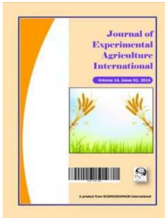

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Farmer Participatory Approach for Formulating Crop-specific Organic Nutrient Packages in Two Contrasting Agroclimatic Zones of the West Bengal State, India

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Authors' contributions

This work was carried out in collaboration between all authors. Authors SB, RG, MNA and MP designed the study together, wrote the protocol and wrote the first draft of the manuscript. Author HB reviewed the experimental design and all drafts of the manuscript. Authors SB and RG managed the statistical analyses of the study. Authors SB and MNA identified the plants. All authors read and approved the final manuscript.

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ABSTRACT

Aims: Low adoption of organic inputs for soil fertility maintenance is one of the major challenges to agricultural extension agents working towards sustainable agriculture. The present article aims to develop the methodology for organic nutrients sourcing for five crops [Rice (*Oryza sativa*), Chilli (*Capsicum annuum)*, Bitter gourd (*Momordica charantia*), French bean (*Phaseolus vulgaris*) and Green gram (*Vigna radiata*)] in two agro-climatic zones of the West Bengal State, India.
Study Design: The study followed a systematic farmer-participatory research (FPR) approach for sourcing crop specific nutrient. Based on the soil fertility and nutrient recommendation of the State Department of Agriculture for individual crops, the nutrients were sourced from available farm resources, mainly agricultural waste, animal excreta and urine with the participation of the farmers.
Results: There were three nutrient packages identified under each of the three farming systems in the agro-climatic zones. These packages were combinations of different ratios of bulky manure (Farm yard manure (FYM), poultry, goat and duck manures) and liquid manure prepared from green biomass, cow dung and water (Sasyagavya) commensurate to their availability in a farm.
Conclusion: The developed packages suits farmers' typology and are more likely to be adopted by the farmers.

Keywords: Farmer participatory research; organic farming system; adaptive nutrient management.

1. INTRODUCTION

Farmers across the globe have cultivated crops since pre-historical period and their farming experience and repertoire of knowledge have come down through ancestry. Farmers often understand better the complexities and interdependencies prevailing within their own systems and also understand the local environment, problems and their solution [1,2,3]. They act as natural experimenters, engaging themselves in a number of experiments as part of their farming routine within the context of agro-ecological and socio-economic circumstances. Thus, the farmers may be considered as potential experimenters and experts in developing appropriate agro-technology or farming practices. Organic nutrient sourcing might be an excellent scope of engaging farmers in formal research and extension [4,5].

The success of good organic nutrient sourcing lies in the better understanding of local agro-ecosystem. Unlike conventional farming, little or no generic and readymade prescription is available for crop-specific organic nutrient sourcing practices. The organic input sourcing and use in farming is so location/farm reliant that recommendation for a particular farming system/agro-ecosystem may not be replicated elsewhere. Components in a farm are interrelated and one must understand this complex inter-relationship before undertaking meaningful recommendations [6]. Hence, there is a need to understand the whole farming system instead of confining interventions within the crop field. Therefore, *'System thinking'* [7], i.e. a holistic understanding of the context of farming and livelihoods of a farmer, will be needed to popularize organic based farming, along with an explicit undertaking of *'Interdisciplinarity'* in the practice of research and extension [8]. And perhaps the crux of the challenge lies in the management of plant nutrients, which needs to be addressed in a holistic manner for sustaining organic based farming systems.

In spite of having a string of benefits [9], the adoption of organic based farming has remained a huge challenge for the extension systems. There is a well-established mechanism to transfer green revolution technologies in the developing countries, where the technologies are developed in research stations and send to the farmers' field using persuasive means without considering the farmers' view point.

The followings are some of the issues that must be considered while developing and transferring for any technology including location-specific organic based farming practices. Are the farmers capable of affording the technology? Are they technically comfortable with it? Is the technology suitable for their farming system? Are the farmers in a position to access and modify technologies to suit their purposes? These are some of the issues that must be considered while developing and transferring location-specific organic based farming practices, but the existing theory on adoption and diffusion of innovations does not explain many of these issues related to organic based farming. The interventions have to follow a different line of thinking for its promotion [10] as well as it must work out the modalities of developing appropriate technologies.

Organic based farming often envisages the low external input strategy, promotes resource recycling and emphasise more on a system's sustainability over productivity. Hence, any research in the field of organic based farming without considering the farmers' viewpoint is bound to yield limited success. Hence, conventional extension system fails to bring organic based farming in the farmers' field. There is a clear need of farmer participatory research (FPR) while conducting any research work on organic farming. FPR is a process where farmers, researchers and other stakeholders are actively involved in designing, planning, implementing, monitoring and evaluation of a research work [6]; farmers are considered as the leader and experts in this research process [4,5]. Further, since nutrient management is the key to successful organic farming, sourcing nutrient from within the farming system itself tend to enhance the sustainability of organic farming system. There is clear dearth of literature that outlines the methodology of formulating organic inputs to meet crops' nutrient requirements from available farm resources in participation with the farmers. Unless this methodology is described one cannot identify the treatments for on-farm trials/testing, from which farm-specific nutrient management packages would be developed. In the present article we outlined the methodology of formulation of organic nutrient inputs to meet crop specific nutrient requirements under two agro-climatic zones of West Bengal. Putting simply, we aim to develop crop specific nutrient packages using available farm resources within a farming system.

2. MATERIALS AND METHODS

2.1 Site Selection

The rainfed areas are more suitable for organic farming because of its low input use [11,12]. So, out of six agro-climatic zones of West Bengal, two extreme zones viz. red lateritic zone (RLZ) and coastal saline zone (CSZ) were chosen for the present study (Table 1). For RLZ, scarcity of water is a challenge in agriculture while for CSZ excessive water and soil salinity pose a great problem. Purulia and South 24 Parganas districts, representatives of these two agro-climatic zones respectively, were chosen for conducting the study.

One village each under the selected blocks namely *'Kalla'* of Udaypur Joynagar panchayat (rural self governing body in India) and *'Paruldaha'* of Brindakhali panchayat was selected for the study. These villages were selected because of their representativeness of respective agro-climatic zones, uniqueness in location (away from towns and nearer to towns) and logistic considerations [13].

2.2 Identification of Major Farming Systems

Focus group discussion method was followed to identify the major farming systems present in the villages under each agro-climatic zone. One group meeting was conducted in each hamlet of the respective villages. After two-hour long discussion with the villagers three major farming systems were identified from each village following the principles of manual discrimination [14].

In village Kalla of Purulia district the following major farming systems were found - (a) Farming System-I comprising of two units viz. Crop husbandry and Cattle unit; (b) Farming System-II comprising of four units viz. Crop husbandry, Cattle, Poultry and Goat unit and (c) Farming System-III comprising of five units viz. Crop husbandry, Cattle, Poultry, Duck and Goat unit (Table 2). In Paruldaha village of South 24 Parganas district the major farming systems were - (a) Farming System-I comprising of Crop husbandry, Cattle and Poultry unit; (b) Farming System-II comprising of Crop husbandry, Cattle, Goatery, Poultry and Fishery unit and (c) System-III comprising of Crop husbandry, Cattle, Goatery, Poultry, Duck and Fishery unit.

2.3 Process of Farmer Selection

Three key decisions regarding sampling are important when using a participatory approach – (a) where to work (site selection), (b) who to work with (selection of participates), and (c) how to work with them [13]. One general village meetings was conducted in each hamlet of those villages wherein farmers gathered at a convenient time in a common place. The research purposes and objectives were thoroughly discussed in the meeting, and at the end, some farmers expressed their interest and agreed to take part in on-farm trial. Finally three farmers from each farming system i.e. nine farmers from each village were selected to develop new organic packages and their field trial [15]. Hence, there were three different packages developed for three farmers under each farming system.

2.4 Determination of Organic Nutrient Sources

To determine the organic nutrient sources for farming the following steps were followed for a given farming system –

a) Assessment of organic nutrient sources available in different farming systems.
b) Nutrient analysis of the experimental soil was done.
c) Recommendation of nutrient for a particular crop from state department of agriculture was taken into consideration.
d) The recommended nutrients were supplied through the available nutrient sources in respective farming systems in consultation with the farmers.

Farmers identified three major farming systems in each agro-climatic zone and three willing farmers were selected under each farming system. Three different organic nutrient packages were developed for these three farmers, based on their farm resources, under each farming system. Thus, nine packages were developed under each agro-climatic zone. The spatial hierarchy of organic package development is shown in Fig. 1.

Table 1. Characteristics of the two selected agro-climatic zones

Agro-climatic zones	District studied	Salient features
Coastal saline	South 24Parganas	Soils are mostly heavy clay containing higher salts of sodium, magnesium, potassium with organic matter at different stages of decomposition. Mostly neutral soils (pH 6.5 to 7.5). Electrical conductivity varies from 3.0 to 18.0 mm, rainfall 1600-1800 mm; salinity and water congestion limit good crop productivity.
Red lateritic	Purulia	Soils are coarse in texture, highly drained with honeycomb type of ferruginous concentration at a depth of 15 to 30 cm; erosion prone; acidic in nature (pH 5.5 to 6.2); poor available nutrients; average rainfall 1100-1400 mm. which is spread over only three months, mid June to mid September., low moisture holding capacity and poor nutrient status limit crop productivity.

Table 2. Enterprises under different farming systems in studied locations

District	Major farming systems		Agriculture (acreage)	Cattle (Nos.)	Poultry (Nos.)	Goat (Nos.)	Duck (Nos.)	Fishery (acreage)
Purulia	FS –I	F-1	2.00	04	-	-	-	-
		F-2	2.14	03	-	-	-	-
		F-3	1.84	02	-	-	-	-
	FS –II	F-1	1.00	04	07	03	-	-
		F-2	2.00	03	11	03	-	-
		F-3	1.87	03	07	01	-	-
	FS –III	F-1	1.83	04	09	06	07	-
		F-2	1.77	04	10	04	08	-
		F-3	2.03	04	06	02	10	-
South 24Parganas	FS –I	F-1	2.64	04	10	-	-	-
		F-2	2.08	03	07	-	-	-
		F-3	0.66	02	10	-	-	-
	FS –II	F-1	1.52	03	15	05	-	0.33
		F-2	2.00	03	07	04	-	0.08
		F-3	1.32	02	10	04	-	0.10
	FS –III	F-1	0.41	04	06	08	01	0.09
		F-2	2.31	03	05	08	04	0.09
		F-3	0.38	04	05	05	05	0.10

2.5 Description of the Nutrient Packages

Nine organic packages were developed in a district for its three major farming systems. Two different modes of nutrient application viz. basal application through bulky manure and top-dressing through liquid manure were taken into consideration for development of organic packages –. Liquid manure contains cow dung, cow urine, agricultural/kitchen waste, water etc. and this was specially used to supply more efficient nutrients to the plants [16,17,18]. There is good evidence that foliar application of liquid manure can be 8 to 10 times more effective than soil supply [19]. The proportion of bulky manure (farm yard manure a FYM) and liquid manure (*Sasyagavya*) in the organic package were also determined as per the quantity of biomass available in the farming system. The proportion of bulky manure was higher than the liquid manure when the availability of organic materials in the farming system was more.

2.6 Method of Preparation of Sasyagavya and Farm Yard Manure (FYM)

For preparing sasyagavya, cow dung (1 part), cow urine (1 part), agricultural waste (1 part), rice boiled water / rice gruel (1 part), soil of cultivable land (1-2 hand full) and water (10 part) were mixed together in a container and kept for 10-12 days for fermentation. The solution was stirred twice a day to ensure enhanced microbial activity. The container was covered with a locally available unused jute bag/cotton cloth so that the solution might come in contact with air easily. On the other hand, FYM was prepared using cattle shed materials such as cow dung, straw, scattered excess food materials, and grasses. All the materials coming from cattle unit were put together in a pit under a shady place for 8-10 months for better fermentation. Then it was used as FYM in the agricultural field.

2.7 Identification of Resources for Preparing Organic Inputs

Preparation of organic inputs was done based on the resource availability in the each and every farming system present in the villages. Mainly available animal/bird excreta and their urine were taken into consideration to develop the organic packages since these were the primary sources available with the farmers of the study locations (Tables 3a and 3b).

Then the recommended nutritional doses for different crops were consulted. The nutritional demand varies from one crop to another and nutrient recommendation is made to supply nutrients as per the crop's demand. The State Department of Agriculture's recommended doses of $N:P_2O_5:K_2O$ for different crops [20] was applied (Table 4).

Now, the nutrient content in the organic sources used for the study was assessed (Table 5). In the present study, the amount was determined from the crop specific recommendation and nutrient percentage in the applied inputs.

Based on the recommendation of the State Department of Agriculture, plant nutrients were chosen through different resources (both bulky manure and liquid manure) available in the farming systems. The proportion of bulky manure and liquid manure in the organic package was determined by the quantity of identified resources available in the respective farming systems and it was finalized in participation with selected farmers. Bulky manure and liquid manure were applied as basal dose and foliar spray, respectively.

3. RESULTS AND DISCUSSION

3.1 Sourcing Plant Nutrients and Development of Nutrient Packages

The determined proportion of bulky manure and liquid manure in the different packages are given in Tables 6a and 6b respectively. In Farming System-1 of Purulia district three different packages were suggested: under Package-1 highest quantity of organic resources was made available, followed by Package-2 and Package-3. As Package – 1 had highest quantity of bulky manure (i.e. 20 kg/day), 80% of total nutrient requirement was sourced by bulky manure and rest 20% was sourced by liquid manure (through Shasyagavya). In package-2 and Package-3 these percentages were 75% and 70% of total nutrient requirement, and these were sourced by bulky manure; rest 25% and 30% were sourced by liquid manure. The same logic was applied for all other farming systems under the study areas. After getting a collaborative discussion with the farmers it was decided that the highest quantity of resources available in the identified farming system will be the Package-1, followed by Package-2 and Package-3. Findings of several studies have shown that foliar application of essential nutrients increased the yield of muskmelon [21,22], maize [23], soybean [24,25] and peanuts [26] along with quality attributes.

Table 3a. Identification of farm resources for development of nutrient package development in Purulia District

Farming system	Package	Available resources	Nutrient management	
			Bulky manure	Liquid Manure
Farming System-1	Package-1	Cattle Dung and Urine	FYM	Sasyagavya
	Package-2	Cattle Dung and Urine	FYM	Sasyagavya
	Package-3	Cattle Dung and Urine	FYM	Sasyagavya
Farming System-2	Package-1	Cattle Dung and Urine +Poultry and Goat Dung	FYM+Poultry Manure + Goat Manure	Sasyagavya
	Package-2	Cattle Dung and Urine +Poultry and Goat Dung	FYM+Poultry Manure + Goat Manure	Sasyagavya
	Package-3	Cattle Dung and Urine +Poultry and Goat Dung	FYM+Poultry Manure + Goat Manure	Sasyagavya
Farming System-3	Package-1	Cattle Dung and Urine +Poultry, Duck and Goat Dung	FYM+Poultry and Duck Manure + Goat Manure	Sasyagavya
	Package-2	Cattle Dung and Urine +Poultry, Duck and Goat Dung	FYM+Poultry and Duck Manure + Goat Manure	Sasyagavya
	Package-3	Cattle Dung and Urine +Poultry, Duck and Goat Dung	FYM+Poultry and Duck Manure + Goat Manure	Sasyagavya

Cattle Excreta– 5 kg/day/cattle; Bird Excreta– 0.10 kg/day/bird; Goat Excreta– 3 kg/day/goat

Table 3b. Identification of farm resources for development of nutrient package in South 24 Parganas District

Farming system	Package	Available resources	Nutrient management	
			Bulky manure	Liquid Manure
Farming System-1	Package-1	Cattle Dung and Urine + Poultry Manure	FYM	Sasyagavya
	Package-2	Cattle Dung and Urine + Poultry Manure	FYM	Sasyagavya
	Package-3	Cattle Dung and Urine + Poultry Manure	FYM	Sasyagavya
Farming System-2	Package-1	Cattle Dung and Urine + Poultry and Goat Dung	FYM+Poultry Manure + Goat Manure	Sasyagavya
	Package-2	Cattle Dung and Urine + Poultry and Goat Dung	FYM+Poultry Manure + Goat Manure	Sasyagavya
	Package-3	Cattle Dung and Urine + Poultry and Goat Dung	FYM+Poultry Manure + Goat Manure	Sasyagavya
Farming System-3	Package-1	Cattle Dung and Urine + Poultry, Duck and Goat Dung	FYM+Poultry and Duck Manure + Goat Manure	Sasyagavya
	Package-2	Cattle Dung and Urine + Poultry, Duck and Goat Dung	FYM+Poultry and Duck Manure + Goat Manure	Sasyagavya
	Package-3	Cattle Dung and Urine + Poultry, Duck and Goat Dung	FYM+Poultry and Duck Manure + Goat Manure	Sasyagavya

Cattle Excreta– 5 kg/day/cattle; Bird Excreta– 0.10 kg/day/bird; Goat Excreta– 3 kg/day/goat

Table 4. Recommended nutritional doses for different crops

Crop	$N : P_2O_5 : K_2O$ (kg/ha)
Paddy	60 : 30 : 30
Greengram	20:40 : 40
Chilli	120 : 60 : 50
Bitter gourd	20 : 30 : 30
French bean	40 : 60 : 50

Table 5. Nutrients present in different organic sources

Organic sources	N%	P%	K%
FYM	0.75	0.2	0.5
Poultry manure	3.03	0.63	1.4
Goat manure	3.0	1.0	2.0
Duck manure	3.0	1.0	1.5
Sasygavya (Liquid manure)	0.083	0.013	0.113

Table 6a. Sourcing of nutrients through available resources in the farming system in South 24 Parganas district

Farming System	Package	Crop	Land under Farming System for different crops (in acre)	Animal / Livestock present in the System	Nutrient (Nitrogen)* Requirement in a year (in kg)		Material (animal excreta / urine) available in the System (kg or lit/ yr)		Nutrient Requirement (yearly)		Nutrient Application (yearly)		Cost of nutrient (INR); per decimal cost; cost of labour
					Crop wise requirement of Nitrogen	Total	Excreta (in kg)	Urine (in lit.)	Bulky Manure (in kg)	Liquid Manure (in lit.)	Bulky Manure (in kg)	Liquid Manure (in lit.)	
Farming System-1	Pacage-1	Paddy	1	Cattle -04	24	28.48	6300	3600	2649 (80% of total N requirement)	6863 (20% of total N requirement)	2233	5783	15,265; 136.30; 91.39
		Chilli	0.08	Poultry-10	3.84						357	925	
		French bean	0.04	(N=0.86 %)	0.64						60	154	
	Pacage-2	Paddy	0.71	Cattle –03	17.04	22.64	4710	2700	1998 (75% of total N requirement)	6819 (25% of total N requirement)	1504	5133	16,681; 193.96; 140.99
		Chilli	0.1	Poultry-07	4.8						424	1446	
		French bean	0.05	(N=0.85 %)	0.8						71	241	
	Pacage-3	Paddy	0.5	Cattle –02	12	18.40	3300	1800	1342 (70% of total N requirement)	6651 (30% of total N requirement)	875	4337	14,222; 215.48; 170.28
		Chilli	0.12	Poultry-10	5.76						420	2082	
		French bean	0.04	(N=0.96 %)	0.64						47	231	

Farming System-2	Pacage-1	Paddy	1	Cattle– 03	24	29.76	9450	2700	872 (80% of total N requirement)	7171 (20% of total N requirement)	703	5783	15,380;
		Chilli	0.1	Poultry-15	4.8						141	1157	132.59;
		French bean	0.06	Goat –05 (N=2.73 %)	0.96						28	231	91.87
	Pacage-2	Paddy	0.92	Cattle– 03	22.08	28.32	8310	2700	1193 (75% of total N requirement)	8530 (25% of total N requirement)	930	6651	18,404;
		Chilli	0.11	Poultry-07	5.28						222	1590	168.84;
		French bean	0.06	Goat -04 (N=1.78%)	0.96						40	289	120.37
	Pacage-3	Paddy	0.94	Cattle– 02	22.56	28.48	6900	1800	987 (70% of total N requirement)	10294 (30% of total N requirement)	782	8154	21,772;
		Chilli	0.1	Poultry-10	4.8						166	1735	196.14;
		French bean	0.07	Goat -04 (N=2.02 %)	1.12						39	405	138.86
Farming System-3	Pacage-1	Paddy	0.92	Cattle– 04	22.08	29.12	13410	3600	1941 (80% of total N requirement)	7017 (20% of total N requirement)	1472	5320	16,495;
		Chilli	0.13	Poultry-06	6.24						416	1504	149.95;
		French bean	0.05	Duck –01 Goat –08 (N=1.20 %)	0.8						53	193	107.61
	Pacage-2	Paddy	0.89	Cattle –03	21.36	28.08	11970	2700	975 (75% of total N requirement)	8458 (25% of total N requirement)	742	6434	19,239;
		Chilli	0.12	Poultry-05	5.76						200	1735	179.80;
		French bean	0.06	Duck – 04 Goat – 08 (N=2.16 %)	0.96						33	289	129.84
	Pacage-3	Paddy	0.85	Cattle– 04	20.4	25.84	10800	3600	1034 (70% of total N requirement)	9340 (30% of total N requirement)	816	7373	20,501;
		Chilli	0.1	Poultry-05	4.8						192	1735	207.08;
		French bean	0.04	Duck – 05 Goat – 05 (N=1.75 %)	0.64						26	231	144.66

Note: Cattle Excreta– 5 kg/day/cattle; Bird Excreta– 0.10 kg/day/bird; Goat Excreta– 3 kg/day/goat
** Calculation of organic manure requirement is based on Nitrogen requirement of the crop*

Table 6b. Sourcing of nutrients through available resources in the farming system in Purulia District

Farming System	Package	Crop	Land under Farming System for different crops (in acre)	Animal / Livestock present in the System (Name and Number)	Nutrient (Nitrogen)* Requirement in a year (in kg)		Material (animal excreta / urine) available in the System (kg or lit/ yr) and N%		Nutrient Management (yearly)		Nutrient Application (yearly)		Cost of nutrient (INR); per decimal cost; cost of labour
					Crop wise requirement of Nitrogen	Total	Excreta (in kg)	Urine (in lit.)	Bulky Manure (in kg)	Liquid Manure (in lit.)	Bulky Manure (in kg)	Liquid Manure (in lit.)	
Farming System-1	Pacage-1	Paddy	1.00	Cattle - 04 (N=0.75 %)	24	27.28	6000	3600	2910 (80% of total N requirement)	6573 (20% of total N requirement)	2560	5783	10,784; 76.48; 64.71
		Green Gram	0.33		2.64						282	636	
		Bitter Gourd	0.08		0.64						68	154	
	Pacage-2	Paddy	0.71	Cattle - 03 (N=0.75 %)	17.12	19.92	4500	2700	1992 (75% of total N requirement)	6000 (25% of total N requirement)	1712	5157	9401; 88.69; 82.43
		Green Gram	0.30		2.4						240	723	
		Bitter Gourd	0.05		0.4						40	120	
	Pacage-3	Paddy	0.61	Cattle - 02 (N=0.75 %)	14.72	17.68	3000	1800	1650 (70% of total N requirement)	6390 (30% of total N requirement)	1374	5320	9859; 100.60; 96.97
		Green Gram	0.33		2.64						246	954	
		Bitter Gourd	0.04		0.32						30	116	
Farming System-2	Pacage-1	Paddy	0.50	Cattle– 4 Poultry–7 Goat –3 (N=1.49 %)	12.00	14.48	8910	3600	777 (80% of total N requiremen	3489 (20% of total N require	644	2892	3055; 37.71; 36.66
		Green Gram	0.25		2.00						107	482	

		Bitter Gourd	0.06		0.48				t)	ment)	26	116	
	Pacage-2	Paddy	1.00	Cattle– 03 Poultry-11 Goat -03 (N=1.66 %)	24.00	27.52	7530	2700	1243 (75% of total N requirement)	8289 (25% of total N requirement)	1084	7229	11,259; 78.19; 67.55
		Green Gram	0.33		2.64						119	795	
		Bitter Gourd	0.11		0.88						40	265	
	Pacage-3	Paddy	0.94	Cattle– 03 Poultry-07 Goat -01 (N=1.20 %)	22.44	25.72	5610	2700	1500 (70% of total N requirement)	9296 (30% of total N requirement)	1309	8111	12,450; 92.22; 79.46
		Green Gram	0.33		2.64						154	954	
		Bitter Gourd	0.08		0.64						37	231	
Farming System-3	Pacage-1	Paddy	0.92	Cattle– 04 Poultry-09 Duck –07 Goat –06 (N=1.86 %)	21.96	25.00	11880	3600	1075 (80% of total N requirement)	6024 (20% of total N requirement)	945	5292	8,321; 64.01; 54.28
		Green Gram	0.33		2.64						114	636	
		Bitter Gourd	0.05		0.4						17	96	
	Pacage-2	Paddy	0.89	Cattle –04 Poultry-10 Duck – 08 Goat – 04 (N=1.16 %)	21.24	25.56	10140	3600	1148 (75% of total N requirement)	7699 (25% of total N requirement)	954	6398	11,107; 77.67; 74.87
		Green Gram	0.45		3.6						162	1084	
		Bitter Gourd	0.09		0.72						32	217	
	Pacage-3	Paddy	1.02	Cattle– 04 Poultry-06 Duck – 10 Goat – 02 (N=1.37 %)	24.36	29.16	8280	3600	1490 (70% of total N requirement)	10540 (30% of total N requirement)	1245	8805	14,993; 92.55; 88.19
		Green Gram	0.5		4						204	1446	
		Bitter Gourd	0.1		0.8						41	289	

N.B.- The amount of Sasyagavya is to be divided by 13 to get the Cattle manure (in kg) present in the sasysagavya;
Cattle Excreta– 5 kg/day/cattle; Bird Excreta– 0.10 kg/day/bird; Goat Excreta– 3 kg/day/goat
** Calculation of organic manure requirement is based on Nitrogen requirement of the crop*

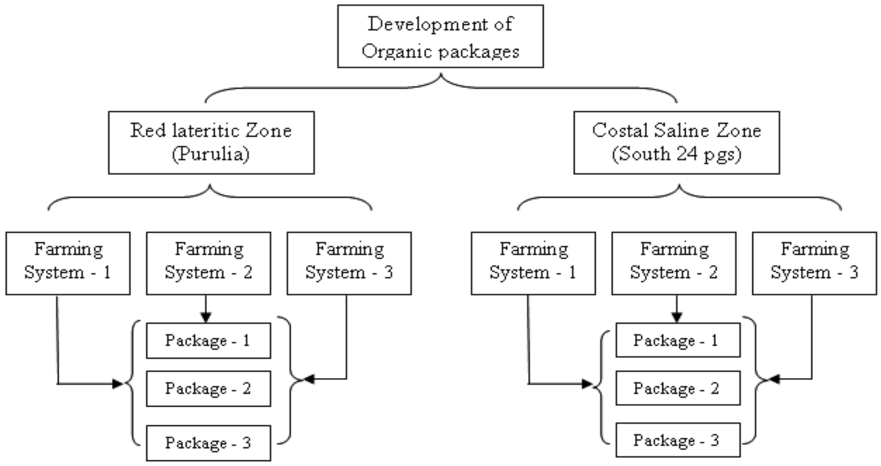

Fig. 1. The scheme of sampling and outline of nutrient package development

4. CONCLUSION AND RECOMMENDATION

The present study has shown the methodological outline of developing location-specific organic nutrient management packages for different crops under farming systems following the principles of farmer participatory research (FPR). The developed packages suit farmers' typology and are more likely to be adopted by the farmers. Moreover, this process may be used in the FPR projects working towards development of appropriate nutrient management practiced for organic growers. The identified organic nutrient management practice may now be conceptualized as treatments for "On–farm agronomic trials" to assess the impact of FPR on crop yield and profitability, besides many social and ecological benefits.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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