Math**, West Bengal for last four years.

v)

a) **The yield of different crops grown in the University Farm at Narendrapur, West Bengal in different seasons** (not included in project report) of different years are shown below:

Year	Crop season	Name of the crop	Yield /plant in gram		
			Panchagavya treated plot	Sanjivani treated plot	Control plot
2008	Kharif	Blackgram	-	10.92	6.32
2008	Rabi	Mustard	1.75	1.66	0.45
2009	Rabi	Chilli	167.80	86.35	41.57
2010	Pre-Kharif	Greengram	68.5	62.75	46.5

Table-14a: Crop Yield record at Narendrapur Farm of the University

b) **Yield result of the crops grown in the University's organic plot in Ranchi, Jharkhand (beyond project activity)**

From the yield record of Ranchi, Jharkhand and Narendrapur, West Bengal farms of the

Name of the crop	Variety	Yield (q/ha)	Potential Yield (q/ha) Source-BAU*
Pre-Kharif-2010			
Brinjal	Swarna Prativa	215 q/ha	200-250 q/ha
Elephant Foot Yam	Gajendra	192 q/ha	50-100 q/ha
Colocasia	Mukta	185 q/ha	40-50 q/ha
Turmeric	Roma	119q/ha	25-30 q/ha
Niger	Local	4.0 q/ha	4-5q/ha
Rabi-2010-11			
Mustard	Pusa Barani	19.23 q/ha	10-15 q/ha
Potato	Kufri Ashoka	323 q /ha	250-300 q/ha

Table-14b: Crop Yield record at Ranchi Farm of the University

Plot size = 6.5 sq m

* **Birsa Agricultural University, Kanke, Ranchi, Jharkhand.**

University, it is clear that the technologies developed by the University is sound enough to produce even potential yield of different crops in different seasons and in two different agro-climatic zones.

Raised Bed Furrow irrigation

Spraying of liquid organic product

Use of Vermicompost

Spraying Organic liquid

Demonstration of different low cost package of technologies for sustainable / organic farming at Farmers' Field.

Organic lentil at Ranchi

Organic chrysanthemum at Belur

11. Food quality improvement

It was observed that no marked qualitative improvement with respect to its protein content but DPPH (1,1-diphenyl-2-picrylhydrazyl (DPPH)) radical scavenging activity was found to be enhanced due to only three applications of *Sanjivani*. So, more antioxidant activity was expected in organic produce having relatively high ionization potential, which will reduce free radical accumulation in our body (Table 15).

Parameters	Control	Treated with *Sanjivani* (10%)
Protein Content (%)	30 ± 3.43	30.76 ± 6.85
DPPH radical scavenging activity (% inhibition)	28.68 ± 0.77	33.76 ± 0.45

Table 15: Biochemical composition of black gram

Courtesy: Bio-technology Laboratory, IIT, Kharagpur

12. Achievements of the project

i) Four multi-purpose and multi-functional liquid organic products viz *Sanjivani* (fermented product of cow dung and cow urine), Sashya*gavya* (fermented product of cow dung, cow urine and vegetable waste), *Kunapajala* (fermented product of cow dung, cow urine and animal waste) and *Panchagavya* (fermented product of cow dung, cow urine, milk, curd and ghee) have been prepared and upgraded based on the teachings of ancient Vedic literatures like Vrikshayurveda (1000 AD) of Surapala and Lokopokara (1025 AD) of Chavundaraya.

ii) Different ingredients and their proportion in these four liquid organic products, preparation methods and storing technique to increase shelf life for more than three months have been standardised .

iii) Bio-chemical and biological analysis of all the four liquid organic products has been done.

iv) Dose, method and time of application in crop cultivation have been recommended based on field experiment.

v) The effects on different crops and cost benefit analysis in comparison to chemical farming have been documented systematically over last three years (2008-09 to 2010-11) in the demonstration farm of the University faculty centre at Narendrapur, Kolkata, West Bengal and also in farmers' plots.

vi) Use of these inputs as starter solution for compost preparation and root promoting medium gave remarkable results.

vii) Improvement in soil health also has been documented.

viii) Low cost package of technologies for sustainable/organic farming has been tested and recommended.

ix) Identification of the scope for rural entrepreneurship development through production and marketing of these preparations with a crop season long shelf life while encouraging eco-friendly technologies for sustainable agriculture.

13. Suggestive Technology (upgraded and standardized under RuTAG — EI) Transfer Strategy

i) Selection of Village: A cluster of five villages of high cropping intensity and high external input use and another cluster of five villages of low cropping intensity and low external use are to be selected by each NGO or block level officer.

ii) Awareness generation and rapport building: Farmers' Day, Video show, Farmers' Exposure Visit etc. followed by small group discussions.

iii) Participatory Appraisal of natural resources and livelihoods with special reference to agriculture and allied sectors in selected villages

iv) Group formation/use of local groups with continuous follow up: At least one group of 10 progressive farmers from each village are to be selected. Field Schools and season-long periodic lessons on sustainable farming (on the crop under demonstration) are to be conducted.

v) Demonstration of standardized package of organic practices in the selected progressive farmers' field.

vi) Need-based Training on organic input preparation/sustainable farming technologies etc.

vii) Preparation and circulation of relevant farm publications in local language.

viii) Cross Visit of farmers among project villages.

ix) Scaling up: Replication of the model and use of trained farmers in Field Schools of neighbouring villages (for the next season).

14. Conclusion

Four multi-purpose and multi-functional liquid organic products with low cost organic technologies have been found to be effective with higher productivity, profitability, sustainability and higher input use efficiency in sustainable agriculture. This has been tested in Narendrapur, West Bengal (Gangetic alluvial Zone) and Ranchi, Jharkhand (Chotanagpur plateau region) and at Belur Math, West Bengal (headquarters of RKMVU) for last four years besides the project activity.

In India, 65% of the cropped area is organic by default as the resource poor farmers cannot purchase high cost inputs like chemical fertilizer, pesticides etc. Hence, these four multi-purpose and multi-functional liquid organic products and low cost package of sustainable/organic farming technologies developed by the University using locally available resources can play a vital role in ushering second and ever green revolution in India involving the resource poor farmers of our country.

Considering the importance of soil biological population in sustainable agriculture, Government of India agreed in principle to incorporate the biological population of soil along with the physical and chemical properties of soil in the soil health card and launched a project to prepare a biological soil health of our country from this year (2011) only. Perhaps, organic inputs only can increase biological population of soil in addition to improvement in other soil properties. This has been shown in Table 5 and 5a.

Now, it is the duty of all us to transfer these technologies among the farmers through different extension methods to achieve the goal of food security mission of our country and to fulfil the 'hunger free India' vision of Swami Vivekananda.

"So long as even a dog of my country remains without food, to feed and take care of him is my religion, and anything else is either non-religion or false religion!" (Ref. *Life of Swami Vivekananda* by his Eastern and Western disciples, publ. Advaita Ashrama, Vol.2, p.440)

15. Scope for future research

With limited resource and time frame, some important objectives only are taken care of. There is lot of scope to work in this field in future. Some of which are mentioned below.

i) Analysis of all macro and micro nutrients in four liquid organic products under study and soil of the experimental plots.

ii) Identification of all beneficial microbes in four liquid organic products under study and soil of the experimental plots.

iii) Effects of these liquid organic products on composting of various organic residues.

iv) Effects of these liquid organic products on root development of different types of planting materials.

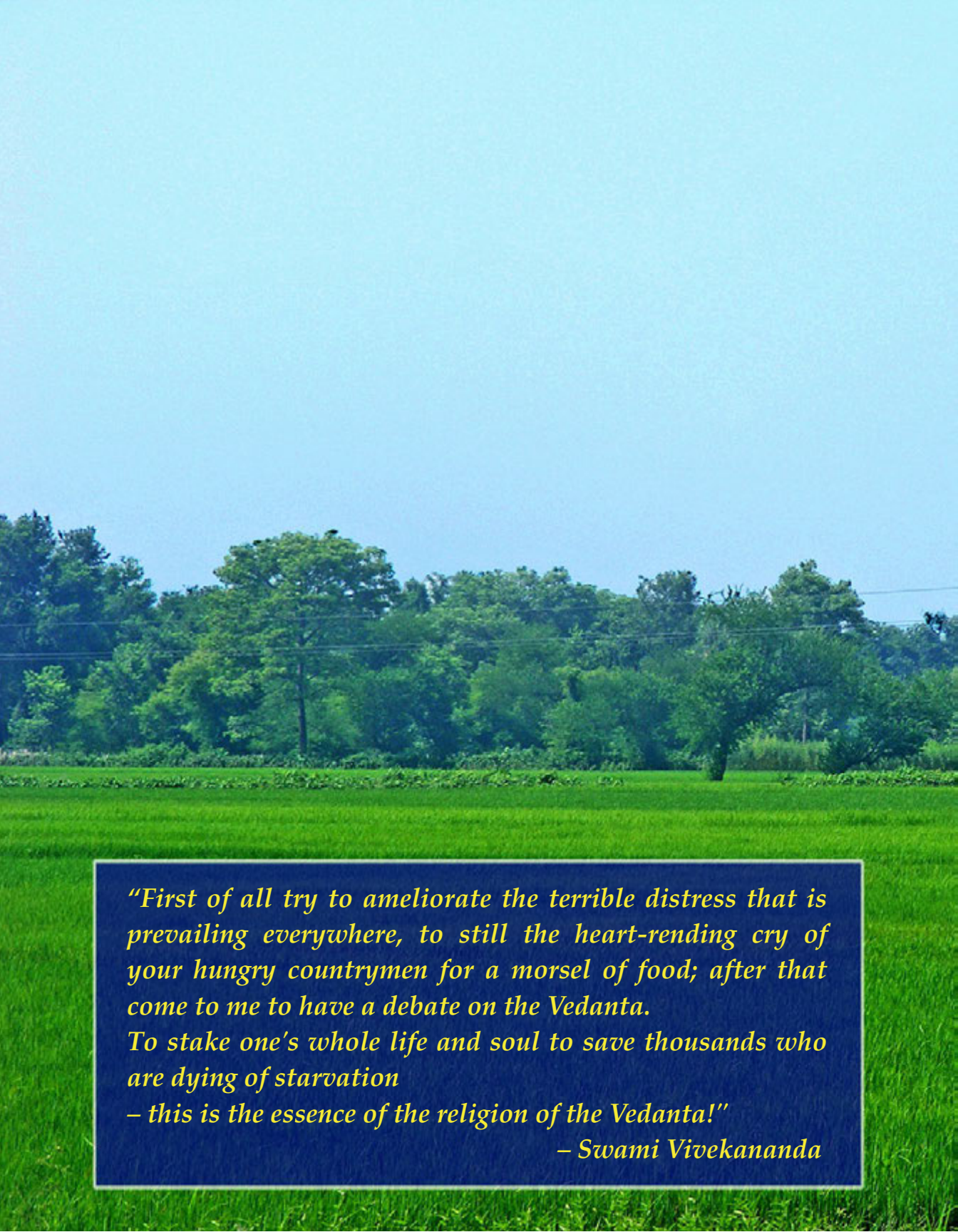
v) Effects of these liquid organic products on germination of different types of seeds with various coatings.

vi) Effects of these liquid organic products on different crops of all agro-climatic zones.

vii) Enrichments of these products, their bio-chemical analysis and effects on different crops and soil.

viii) Use of these products as bio-pesticides and for seed treatment etc.

"To those who are hungry, God is bread" - Mahatma Gandhi, 1946



"First of all try to ameliorate the terrible distress that is prevailing everywhere, to still the heart-rending cry of your hungry countrymen for a morsel of food; after that come to me to have a debate on the Vedanta.
To stake one's whole life and soul to save thousands who are dying of starvation
– this is the essence of the religion of the Vedanta!"

– Swami Vivekananda

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"So long as the millions live in hunger and ignorance, I hold every person a traitor who having been educated at the expenses of others, pays not the least heed to them." *– Swami Vivekananda*