

Original Research Article

Farmer Participatory Research approach for formulating Crop-specific Organic Nutrient Sourcing packages under Organic Farming System in two contrasting agroclimatic zones of the West Bengal State, India.

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ABSTRACT

Aims: Low adoption of organic ~~agriculture 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 ~~of for organic~~ nutrients sourcing for five crops [Paddy ~~rice~~ (*Oryza sativa*), Chilli (*Capsicum annuum*), Bitter gourd (*Momordica charantia*), French bean (*Phaseolus vulgaris*) and Green gram (*Vigna radiata*)] ~~under organic farming~~ in two agro-climatic zones of the West Bengal State, India.

Study Design: The study ~~follows~~ 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 ~~etc.~~ in with the participation of the farmers.

Results: ~~In consultation with the farmers, the exercise resulted in~~ There were three nutrient packages identified under each of the three farming systems ~~of an in the~~ agro-climatic zones. These ~~developed~~ packages were combinations of different ratios of bulky manure (Farm yard manure (FYM), poultry

23 | ~~manure~~, goat ~~manure~~ and duck manures) and liquid manure (Sasyagavya) commensurate to their
24 | availability in a farm.

Comment [G. O.1]: Please define this in a conventional way

25 | **Conclusion:** The developed packages ~~were suitable to the context of suits~~ -farmers' own system ~~typology~~
26 | and are more likely to be adopted by the farmers. ~~These packages may be used in the farmers' field for~~
27 | ~~on-farm trials on a variety of agronomic and socio-economic parameters.~~

28 | Key Words: Farmer Participation ~~in Research~~, ~~On-farm Trials~~ Farming System, Adaptive Nutrient
29 | Management

30

31 | 1. INTRODUCTION

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

40 | The success of good organic farming lies in the better understanding of local agro-ecosystem. Unlike
41 | conventional farming, little or no generic and readymade prescription is available for crop-specific organic
42 | farming practices. The organic input sourcing and use in organic farming is so location/farm reliant that
43 | recommendation for a particular farming system/agro-ecosystem may not be replicated elsewhere.
44 | Components in a farm are interrelated and one must understand this complex inter-relationship before
45 | undertaking meaningful recommendations [6]. Hence, there is a need to understand the whole farming
46 | system instead of confining interventions within the crop field. Therefore, 'System thinking' [7], i.e. a
47 | holistic understanding of the context of farming and livelihoods of a farmer, will be needed to popularize
48 | organic based farming, along with an explicit undertaking of 'Interdisciplinarity' in the practice of research

Comment [G. O.2]: Organic agriculture is not synonymous with the use of organic residues only!!!

49 and extension [8]. And perhaps the crux of the challenge lies in the management of plant nutrients, which
50 needs to be addressed in a holistic manner for sustaining organic [based](#) farming systems.

51 In spite of having a string of benefits [9], the adoption of organic [based](#) farming has remained a huge
52 challenge for the extension systems. There is a well established mechanism to transfer green revolution
53 technologies in the developing countries, where the technologies are developed in research stations and
54 send to the farmers' field using persuasive means without considering the farmers' view point. The
55 followings are some of the issues that must be considered while developing and transferring for any
56 technology including location-specific organic [based](#) farming practices. Are the farmers capable of
57 affording the technology? Are they technically comfortable with it? Is the technology suitable for their
58 farming system? Are the farmers in a position to access and modify technologies to suit their purposes?
59 These are some of the issues that must be considered while developing and transferring location-specific
60 organic [based](#) farming practices, but the existing theory on adoption and diffusion of innovations does not
61 explain many of these issues related to organic [based](#) farming. The interventions have to follow a
62 different line of thinking for its promotion [10] as well as it must work out the modalities of developing
63 appropriate technologies.

64 Organic [based](#) farming often envisages the low external input strategy, promotes resource recycling and
65 emphasise more on a system's sustainability over productivity. Hence, any research in the field of organic
66 [based](#) farming without considering the farmers' view point is bound to yield limited success and hence,
67 [conventional extension system fails to bring organic farming in the farmers' field](#). There is a clear need of
68 farmer participatory research (FPR) while conducting any research work on organic farming. FPR is a
69 process where farmers, researchers and other stakeholders are actively involved in designing, planning,
70 implementing, monitoring and evaluation of a research work [6]; farmers are considered as the leader and
71 experts in this research process [4, 5]. Further, since nutrient management is the key to successful
72 organic farming, sourcing nutrient from within the farming system itself tend to enhance the sustainability
73 of organic farming system. There is clear dearth of literature that [outlines the methodology of sourcing](#)
74 [plant nutrients from available farm resources](#) [in participation with the farmers](#). Unless this methodology is
75 described one cannot identify the treatments for on-farm trials/testing, from which farm-specific nutrient
76 management packages would be developed.

Comment [G. O.3]: Recast please

Comment [G. O.4]: I do not understand what you mean. Do you mean formulation of organic inputs to meet crops' nutrient requirements?

77 In the present article we outlined ~~the methodology of sourcing location and farming system specific~~
 78 nutrient packages for different crops under two agro-climatic zones of West Bengal. Putting simply, we
 79 aim to ~~source the requisite nutrients for individual crop by using available farm resources and~~ develop
 80 crop specific nutrient packages ~~using available farm resources recommendable for within~~ a farming
 81 system.

82

83 2. MATERIALS AND METHODS

84 2.1 Site Selection

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

91

92 Table 1: ~~Characteristics of the Two-two~~ selected agro-climatic zones ~~and their characteristics~~

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

Comment [G. O.5]: Did you develop methodology for nutrient sourcing or for formulation of organic nutrient inputs to meet crop specific nutrient requirements?

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.

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 ~~to conduct the farmer participatory research on organic farming 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. ~~Purposive selection of locations is a hallmark of FPR and this has been practiced in different parts of the globe [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. ~~A number of group meetings were conducted in different hamlets of the respective villages. After a long discussion with the villagers three major farming systems were identified from each village following the principles of manual discrimination [14].~~

~~Three farming systems each in Purulia and South 24 Parganas were identified.~~ 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 Agriculture, Cattle and Poultry unit; (b) Farming System-II comprising of Agriculture, Cattle, Goatery, Poultry and Fishery unit and (c) System-III comprising of Agriculture, Cattle, Goatery, Poultry, Duck and Fishery unit.

Table-2 Enterprises under different farming systems in studied locations

District	Major Farming	Agriculture	Cattle	Poultry	Goat	Duck	Fishery
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Comment [G. O.6]: Be specific

Comment [G. O.7]: How long?

Comment [G. O.8]: What is the difference between agriculture and crop husbandry??

	Systems		(acreage)	(Nos.)	(Nos.)	(Nos.)	(Nos.)	(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

114

115 2.3 Process of farmer selection

116 Three key decisions regarding sampling are important when using a participatory approach – (a) where to
 117 work (site selection), (b) who to work with (selection of participates), and (c) how to work with them [13]. A
 118 number of general village meetings were conducted in different hamlets of those villages wherein farmers
 119 gathered at a convenient time in a common place. The research purposes and objectives were thoroughly
 120 discussed in the meeting thoroughly, and at the end, some farmers expressed their interest and agreed to
 121 take part in on-farm trial. Finally three farmers from each farming system i.e. nine farmers from each

Comment [G. 0.9]: How many?

122 village were selected to develop new organic packages and their field trial [15]. Hence, there were three
123 different packages developed for three farmers under each farming system.

124 **2.4 Logic of determining Determination of organic nutrient sources for organic farming**

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

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

133 Farmers identified three major farming systems in each agro-climatic zone and three willing farmers were
134 selected under each farming system. Three different organic nutrient packages were developed for these
135 three farmers, based on their farm resources, under each farming system. Thus, nine packages were
136 developed under each agro-climatic zone. The spatial hierarchy of organic package development is given
137 shown in figure 2. below through a diagram:

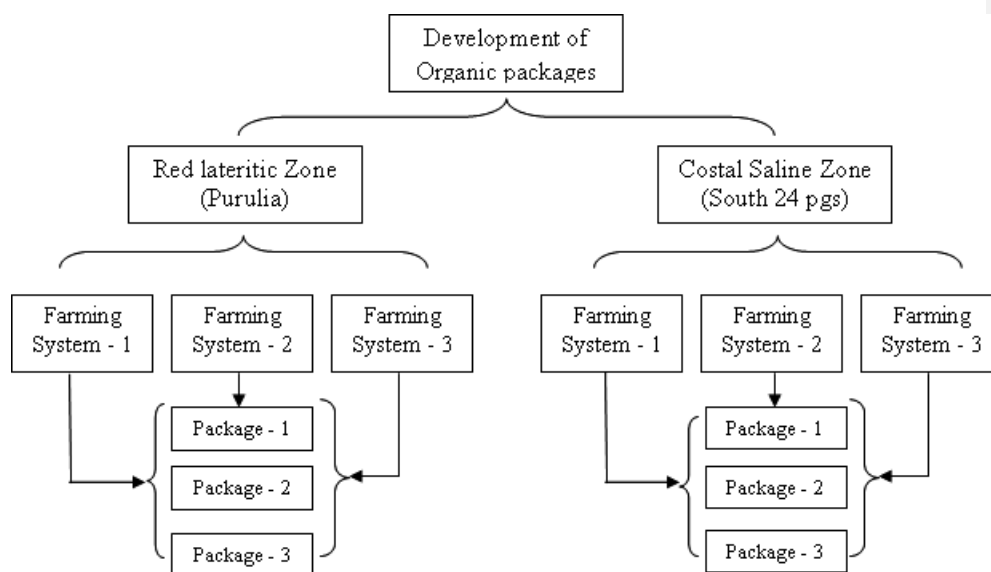


Fig. 2. The scheme of sampling and outline of nutrient package development

2.5 Description of the nutrient packages

Three different packages were developed for three farmers under each farming system. Therefore, total 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]. Some exciting findings of several studies have shown that foliar application of essential nutrients increased the yield of muskmelon [20, 21], maize [22], soybean [23, 24, 25] and peanuts [26] along with quality attributes. 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.

Comment [G. O.10]: There are lots of repetitions of this sentence in the body of the paper

Comment [G. O.11]: This should be taken to discussion section

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

153 Cow Dung (1 part), cow urine (1 part), agricultural waste (1 part), rice boiled water / rice gruel (1 part), soil
 154 of cultivable land (1-2 hand full) and water (10 part) mixed together in a container and kept for 10-12 days
 155 for fermentation. The solution was stirred twice a day to ensure enhanced microbial activity. The
 156 container was covered with a locally available unused jute bag/cotton cloth so that the solution might
 157 come in contact with air easily.

158 FYM was prepared using cattle shed materials such as cow dung, straw, scattered excess food materials,
 159 and grasses. All the materials coming from cattle unit were put together in a pit under a shady place for 8-
 160 10 months for better fermentation. Then it was used as FYM in the agricultural field.

Comment [G. O.12]: What is the relationship of this paragraph and the one above it? You should clarify which of the two is FYM

161 2.7 The logic of identification-Identification of resources for preparing organic inputs

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

166 **Table 3a. Identification of farm resources for development of nutrient package development in**
 167 **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

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

169 **Table 3b. Identification of farm resources for development of nutrient package in South 24 pgs**

170 **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
	Package-1	Cattle Dung and Urine + Poultry and Goat Dung	FYM+Poultry Manure + Goat Manure	Sasyagavya
Farming System-2	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
	Package-1	Cattle Dung and Urine + Poultry, Duck and Goat Dung	FYM+Poultry and Duck Manure + Goat Manure	Sasyagavya
Farming System-3	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

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

172 2.9 Soil nutrient analysis

173 The methods involved in analyses of soil samples are given in Table 4.

174 **Table 4. Methods of Soil Nutrient Analysis employed in the study**

Chemical Properties of Soil	Method of Analysis
Soil Nitrogen Analysis	A rapid procedure for estimation of available nitrogen in soils. [27]
Soil Phosphorus Analysis	Estimation of available phosphorus in soils by extraction with sodium bicarbonate. [28]

Soil Potassium Analysis	Flame Photometer
Organic Carbon Analysis	An examination of the Degtjareff method for determining soil organic matter, and a proposed modification of the chromic acid titration method. [29]
pH and EC	Soil survey laboratory methods manual. [30]

175

176 **2.10 Identification of nutrient sources for a farming system** First, the initial soil nutrients status of
177 experimental plots was analyzed by standard methods (Table 4). From the results (Table 5) it is clear that
178 the soils of Purulia and South 24 Parganas district are acidic and neutral to slight alkaline in nature,
179 respectively. Variation in organic matter content between soils of two study locations was remarkable.
180 This analysis was done to impressionistically assess the soil health and not for calculating nutrient need
181 of crops. Since the soil fertility was average, and also we didn't have results of omission plot trials, we
182 decided to source the nutrients from external sources (FYM, liquid manure etc.) only.

183

Table 5. Soil Health Report for two study locations

District	Major Farming Systems	pH	EC (dS/m)	Organic	Total N	Available	Available	
				carbon		P ₂ O ₅	K ₂ O	
				(%)		(%)	(kg/ha)	(kg/ha)
Purulia	ES - I	F-1	5.06	0.13	0.41	0.030	74.9	127.9
		F-2	4.68	0.17	0.36	0.029	83.1	154.6
		F-3	5.23	0.14	0.50	0.030	67.8	169.4
	ES - II	F-1	5.46	0.15	0.57	0.026	74.9	142.8
		F-2	5.52	0.17	0.48	0.028	90.4	149.7
		F-3	5.78	0.14	0.52	0.025	76.2	139.7
	ES - III	F-1	4.99	0.15	0.47	0.028	84.9	159.5
		F-2	5.23	0.15	0.37	0.026	78.2	142.1

		F-3	4.78	0.16	0.47	0.026	67.2	132.7
		F-1	6.73	0.66	0.41	0.056	65.7	188.7
	FS –I	F-2	7.10	0.57	0.46	0.060	68.5	193.0
		F-3	6.91	0.62	0.33	0.062	74.4	203.3
South 24		F-1	7.39	0.61	0.39	0.049	67.0	185.7
Parganas	FS –II	F-2	7.59	0.62	0.43	0.052	69.4	189.3
		F-3	7.37	0.64	0.33	0.055	64.0	183.8
		F-1	7.05	0.60	0.38	0.065	66.0	186.9
	FS –II	F-2	6.98	0.61	0.44	0.063	69.0	189.6
		F-3	7.22	0.64	0.33	0.060	66.3	185.3

184 FS- Farming System; F- Farmer

185

186 Then the recommended nutritional doses for different crops were consulted. The nutritional demand
 187 varies from one crop to another and nutrient recommendation is made to supply nutrients as per the
 188 crop's demand. The State Department of Agriculture's recommended doses of N:P₂O₅:K₂O for different
 189 crops [34] was applied (Table 6).

190 **Table 6. Recommended nutritional doses for different crops**

Crop	N : P ₂ O ₅ : K ₂ O (kg/ha)
Paddy	60 : 30 : 30
Greengram	20:40 : 40
Chilli	120 : 60 : 50
Bitter gourd	20 : 30 : 30
French bean	40 : 60 : 50

191 Now, the nutrient content in the organic sources used for the study was assessed (Table 7). ~~This is~~
 192 ~~important because the appropriate nutrient needed for a given crop will be dependent on the crop specific~~
 193 ~~recommendation of the state department of Agriculture, the amount of nutrient present in the inputs and~~

Comment [G. O.13]: This section can be expunged from this paper. The relevance is not very clear to me. The results of the soil analysis was not used to determine the nutrient requirements of the crops

194 | ~~nutrient status of the selected soil.~~ In the present study, ~~as we have mentioned above,~~ the amount was
 195 determined from the crop specific recommendation and nutrient percentage in the applied inputs.

196 **Table 7. 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

197 3. RESULTS AND DISCUSSION

198 3.1 Sourcing plant nutrients and development of nutrient packages:

199 Based on the recommendation of the State Department of Agriculture, plant nutrients were chosen
 200 through different resources (both bulky manure and liquid manure) available in the farming systems. The
 201 proportion of bulky manure and liquid manure in the organic package was determined by the quantity of
 202 identified resources available in the respective farming systems and it was finalized in participation with
 203 selected farmers. Bulky manure and liquid manure were applied as basal dose and foliar spray,
 204 respectively. ~~The determined proportion of bulky manure and liquid manure in the different packages are~~
 205 given in Tables 8a and 8b respectively. In Farming System-1 of Purulia district three different packages
 206 were suggested: under Package-1 highest quantity of organic resources was made available, followed by
 207 Package-2 and Package-3. As Package – 1 had highest quantity of bulky manure (i.e. 20 kg/day), 80% of
 208 total nutrient requirement was sourced by bulky manure and rest 20% was sourced by liquid manure
 209 (through Shasyagavya). In package-2 and Package-3 these percentages were 75% and 70% of total
 210 nutrient requirement, and these were sourced by bulky manure; rest 25% and 30% were sourced by liquid
 211 manure. The same logic was applied for all other farming systems under the study areas. After getting a
 212 collaborative discussion with the farmers it was decided that the highest quantity of resources available in
 213 the identified farming system will be the Package-1, followed by Package-2 and Package-3.

Comment [G. O.14]: This is more of materials and methods

Table 8a. Sourcing of nutrients through available resources in the farming system in South 24 Parganas district

	Package	Available Resources			Nutrient Management		Cost of cultivation (INR); per decimal cost; cost of labour
		Sources (Name and Number)	Qty/day (in kg)	Nitrogen required in a year	Bulky Manure	Liquid Manure	
Farming System-1	Package-1	Cattle Dung and Urine	20		FYM	Sasyagavya	7648; 76.48;
		No. of Cattle- 04	(N ₂ =0.75 %)	44 kg	(4,693.5 kg)	(10,602 lit)	45.89
		Area- 1.0 acre			(80 %)	(20%)	
	Package-2	Cattle Dung and Urine	15		FYM	Sasyagavya	6297; 88.69;
		No. of Cattle- 03	(N ₂ =0.75 %)	15.69 kg	(3,139 kg)	(9,454 lit)	55.21
		Area- 0.71 acre			(75 %)	(25%)	
	Package-3	Cattle Dung and Urine	10		FYM	Sasyagavya	6137; 100.60;
		No. of Cattle- 02	(N ₂ =0.75 %)	26.99 kg	(2,519 kg)	(9,754 lit)	60.36
		Area- 0.61 acre			(70 %)	(30%)	
Farming System-2	Package-1	Cattle Dung and Urine +Poultry and Goat Dung			FYM+Poultry Manure + Goat Manure	Sasyagavya	3771; 37.71;
		No. of Cattle – 04	20+0.7+9 =29.7	22 kg		(1,181 lit)	22.63
		No. of Poultry – 07	(N ₂ =1.49 %)				
		No. of Goat – 03			(5,301 kg)	(20%)	
		Area- 0.50 acre			(80 %)		

Farming System-3	Package-2	Cattle Dung and Urine +Poultry and Goat Dung				FYM+Poultry Manure + Goat Manure	Sasyagavya	7819; 78.19; 46.91
		No. of Cattle – 03	15+1.1+9 =25.1		44 kg			
		No. of Poultry – 11	(N ₂ =1.66 %)			(1,988 kg)	(13,253 lit)	
		No. of Goat – 03				(75 %)	(25%)	
		Area- 1.0 acre						
	Package-3	Cattle Dung and Urine +Poultry and Goat Dung				FYM+Poultry Manure + Goat Manure	Sasyagavya	8669; 92.22; 55.33
		No. of Cattle – 03	15+0.7+3		41.14 kg			
		No. of Poultry – 07	= 18.7			(2,400 kg)	(14,458 lit)	
		No. of Goat – 01	(N ₂ =1.20 %)			(70 %)	(30%)	
		Area- 0.94 acre						
	Package-1	Cattle Dung and Urine + Poultry, Duck and Goat Dung				FYM+Poultry and Duck Manure + Goat Manure	Sasyagavya	5889; 64.01; 38.41
		No. of Cattle – 04	20+0.9+0.7+18 = 39.6		40.26 kg	(1,732 kg)	(9,701 lit)	
		No. of Poultry – 09	(N ₂ =1.86 %)			(80 %)	(20%)	
		No. of Duck – 07						
		No. of Goat – 06						
		Area- 0.92 acre						

Package-2	Cattle Dung and Urine +Poultry, Duck and Goat Dung			FYM+Poultry and Duck Manure + Goat Manure	Sasyagavya (11,729 lit)	6913; 77.67; 46.60
	No. of Cattle – 04	20+1+0.8+12 =33.8		(1,749 kg)	(25%)	
	No. of Poultry – 10	(N ₂ =1.67 %)	44 kg	(75 %)		
	No. of Duck – 08					
	No. of Goat – 04					
	Area- 0.89 acre					
Package-3	Cattle Dung and Urine +Poultry, Duck and Goat Dung			FYM+Poultry and Duck Manure + Goat Manure	Sasyagavya (16,142 lit)	9440; 92.55; 55.53
	No. of Cattle – 04	20+0.6+1+6 =27.6		(2,282 kg)	(30%)	
	No. of Poultry – 06	(N ₂ =1.37 %)	44.66 kg	(70 %)		
	No. of Duck – 10					
	No. of Goat – 02					
	Area- 1.02 acre					

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

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Comment [G. O.15]: Table of the quantities of each organic input applied and the amount of NPK supplied to arrive at the recommended rates for each crop in each of the identified farming system would be more informative

217
218 Table 8b. Sourcing of nutrients through available resources in the farming system in South 24 Parganas district

Farming System	Package	Available Resources		Nutrient Management		
		Sources (Name and Number)	Qty/day (in kg)	Nitrogen required in a year	Bulky Manure Liquid Manure	Cost (INR)
Farming System-1	Package-1	Cattle Dung and Urine				11995;
		No. of Cattle- 04	20+1=21		FYM	136.30;
		No. of Poultry Bird- 10	(N2= 0.86 %)	84.48 kg	(3,634 kg)	(20,356 lit)
		Area- 0.88 acre			(80 %)	(20%)
	Package-2	Cattle Dung and Urine+ Poultry Manure				10086;
		No. of Cattle- 03	15+0.7= 15.7		FYM	193.96;
		No. of Poultry Bird- 07	(N2= 0.85 %)	49.92 kg	(4,280 kg)	(15,036 lit)
		Area- 0.52 acre			(75 %)	(25%)
	Package-3	Cattle Dung and Urine				7111;
		No. of Cattle- 02	10+1=11		FYM	215.48;
		No. of Poultry Bird- 10	(N2= 0.96 %)	31.62 kg	(2,310 kg)	(11,451 lit)
		Area- 0.33 acre			(70 %)	(30%)

Farming System-2	Package-1	Cattle Dung and Urine +Poultry and Goat Dung					10077; 132.59;
		No. of Cattle – 03	15+1.5+12 =31.5	72.96 kg	FYM+Poultry Manure + Goat Manure	Sasyagavya	79.2
		No. of Poultry – 15	(N2= 2.73 %)		(2,146 kg)	(17,580 lit)	
		No. of Goat – 05			(80 %)	(20%)	
	Package-2	Area- 0.76 acre					
		Cattle Dung and Urine +Poultry and Goat Dung					16884; 168.84;
		No. of Cattle – 03	15+0.7+12	96 kg	FYM+Poultry Manure + Goat Manure	Sasyagavya	101.4
		No. of Poultry – 07	=27.7		(4,045 kg)	(28,915 lit)	
		No. of Goat – 04	(N2= 1.78 %)		(75 %)	(25%)	
	Package-3	Area- 1.0 acre					
		Cattle Dung and Urine +Poultry and Goat Dung					12945; 196.14;
		No. of Cattle – 02	10+1+12	63.36 kg	FYM+Poultry Manure + Goat Manure	Sasyagavya	117.6
		No. of Poultry – 10	= 23.0		(2,492 kg)	(22,901 lit)	
		No. of Goat – 04	(N2= 2.02 %)		(70 %)	(30%)	
		Area- 0.66 acre					

Farming System-3	Package-1	Cattle Dung and Urine +Poultry, Duck and Goat Dung			FYM+Poultry and Duck Manure + Goat Manure	Sasyagavya (4,724 lit)	3149; 149.95; 90
		No. of Cattle – 04	20+0.6+0.1+24 = 44.7		(1,312 kg)	(20%)	
		No. of Poultry – 06		19.68 kg	(80 %)		
		No. of Duck – 01	(N2= 1.20 %)				
		No. of Goat – 08					
		Area- 0.21 acre					
	Package-2	Cattle Dung and Urine +Poultry, Duck and Goat Dung			FYM+Poultry and Duck Manure + Goat Manure	Sasyagavya (33,398 lit)	20857; 179.80; 108
		No. of Cattle – 03	15+0.5+0.4+24 =39.9		(6,930 kg)	(25%)	
		No. of Poultry – 05		110.88 kg	(75 %)		
		No. of Duck – 04	(N2= 2.16 %)				
		No. of Goat – 08					
		Area- 1.16 acre					

Package-3	Cattle Dung and Urine +Poultry, Duck and Goat Dung			FYM+Poultry and Duck Manure + Goat Manure	Sasyagavya (13,185 lit)	7869; 207.08; 124.2
	No. of Cattle – 04	20+0.5+0.5+15		(2,128 kg)	(30%)	
	No. of Poultry – 05	=36.0	36.48 kg	(70 %)		
	No. of Duck – 05	(N2= 1.75 %)				
	No. of Goat – 05					
	Area- 0.38 acre					

219 N.B.- The amount of Sasyagavya is to be divided by 13 to get the Cattle manure (in kg) present in the sasysagavya.

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

221 4. CONCLUSION

222 The present study has shown the methodological outline of developing location-specific organic nutrient
223 management packages for different crops under farming systems following the principles of farmer
224 participatory research (FPR). ~~After identification of farming systems and their quantum of availability of~~
225 ~~resources, the amount of applied nutrient of specific crops are to be calculated through nutrient content~~
226 ~~in farm resources nutrient content of the soil and nutrient recommendation for the crops. Farmers~~
227 ~~themselves participated in the research to source plant nutrients based on available farm resources. This~~
228 process may be used in the FPR projects working towards development of appropriate nutrient
229 management practiced for organic growers. The identified organic nutrient management practice may
230 now be conceptualized as treatments for "On-farm agronomic trials" to assess the impact of FPR on crop
231 yield and profitability, besides many social and ecological benefits.

Comment [G. O.16]: This is more of
recommendation than conclusion

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