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Economic Impact of Organic Agriculture: Evidence from a Pan-India Survey

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Abstract: The demand for organic foods is increasing worldwide due to health and environmental benefits. However, there are several unanswered questions, such as: Do organic farmers generate higher profits? Will the cost of cultivation reduce to compensate for low yields? Can farmers practice as per the organic agriculture protocols and obtain certification? The literature on organic agriculture varies widely in terms of profitability, yields and costs of organic products. A few studies have researched site-specific organic agriculture, but none have compared organic with conventional agriculture at larger scale in India. The Indian government has promoted organic agriculture since 2015 through its pan-India scheme—Paramparagat Krishi Vikas Yojana (PKVY). Under this program, there were 13.9 million certified organic farmers in 29,859 organic clusters, covering 0.59 million hectares (about 0.4% of the cropped area in India). This study assessed the implementation process of PKVY and the impact at the farmer level using the Difference-in-Difference approach. An economic surplus model was employed to observe the macro scale using data from an all-India representative sample from 576 clusters for the crop year 2017. The results identified that organic farmers experienced 14–19 percent less costs and 12–18 percent lower yields than conventional farmers. The net result is a marginal increase in profitability compared to traditional agriculture. The economy-wide economic surplus model indicates that there will be a reduction in producer and consumer surplus due to reduced crop yields. However, if the shift from conventional to organic is confined to rainfed, hilly and tribal areas, there will be an increase in both consumer and producer surplus.

Keywords: impact assessment; organic farming; natural farming; alternative farming; process analysis; South-Asia; theory of change

1. Introduction

Conventional input-intensive and agro-chemical-based agriculture has improved yields and addressed food security issues globally through the green revolution since the 1960s. However, the continued, imbalanced and often overuse of chemical pesticides and fertilizers has affected the environment and health of human beings [1]. Therefore, the demand for non-chemical-based and organic agricultural products has increased over the years. During the past decade, the demand for organic products has grown at 16% per annum [2–6]. Further, rising costs of chemical inputs, such as fertilizers and pesticides, and increased demand for Non-Genetically Modified Organisms (Non-GMO) foods are also pulling farmers toward organic and environmentally friendly agriculture [1,7–9]. According to the FAO, organic agriculture is a system that relies on ecosystem management rather than external agricultural inputs such as synthetic fertilizers and pesticides [10].

However, at the policy level, apprehensions have been raised on the efficacy of organic farming in feeding the vast population, particularly in densely populated nations such as in South Asia given the effect on yield, cost of production per unit quantity of agricultural products and farm profitability [11]. The recent food security constraints in Sri Lanka due to the shift to organic agriculture have further accentuated the fear [12]. Many studies have reported a reduction in crop yields to a significant extent due to organic farming [13], and some studies have reported an increase in the variability in crop yields [14]. Some other studies have pointed out that because of the low yields in organic agriculture, there is a need for more land for agriculture by diverting forest land to meet the food demand [15], which will negatively impact the environment. However, despite lower yields, premium prices received by organic farmers are one way to increase the profitability of small and marginal landholding farmers with less than one hectare of cultivated land, as in the case of India and China [16,17]. Some studies have also pointed out that gains of organic agriculture in terms of increased farm-level biodiversity, organic matter and organic carbon content in the soil more than compensate for the losses due to lower yields through enhancing sustainability [11]. Thus, there is a wide divergence of opinions about the costs and benefits of organic agriculture. The recent episode of shifting from conventional to organic farming in Sri Lanka and the consequent reduction in crop yields, the food crisis, highlight the negative consequence of unplanned and blanket adoption of organic agriculture. In a large country similar to India, a random approach may lead to severe food shortages due to the size of the Indian population. Hence, India needs to adopt a gradual calibrated approach to shift from conventional to organic agriculture, which requires a holistic examination of the possible impacts and consequences of organic agriculture. These concerns are summarized in Figure 1.

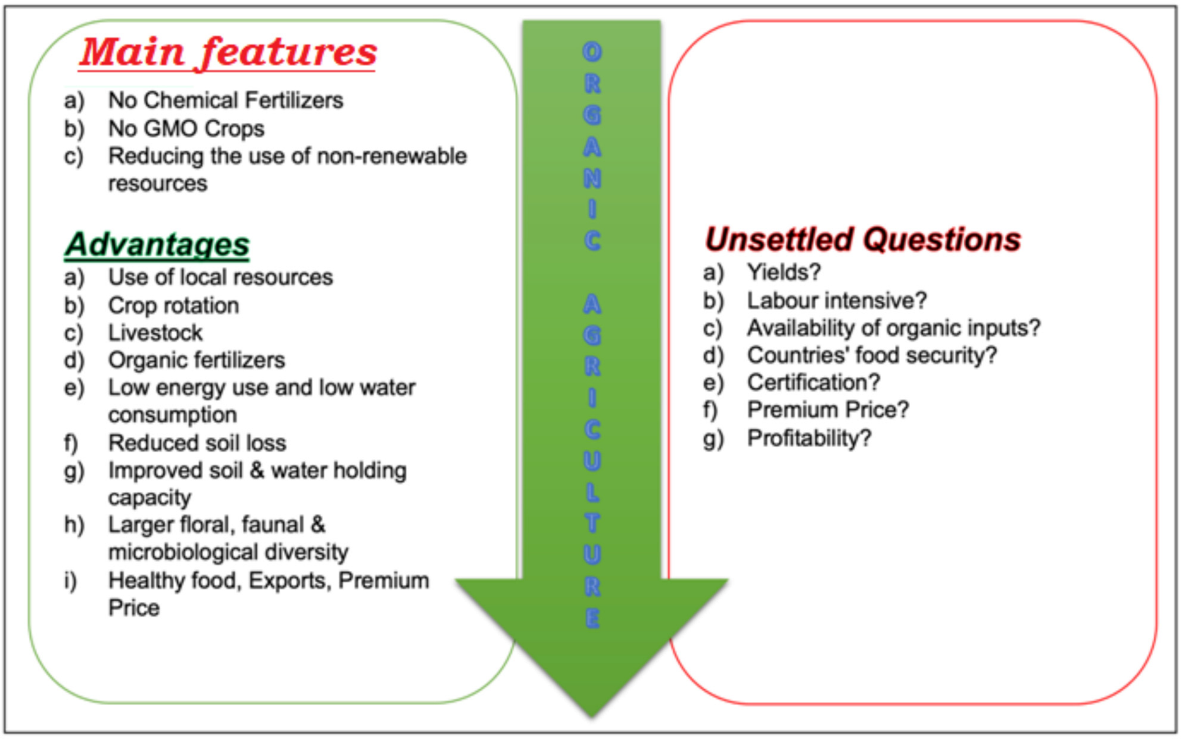

Figure 1. Theoretical rationale of organic agriculture and unanswered questions in red.

The strategies toward organic agriculture are primarily country-specific depending on the environmental, economic and political considerations. This indicates that every country needs to evolve country-specific strategies to balance food security and safety and farmers' incomes and ecology [18–20]. Given that most of India's rainfed and hilly farmers follow organic agriculture by default with a low level of chemical fertilizers, it is the right time to answer questions such as whether rainfed and hilly areas are more suitable for expanding organic agriculture instead of blanket adoption across India.

The Union government of India has promoted organic agriculture under the Paramparagat Krishi Vikas Yojana (PKVY) scheme since 2015. The demand for organic produce has increased by 20% per annum in India [21]. Under this scheme, 29,859 certified organic clusters (comprising 2–3 villages) have formed across India, covering about 0.4% of cropped area by 2021.

This scheme was launched to support organic farming via a cluster approach (with an average of 20 hectares per cluster) with the Participatory Guarantee Scheme (PGS) certification system [22]. The PGS is a locally focused quality assurance system. It certifies producers based on stakeholders' active participation and is built on a foundation of trust, social networks and knowledge exchange [6]. Despite government incentives, organic agriculture has not picked up as expected in terms of the expanding area, production, certification and exports of organic products. The transformation from conventional agriculture to organic agriculture is complex and depends on local conditions [19]. As the scheme has already completed 3 years, it is the right time to examine the bottlenecks, learning and impacts to guide future policy development. We are not aware of any comprehensive study to date that has addressed the following questions: (i) What are the impacts of the PKVY scheme on farmers' costs, yields and profitability? (ii) What are the economy-wide implications of food security and economic welfare (consumer and producer surplus) due to the adoption of organic agriculture? (iii) What are the implementation bottlenecks in the organic agriculture scheme?

Therefore, this paper addresses these issues with the following specific objectives to fill the research gap.

The main objectives of the paper are to assess the economic impact of the organic agriculture scheme in India with the following specific purposes:

1. To understand the effect of the organic agriculture in terms of costs, yields and profitability of farmers using the Difference-in-Difference approach in India, as well as rainfed and hilly areas.
2. To assess the economy-wide impacts of organic agriculture using the economic surplus model.
3. To evaluate the project implementation bottlenecks of the organic agriculture scheme in India.

2. Sampling Framework and Methodology

To accomplish the study's objectives, data were collected using a multistage random sampling framework covering 576 organic clusters. For selecting organic and conventional farmers, the following criteria were used. A farmer was considered organic, only if he was a member of organic cluster formed under PKVY scheme in the last 3 years (from 2015 to 2017), was member as on the date of personal interview in year 2017 and was not using any chemical-based inputs. The conventional farmer was a farmer who used chemical fertilizer and was not a member of any organic cluster in the last 3 years.

A total of 2880 organic cluster farmers and an equal number of conventional farmers were selected from all six zones of the country (Table 1) to obtain a representative sample. [23]. This sampling framework gave equal weightage to all the zones and hence represented all zones equally without any bias toward specific agro-climatic conditions or geographies. The states included in the sample were from the central zone (Chhattisgarh, Madhya Pradesh), east zone (Bihar, Orissa), north zone (Haryana, Rajasthan), south zone (Karnataka, Kerala), west zone (Gujarat, Maharashtra) and northeast zone (Mizoram and Sikkim). From each zone, two states were selected (India is divided into 29 states); from each state, two districts (states are further divided in to districts, India is having 766 districts) were selected; from each district, four blocks were selected (India is having 7230 blocks); from each block, six clusters were selected; and from each cluster, five organic farmers and five neighboring conventional agricultural farmers (who are not members of the organic clusters and used chemical fertilizers) were selected randomly from official records for the intensive survey. Due care was taken to cover all farm size categories of small, medium and large landholding farmers, as well as all social groups, such as scheduled caste (SCs), scheduled tribe (STs), other backward caste (OBCs) and forward caste (FCs) farmers in proportion to their population so that the sample represented the population. The detailed sampling framework is provided in Figure 2.

Table 1. Production of bio-inputs by cluster categories (%) in 2017.

Criteria	State Category		Management of RCs		All
Cluster Group	**Developed**	**Less Developed**	**Govt.**	**Non-Govt.**	
Organic Seed	6.3	19.9 *	6.3	19.9 *	13.8
Green Manure	55.0	76.8 *	52.0	79.3 *	67.0
Compost	37.0	69.7 *	34.0	72.2 *	55.0
Bio-Fertilizer (other than green manure and compost)	9.0	12.1	7.2	13.6	10.7
Bio-pesticide	8.0	15.3 *	6.5	16.5 *	12.0
Panchamruth	8.8	13.2 *	5.4	15.9 *	11.2
Panchagavya	6.4	21.2 *	4.3	22.8 *	14.5
Beejamruth	5.1	12.2 *	4.5	12.7 *	9.0
Drip Irrigation	2.5	1.0	3.1	0.6	1.7

Note: * indicates a significant difference at 5%. Chi-Square $p < 0.05$.

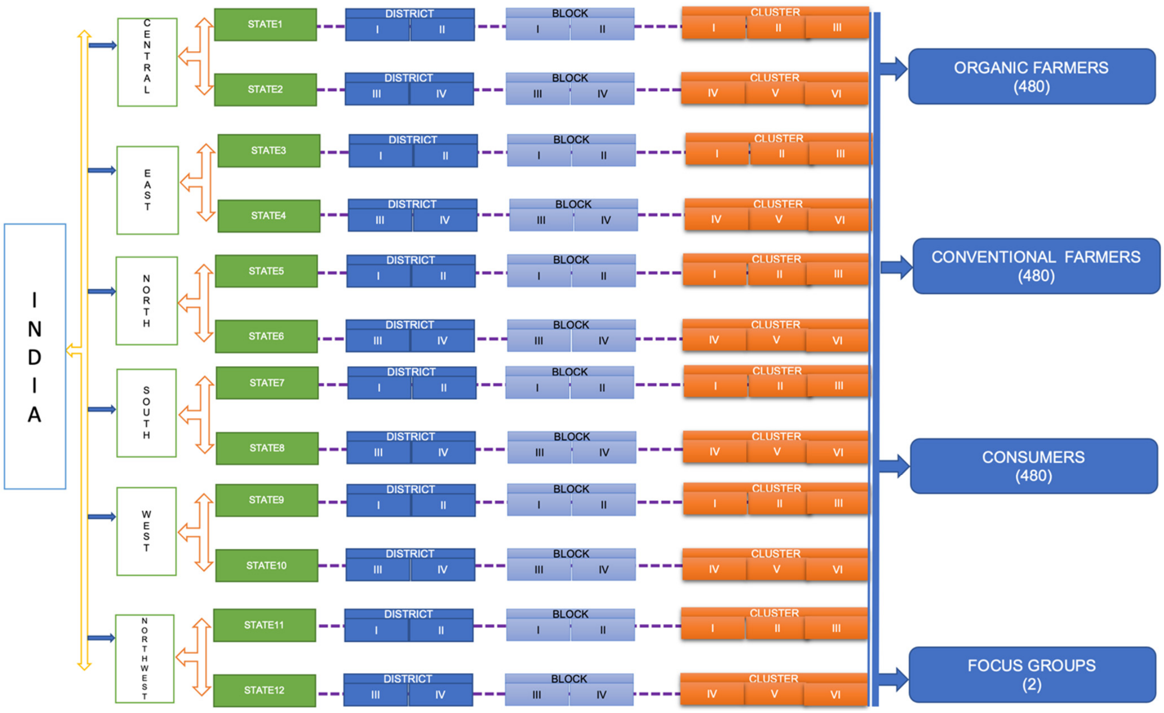

Figure 2. Sampling framework. Note: The states were grouped into zones based on the standard classification of the Planning Commission, India.

Two questionnaires were prepared: one for the farmers and the other at the cluster level. The farmer questionnaire was designed and pretested to know the process flow and bottlenecks in implementation at each stage and the impact of organic agriculture on the costs, yields, gross returns and profits of major crops. A cluster-level questionnaire was designed to identify the process flow and the PKVY scheme's implementation bottlenecks. The cluster questionnaire was filled up by interviewing any one of the clusters' members. Data were collected for 2014 (before PKVY) and 2017 (after PKVY) on a recall basis.

In addition to the statistical analysis of data from 5760 farmers and 2880 consumers, we collected qualitative data by arranging 12 focus group discussions (FGDs) among implementing agencies and critical informants regarding (i) the problems in the implementation of the scheme, (ii) the constraints in the adoption of organic farming by the farmers, (iii) possible strategies to enhance the area under organic agriculture and (iv) strategies to raise farmers' income from organic farming. Secondary data on fund allocation, release and utilization patterns were analyzed. The detailed methodology is available in Reddy, 2017 [24].

For analytical purposes, states were categorized as developed and less-developed based on the agricultural Gross Domestic Product (GDP) per hectare for the year 2017 to understand the impact of level of local development environment on implementation of the PKVY program [25,26]. States with a higher agricultural GDP per hectare than the all-India average was categorized as developed, and those with less were categorized as less developed states. Accordingly, the developed states included Haryana, Punjab, Karnataka, Kerala, Maharashtra and Gujarat. The less-developed states included Madhya Pradesh, Orissa, Rajasthan, Mizoram and Sikkim. It was hypothesized that more developed states would better implement organic agriculture schemes.

Further, clusters were classified based on the promotors of Regional Councils. The Regional Council (RC) is an agency authorized by the government to promote and handhold (coordinate, monitor and approve certification decisions) local organic clusters under the PGS-India Organic Guarantee Programme. There are two types of RCs: Government-RCs and Non-Government Organization- RCs. The Government-RCs are run by the state department of agriculture (all clusters in Chhattisgarh, Madhya Pradesh, Haryana, Rajasthan, Gujarat and Maharashtra). In contrast, NGOs handle NGO-RCs (all clusters in Orissa, Punjab, Karnataka and Kerala). Based on FGDs, it was hypothesized that NGO-RCs would perform better in implementing organic agriculture schemes as their strength lies in community mobilization. In contrast, Government-RCs are good at getting funds sanctioned and developing infrastructure. There is some overlap between the two classifications: a classification based on development and promotor.

The data were analyzed using statistical tools such as the t-test for quantitative data [27] and Pearson's chi-squared test for qualitative data [28]. The paper performed a cost-benefit analysis to assess the profitability of organic agriculture by deducting all paid out costs in addition to owned family and bullock labor costs from the gross revenue (gross revenue: all main products and byproducts and byproducts valued at market prices). It is generally known as Cost A2 plus family labor [29]. The paid-out cost included (i) the value of hired human labor, (ii) the value of hired bullock labor, (iii) the value of owned bullock labor, (iv) the value of hired machinery labor, (v) hired machinery charges, (vi) the value of seed (both farms produced and purchased), (vii) the value of insecticides and pesticides, (viii) the value of manure (owned and purchased), (ix) the value of fertilizers and (x) irrigation charges.

The study used the Difference-in-Difference (DiD) approach to assess the impact of organic agriculture at the farmer level (micro) and the economic surplus model to assess the impact at the societal (macro) level. The detailed methodology is presented in Appendix A (DiD approach is presented in Appendix A.1 and economic surplus model is in Appendix A.2).

3. Results and Analysis

3.1. Theory of Change

A theory of change illuminates how activities under the organic agriculture (PKVY) scheme are assumed to produce a series of results that contribute to achieving the final intended impacts. In an impact assessment, a theory of change helps identify the data that need to be collected and how they should be analyzed [30,31]. All indicators used in the theory of change were classified as inputs (financial and physical inputs under the scheme), activities (different activities done under the scheme), outputs (actual outputs of the scheme), outcomes (whether the clusters utilized generated outputs) and impacts (what are the ultimate benefits of organic farming to the farmers and to the economy in general). The theory of change behind the PKVY scheme is depicted in Figure 3. This framework was developed based on discussions with key informants and in FGDs.

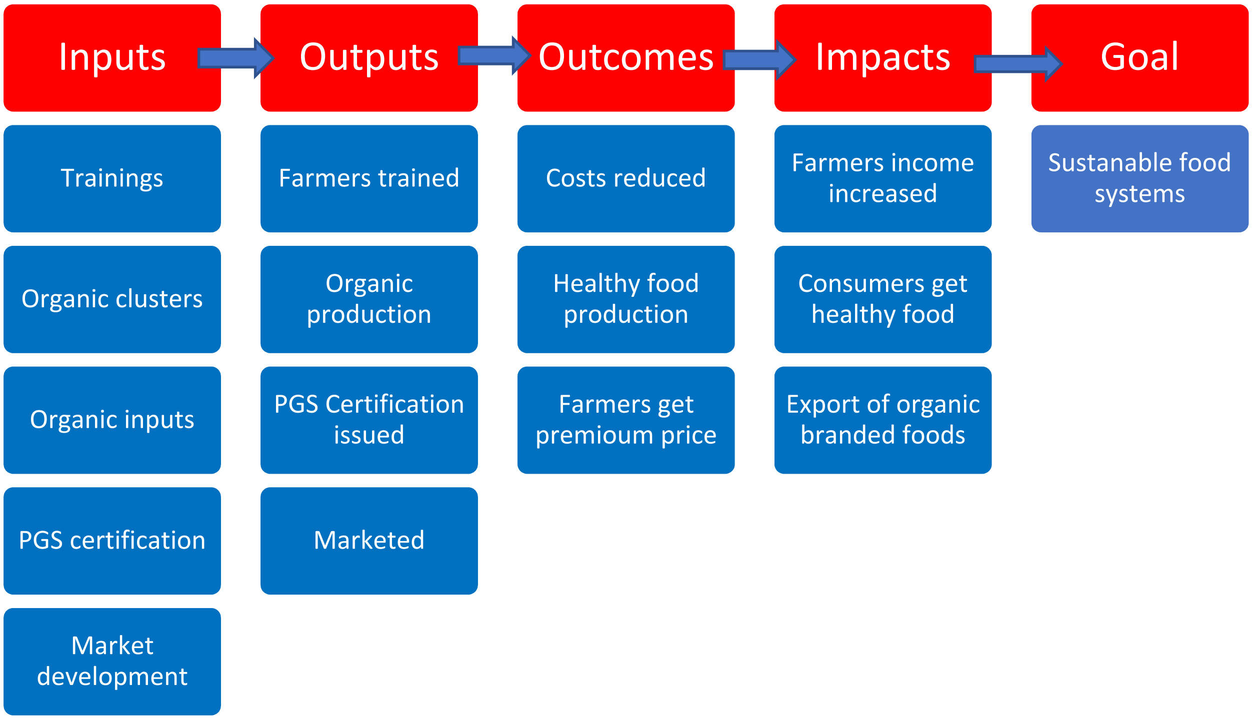

Figure 3. Theory of change conceptualized for the study (process flow). Note: Prepared by the authors based on the focus group interaction.

Figure 3 shows that the first step was to train the farmers and help them acquire the knowledge and skills about organic agriculture and be ready to change their behavior to shift from conventional farming to organic farming by forming organic clusters. The next step was the formation of clusters, an essential requirement of the scheme to ease the adoption of various components of organic agriculture technologies. From the initiation of training up to organic certification, the clusters were supported by the RCs (Figure 3). The state agricultural departments selected the RCs to promote and handhold clusters to implement the PKVY scheme. The RCs formed clusters of 20 hectares each, comprising about 50 farmers at the village level. RCs facilitated the clusters in the production of the organic inputs, organic certification, labelling and marketing. The seed-to-seed involvement of RCs in promoting clusters was aimed at increasing organic production and obtain premium prices for farmers.

3.2. Implementation Bottlenecks at the Cluster Level

In this section, we only used data from 2880 organic cluster farmers. Figure 4 presents the characteristics of clusters based on the agricultural development status of states (developed states versus less-developed states) and the type of RCs (govt-RCs versus NGO-RCs). The main activities of RCs included organizing the training for cluster members and assisting in obtaining PGS certification [32]. The clusters supported by NGO-RCs and located in less developed states had more area per cluster. Naturally, NGOs strength lies in community mobilization; hence, the number of farmers and area were higher in clusters promoted by NGO-RCs. A larger area under the cluster may increase scale economies, especially in preparing organic inputs, and help in price bargaining through bulk contracts with consumers. Nearly 85 percent of cluster farmers were registered under PGS certification under the PKVY scheme. It is worth mentioning that 52 percent of the total registered farmers were small land-owning farmers.

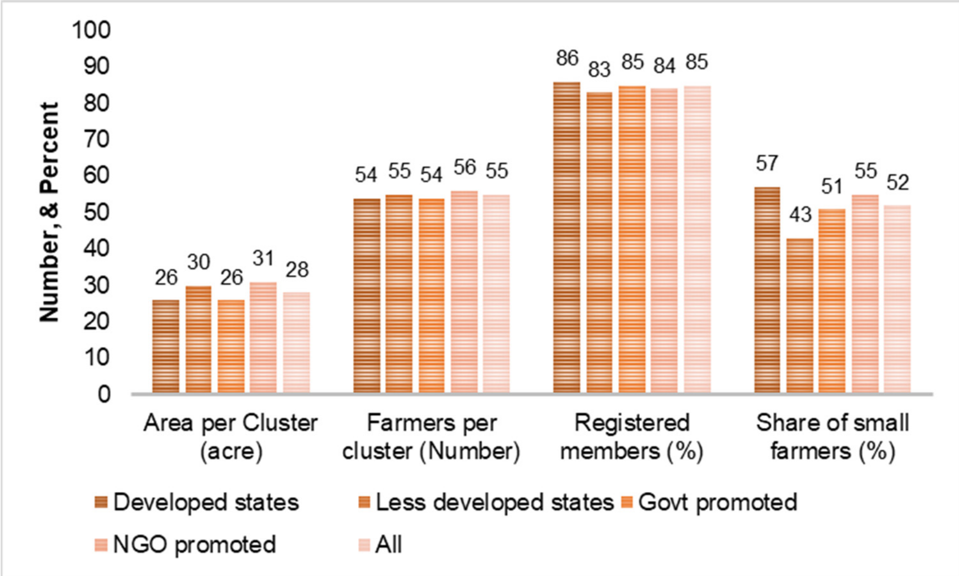

Figure 4. Characteristics of clusters, across agriculture development status and RCs, in 2017.

3.3. Procedures for Certification

Under PGS certification, specific mandatory procedures and milestones must be completed for certification and release of matching grants. Data from Figure 5 show that about 96 percent of the clusters prepared the annual action plan, and they even succeeded in executing organic production in nearly all the clusters. Most of the clusters have also appointed technical staff and data entry operators to oversee all the activities and for proper documentation for certification. The production of organic crops started in 95 percent of the clusters. Moreover, 83 percent of the clusters already had PGS certification, 78 percent had made efforts to establish packaging and labelling facilities, and 80 percent had established marketing facilities. Generally, the performance was better in clusters located in less-developed states and managed by NGO-RCs than their counterparts. Less-developed states are mostly hilly, rainfed and remote, where the use of chemical fertilizers and yields is low and the inherent potential for organic agriculture is high. Interestingly, only 28% of the farmers knew about the certification process despite 83% of the clusters being certified, as most of the certification procedures were handled by the resource person appointed by the RCs rather than the farmers themselves. This bottleneck must be removed through awareness creation and involving farmers in the process.

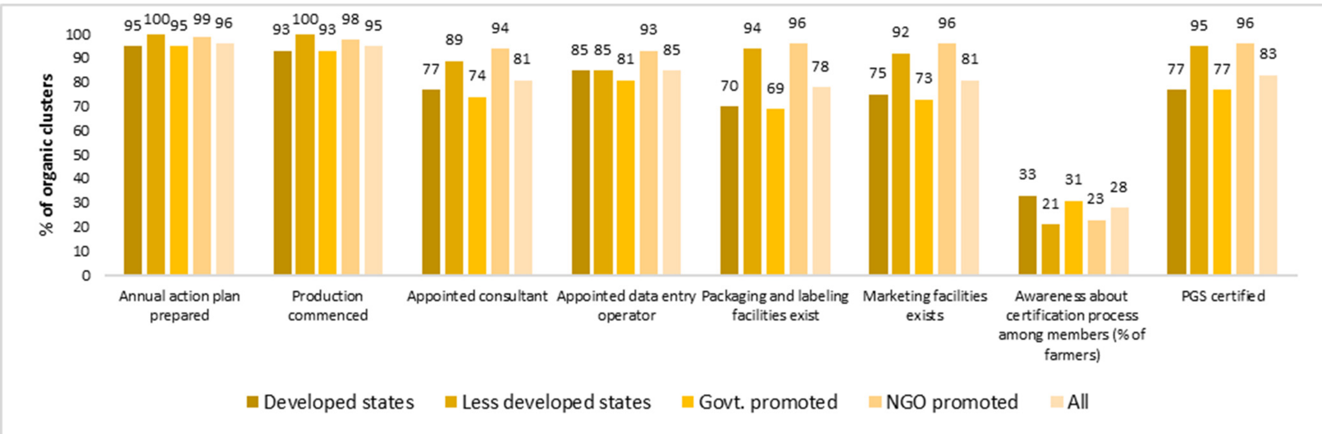

Figure 5. Various activities conducted and achieved by clusters under PKVY (% of clusters) in 2017.

3.4. Facilities and Infrastructure at the Cluster Level

More than 95 percent of the clusters had organic input production plants (manufacturing units), and over 92 percent of the clusters had biological nitrogen harvest plantations (*Gliricidia* sp., *Sesbania* sp. and *Calliandra* sp.) either on wastelands or on farmers' own or community lands. About 65 percent had botanical extraction production units. However, there was a low performance in producing phosphate-rich organic manure, running custom hiring center services and having walk-in tunnels for horticulture crops, cattle sheds and indigenous animals (Rashtriya Gokul Mission' is a focused project under the National Programme for Bovine Breeding and Dairy Development. The aims of the mission are to conserve and develop indigenous breeds in a focused and scientific manner, Minister added). As they are against the community activities, cluster-level infrastructure facilities performed much better in terms of developed states and clusters managed by Government-RCs than their counterparts (Figure 6).

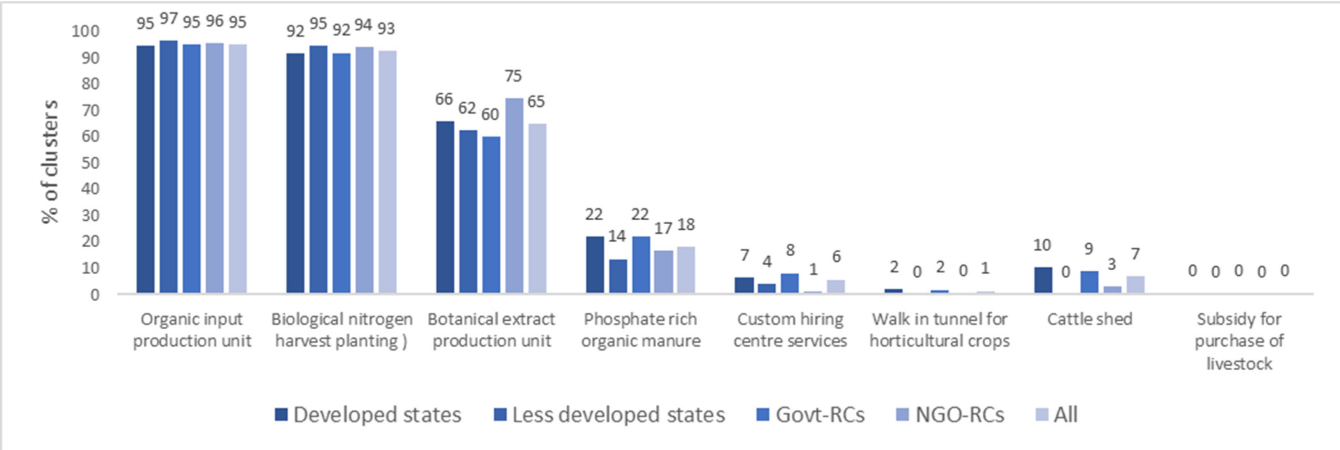

Figure 6. Facilities and infrastructure existing at the cluster level (%) in 2017.

3.5. Preparation and Use of Bio-Inputs

Although facilities exist at the cluster level, many clusters are not able to use these facilities to produce organic inputs or to use these organic inputs in cultivation. Table 1 depicts the status of production of organic inputs and their use at the cluster level. In general, organic inputs production was less compared to the facilities available at the cluster level. Except for the production of compost and green manure, the production of other organic inputs was significantly lower in many clusters. Less than 15 percent of the clusters produce organic seed, traditional inputs such as *Panchamruth* (*Panchamrita* (five Amritas in Sanskrit) is a mixture of five foods used in Hindu worship: honey, liquid jaggery, cow milk, yoghurt and ghee), *Panchagavya*, (*Panchagavya*, an organic product, has the potential to play the role of promoting growth and providing immunity in the plant system. *Panchagavya* consists of nine products: cow dung, cow urine, milk, curd, jaggery, ghee, banana, tender coconut and water. When suitably mixed and used, these have miraculous effects), *Beejamruth* (*Bijamrita/beejamrutha* is a treatment used for seeds, seedlings or any planting material. *Bijamrita* effectively protects young roots from fungus and soil-borne and seed-borne diseases that commonly affect plants after the monsoon period), bio-pesticides and bio-fertilizers. However, one interesting finding is that the production of organic inputs at the cluster level was significantly higher in clusters located in less-developed states and managed by NGO-RCs than their counterparts. Although many clusters had infrastructure and facilities to prepare organic inputs, only a few produced them. The low production of organic inputs was mainly due to their highly labor-intensive nature against the backdrop of the growing labor shortage and increasing wage rates across India. Plants and trees used in the preparation of bio-pesticides and other plant-based inputs such as phyretrins, rotenone, nicotine and *Azadirachtin* derived from species of Tanacetum, Derris (leguminous herb), Nicotiana (tobacco-related) and Azadirachta (neem) have been diminished and neglected over the years. It may take a long time to regrow them.

The farmers were aware of the risks involved and adopted the diversification strategy. Most of the farmers practiced both conventional and organic agriculture in different plots/parcels of land. Commercial crops such as chilies and cotton were mainly grown conventionally using chemical pesticides and fertilizers, while pulses, millets and oilseeds requiring fewer inputs were grown organically. Commercial and vegetable crops were input-intensive and largely depended on irrigation, while pulses, millets and oilseeds were grown under rainfed conditions with a lower use of inputs. In input management, it is relatively more straightforward for the farmers to shift to organic agriculture in these rainfed crops compared to commercial crops.

3.6. Impact Assessment of PKVY at Farm Level

When calculating the impact of organic agriculture, only three crops were considered: wheat, paddy and soybean. All farmers did not grow all three crops. Hence, only farmers who grow these crops were included in this analysis. Among 2880 conventional farmers, only 1008 cultivated paddy, 691 cultivated wheat and 202 cultivated soybeans. Among 2880 organic farmers, 806 cultivated paddy, 518 cultivated wheat and 135 cultivated soybeans. Tables 2 and 3 present the tabular and regression analysis for the costs, gross revenue, profits, yields and manure usage per hectare using the Difference-in-Difference approach. In the table, we are only interested in the Difference-in-Difference component (change in target variable due to adoption of organic agriculture after discounting for the initial differences recorded in the base year). For example, in the case of wheat, before the introduction of organic agriculture, the cost of controlled (conventional) farmers was Rs 40,008/ha (USD 615/ha), while for treatment farmers, it was Rs 40,059/ha (USD 616/ha). However, after the introduction of PKVY and once treatment farmers started adopting organic agriculture, the costs were raised to Rs 42, 752/ha (USD 657/ha) for organic farmers. At the same time, the costs of conventional farmers further grew to Rs 48, 202/ha (USD 741/ha). A similar analogy applies to other variables in the table.

Table 2. Impact of organic agriculture on costs, farm returns and manure use per ha in 2017.

		Wheat			Paddy			Soybean		
		Conventional Farmers	**Organic Farmers**	**Impact of Organic Agriculture (Double Difference)**	**Conventional Farmers**	**Organic Farmers**	**Impact of Organic Agriculture (Double Difference)**	**Conventional Farmers**	**Organic Farmers**	**Impact of Organic Agriculture (Double Difference)**
Cost (Rs/ha)	Before	40,008	40,059		49,017	48,347		27,874	27,000	
	After	48,202	42,752		60,742	51,598		33,183	27,468	
	% change	20.5	6.7	−13.7	23.9	6.7	−17.3	19.0	1.7	−17.4
Gross revenue (Rs/ha)	Before	50,796	51,304		59,269	59,861		31,954	32,274	
	After	61,200	56,228		71,408	64,105		37,771	33,380	
	% change	20.5	9.6	−10.8	20.5	7.1	−13.3	18.2	3.4	−14.7
Profit (gross revenue-costs) (Rs/ha)	Before	10,788	11,245		10,252	11,514		4081	5274	
	After	12,998	13,476		10,666	12,507		4588	5912	
	% change	20.5	19.8	0.2	4.0	8.6	5.6	12.4	12.1	3.2
Yield (Rs/ha)	Before	35.3	35.3		39.0	39.0		11.8	11.8	
	After	36.0	31.5		41.0	33.9		12.0	10.1	
	% change	2.0	−10.7	−12.8	5.1	−13.1	−18.2	2.0	−14.1	−16.2
Manure (quintal/ha)	Before	4.0	4.0		12.0	12.0		5.0	5.0	
	After	4.0	6.0		12.0	15.0		5.0	6.0	
	% change	0.0	50.0	50.0	0.0	25.0	25.0	0.0	20.0	20.0

Note: I USD = 65 India Rupees; conventional farmers practiced chemical farming both before (2014) and after (2017); whereas organic farmers practiced chemical farming 2014, they shifted to organic farming in 2015 and have continued since then as organic farmers.

Table 3. Difference-in-Difference regression results.

	Overall Sample			Sub Sample of Rainfed, Tribal and Hilly Areas		
	Wheat	**Paddy**	**Soybean**	**Wheat**	**Paddy**	**Soybean**
Cost (Rs/ha) (Dependent variable)						
(Constant)	40,008	49,017	27,874	30,006	36,763	20,905
Time	8194	11,725	5309	7785	9713	5150
Intervention	51	−670	−874	48	−863	−743
Intervention ∗ Time	−5501 *	−8474 *	−4841 *	−4291 *	−6610 *	−3776 *
R^2	0.84	0.86	0.78	0.76	0.77	0.67
Profit(Rs/ha) (Dependent variable)						
(Constant)	10,788	10,252	4081	8091	7689	3060
Time	2210	414	507	2099	455	492
Intervention	457	1262	1193	474	−18	435
Intervention ∗ Time	21	579	3436	16	451	2680 *
R^2	0.81	0.83	0.75	0.73	0.74	0.67
Yield (Quintal/ha) (Dependent variable)						
(Constant)	35.3	39.0	11.8	26	29	9
Time	0.7	2.0	0.2	0.8	2.2	0.2
Intervention	0.0	0.0	0.0	0	0	0
Intervention ∗ Time	−4.5	−7.1	−0.9	−1.3 *	−2.0 *	−0.5
R^2	0.81	0.83	0.76	0.73	0.75	0.68
Number of sample	1210	1814	337	242	544	202

Note: * indicates a significant difference between groups ($p < 0.05$).

Overall, the relative costs were reduced by 17% in organic farming in both paddy and soybean, while they were reduced by 14% for wheat. Gross revenue (production × price) was also reduced to 8–9% among organic farmers compared to conventional farmers. However, the profitability of organic farmers was increased marginally by 3.2% in soybean, 5.6% in paddy and just 0.2% in wheat. However, yields were reduced by 9% in soybean, 8% in paddy and 6% in wheat in organic agriculture compared to conventional agriculture. Manure use was increased by 20% to 50% depending on the crop. Farmers opine that organic produce fetches higher prices if sold as packaged and branded products or sold to known people within the village. However, if there is no proper labelling and certification, then the market price is the same as buyers cannot distinguish between organic and conventional foods. The results were similar to other studies in developing countries [33,34]. The farmers did not convert the entire holdings into organic farming, but only in a small portion of the farm holding, primarily in food grains and legumes for home consumption. The production was sometimes channeled to locally known consumers, fetching relatively higher prices. The tabular analysis results were confirmed by the regression analysis shown in Table 3. The agrochemical use in rainfed, hilly and tribal areas was much lower compared to the irrigated farming system, therefore, the conversion to organic agriculture need not result in a sharp yield decrease. However, in irrigated regions, the yield decrease was sharper, as noted in the case of wheat in Punjab.

Further, in soils with higher organic matter and soil carbon, organic farmers profited more than in other areas. In the regression analysis, in addition to the total sample, a sub-sample of rainfed and the hilly regions was considered to run a separate regression. The results confirm the tabular analysis. In the case of irrigated farmers, the yield decrease was more severe. Further, in the hilly areas, soils are rich with organic matter and soil carbon; hence, organic farming is sustainable and profitable.

3.7. Impact of PKVY at the Macro Level

At the farmer level, the impact of the adoption of organic agriculture was positive in terms of profitability and reduction in cost, even though there was a reduction in the yield in all crops. However, at the macro level, the decrease in production may raise food insecurity if area under organic agriculture is expanded beyond a threshold level. Hence, in this section, we employed the economic surplus model to determine the impact of adopting organic agriculture at the national level (overall) as well as whether adoption was confined to rainfed, hilly and tribal areas only [35]. The economic surplus model was applied in two scenarios with 10% of the area converted from conventional to organic farming and another with 30% converted to organic agriculture. In addition, a third and fourth scenario of conversion was confined to only in rainfed, hilly and tribal areas by the same area.

The economic surplus model shows that if organic agriculture is adopted on 10% and 30% of the overall cropped area under each crop, there is a likely increased food deficit in all the three crops, wheat, paddy and soybean due to a decrease in production (Tables 3–5). The reduction in yields and consequent reduction in production leads to a food shortage for consumption, which may lead to food insecurity. There is a likely reduction in economic surplus, both producer and consumer surplus (Table 4). However, the loss is less than 5% of the total value of production in a paddy and about 3% in soybean and wheat, even if there is a 30% area conversion to organic farming. The marginal loss of up to 5% can be recovered by enhancing the price premium through exporting branded and certified organic produce in the future.

Table 4. Change in economic surplus due to shift in area from conventional to organic agriculture at all Indian levels (2017 constant price).

Crop			10% Area under Organic			30% Area under Organic		
	Total Production (MT)	Value of Production (Rs. Billion)	Total Surplus	Consumer Surplus	Producer Surplus	Total Surplus	Consumer Surplus	Producer Surplus
					Change in Rs. billion			
Paddy	109.0	1744	−26.6	−17.8	−8.8	−79.5	−53.2	−26.3
Wheat	98.5	1773	−17.5	−10.4	−7.1	−52.5	−31.2	−21.2
Soybean	13.1	408	−4.5	−2.3	−2.3	−13.6	−6.8	−6.8
			Change in Rs. billion (shift confined to rainfed, hilly and tribal areas only)					
Paddy	43.6	697.6	6.8	4.5	2.2	21.7	14.5	7.2
Wheat	39.4	709.2	6.3	3.7	2.5	20.2	12	8.2
Soybean	7.86	244.8	2.5	1.3	1.3	7.5	3.8	3.7

Note: Assumptions: (1) The production and prices are concerning the year 2017; (2) the demand elasticities of paddy, soybean and wheat were −0.247, −0.504 and −0.340, respectively [36]; (3) the supply elasticities of rice, soybean and wheat were 0.50,0.50 and 0.50, respectively; (4) the percent change in the cost of production and yield was taken with and without organic agriculture for the year 2017; (4) the consumer surplus for each crop was estimated with the assumption that 10% and 30% of the cropped area may be converted into organic farming; (5) it was assumed that 40% of rice and wheat production and 60% of soybean production came from rainfed, hilly and tribal areas; (6) it was assumed that the rainfed area yield was 75% of the overall yield in case of soybean and 70% of the overall yield in the case of rice and wheat.

However, if the area shifts from conventional to organic is confined to only rainfed, hilly and tribal areas, then producer, consumer and total surplus to the economy will increase in all three crops.

Overall, economy wide conversion to organic agriculture may not be economically viable, as soil fertility will reduce year after year without the application of fertilizers.

Consequently, the yield reduction will steepen, leading to food insecurity and welfare loss. However, there is huge scope for expanding organic agriculture in rainfed areas.

3.8. Farmer's Attitude toward Organic Farming

This section assessed farmers' attitudes toward organic farming based on the behavioral principles developed by Chetsumon and Wheeler [37,38]. The indicators were divided into five parts (Figure 7). About 46 percent of farmers said they adopted organic farming for health and food safety reasons. Reduction in the cost of production was the second reason for adopting organic farming. The role of agricultural officers was important, as 32 percent of farmers mentioned that they shifted to organic farming due to advice from government agricultural officers. The part of private companies was limited in encouraging organic farming, as only 12 percent responded positively, as most of the private companies are in the business of selling chemical fertilizers and pesticides. It was ascertained that the main problem while converting to organic farming was the lack of certification (57 percent), resulting in no premium price.

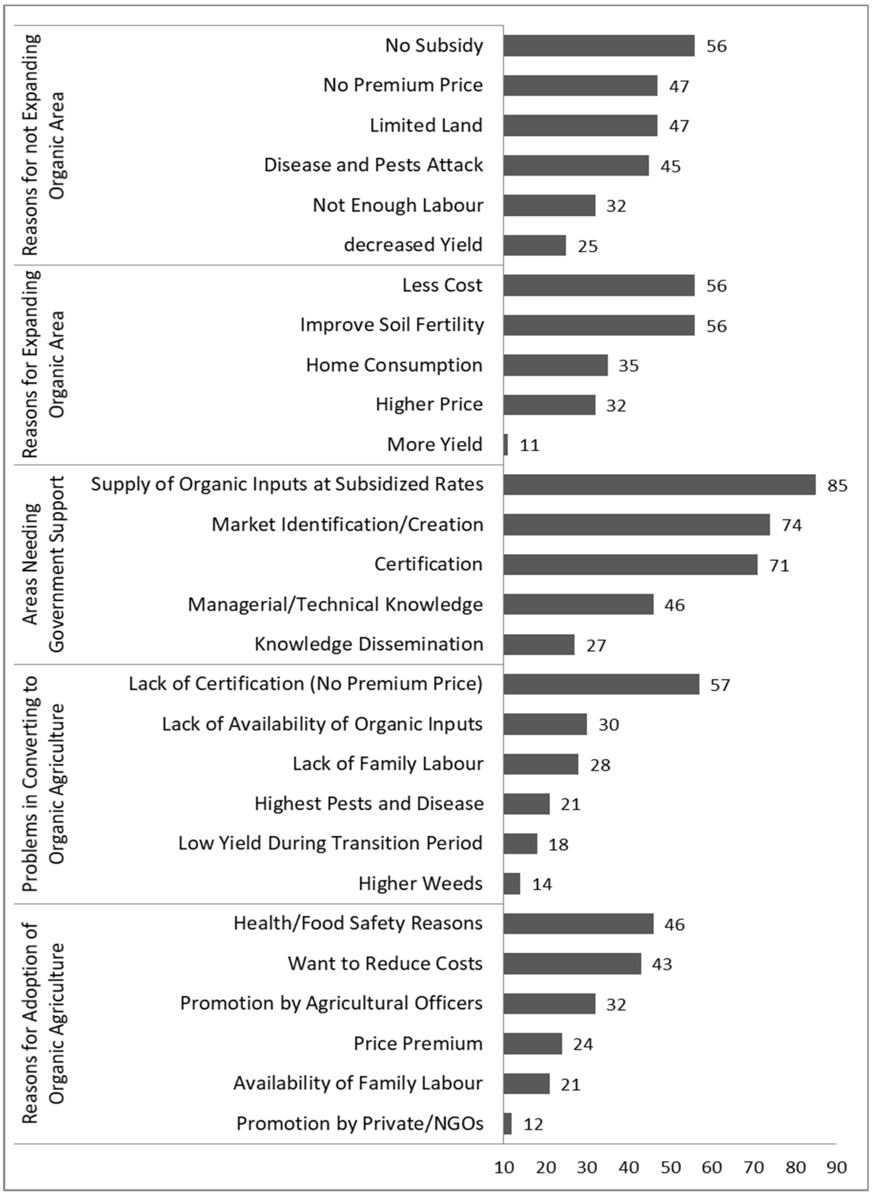

Figure 7. Farmers' attitudes toward organic farming 2017.

Further, the scarcity of organic inputs and labor (particularly family labor) was another constraint, as organic agriculture is relatively more labor-intensive than conventional agriculture. Although lower costs attract farmers to adopt organic farming, they are hesitant to adopt it widely due to low yields, higher labor and supervision time requirements and lack of premium price [39–41]. Some farmers prefer organic agriculture to meet their own consumption needs. Overall, farmers opine that government should support supplying subsidized organic inputs and ensure premium prices for their output for wider adoption of organic agriculture.

3.9. Constraints in PKVY Programme Implementation

The study results show that organic agriculture is profitable, especially in the rainfed and hilly areas, for all three crops. This section examines the constraints in implementing the organic agriculture scheme in rainfed and the hilly regions. In all 576 sample clusters, FGDs were organized with critical informants such as local agricultural officers and progressive farmers to elucidate constraints faced by farmers to expand the area under organic agriculture. The organic agriculture profitability is location-specific, but the PKVY scheme was implemented in all regions without seeing suitability and profitability. Hence, there is a need to identify and prioritize locations and crops for vertical expansion and the saturation of identified locations to reap the scale and brand benefits. Funds are thinly distributed over large areas; focusing on specific areas can also ensure adequate availability of funds in priority zones.

Further, it is also worth mentioning that in-between the transition period of the first and second year, some farmers discontinued organic agriculture in the middle due to the discontinuation of matching grants from the government. To reap the full benefits, such as certification, there should be uninterrupted support for at least 3 years. Most farmers do not realize the price premium for the organic produce. All regulated government markets must arrange separate sale counters for certified organic produce. The services of private marketing agencies, farmers' producer companies and cooperatives need to be taken for marketing and certification systems in Public-Private Partnership mode. Most of the inputs required in organic agriculture come from animals and native tree species. Hence, farmers need to be encouraged to grow livestock and native trees to produce bio-inputs.

4. Implementation Bottlenecks and Gaps at Macro-Level

Fund Allocation and Utilization

The last few years' experience has shown that the budget allocations to the organic agricultural scheme were interrupted and discontinued at the local level. There was a discrepancy in the release of funds to the extent that only 50–60 percent of the allocated funds were released. Further, of the released amount, only 60–70 percent were utilized (Figure 8). It indicates a need to streamline fund release and utilization.

Focus group discussions with officials indicated several governance issues leading to a delay in the supply of crucial inputs at the required time. Handholding by NGO-RCs is better in community activities such as bio-input preparations; hence, NGOs' participation is needed in organic agriculture.

Although budget release guidelines are uniform across zones, the actual release and utilization showed significant differences due to implementation problems, diversion of funds and low government capabilities in some states. This study shows that although the utilization of funds was better in the eastern and western zones, progress in terms of area and number of farmers under PKVY was better in the central and southern zones (Table 5). These regional glitches need to be addressed.

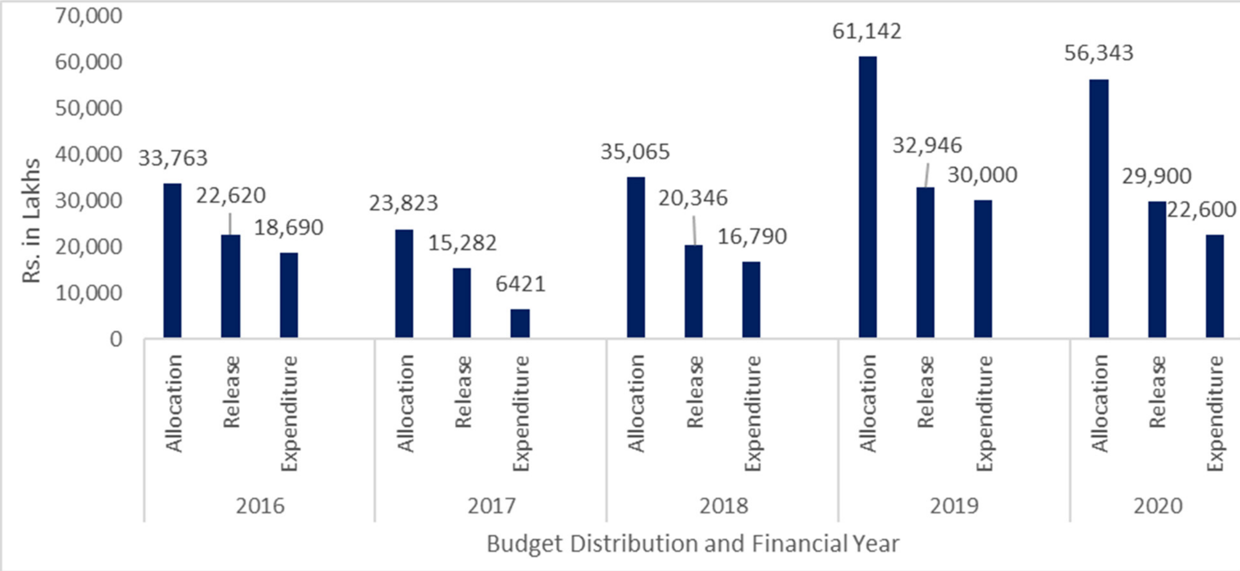

Figure 8. Budget allocation, release and expenditure (Rs. in lakh) under the PKVY scheme. Note: 1 lakh = 100,000. Source: Ministry of Agriculture & Farmers Welfare, Government of India, annual reports.

Table 5. Zone-wise progress of the organic agricultural scheme (PKVY), 2016–2020.

Zone	Clusters (N)	Farmers (lakh)	Area (lakh ha)	Net Cropped Area (%)	Area in All-India (%)	Amount (Rs.lakh) per Group
Central	10,133	5.07	2.03	0.543	34	3.9
South	7677	3.84	1.54	0.524	26	4.2
North	7223	3.61	1.44	0.460	24	1.8
East	2409	1.20	0.48	0.233	8	6.4
West	2417	1.21	0.48	0.175	8	4.5
Overall India	29,859	14.9	5.97	0.408	100	3.7

Source: Parliament (2020) Lok Sabha question no.1496 to be answered on the 11 February 2020 status of PKVY, Parliament of India. New Delhi [42]. 1 Lakh = 100,000. Note: The northeast zone was merged with the east zone.

5. Policy Analysis and Conclusions

The blanket adoption of organic farming may reduce the yield of the crops and would affect the food security and the welfare of the consumers and producers, as noted in the economic surplus model [43–45]. However, the economic surplus model shows that expanding organic agriculture in rainfed and hilly areas will be more beneficial at the farmer and national levels [46–49]. Therefore, a location-specific strategy is more effective than the blanket recommendation for organic farming. The government needs to identify the areas that can be brought under organic farming, prioritize these areas and build a "Geographical Indication" tag to obtain a premium price. As a general principle, by default, rainfed, hilly and tribal areas where the farmers use fewer chemical fertilizers can be prioritized for conversion toward organic farming. Identifying and mapping these default organic growing areas and focusing on saturation, vertical expansion and brand building are low-hanging fruit in promoting organic agriculture. Hence, the government should prioritize these strategies. Identifying contiguous areas covering between 300 and 1000 farmers as the organic cluster will help in reaping scale economies for providing support services such as transport and marketing. The whole-area approach (saturation) may be followed before venturing into new areas.

The constraints, such as gaps and delays in allocation, the release and utilization of funds, the interrupted supply of funds, higher labor requirement, non-availability of bio-inputs, certification issues and not obtaining premium price, need to be addressed [50].

Affluent consumers are often willing to pay a premium for organic produce because of better health benefits [51–56], but consumers in developing countries are more price-conscious, and the majority cannot afford premium prices. However, even in developing countries, a niche market is growing for organic produce. There is a growing demand for organic produce, especially among urban centers in India. Because of the increased awareness about the negative consequence of chemical residues in foods, consumers are willing to pay a premium for organic produce.

According to the World Organic Agriculture Report 2018, India is the home to the most significant number of organic farmers globally, comprising almost 30 percent of the total 2.7 million certified organic farmers. However, the share of the organic agricultural area to total cropland is less than 3% in India [57]. This area can be increased to 10% of the cropped area with a focus on rainfed and the hilly regions [58] without any loss to food security at country level with increased profits to farmers. Therefore, a well-calibrated strategy to prioritize the areas [59] that can be converted for organic farming, certification and marketing is urgently needed.

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Appendix A

Appendix A.1. Difference-in-Difference (DID) Model

DID is typically used to estimate the effect of a specific intervention or treatment (here, organic agriculture) by comparing the changes in outcomes (cost, profit and yield) over time between organic farmers (treatment group) and conventional (control group) farmers, as indicated below:

$$Y = \beta 0 + \beta 1 * [\text{Time}] + \beta 2 * [\text{Intervention}] + \beta 3 * [\text{Time} * \text{Intervention}] + \varepsilon$$

In the DID approach, the interaction term between the time and treatment group dummy variable shows the treatment's impact after the treatment's introduction, as shown in Table A1 and Figure A1. This β_3 indicates the impact of organic agriculture on the change in the outcome (profit) over conventional agriculture. We used data for 2014 (before PKVY) and 2017 (after PKVY). In Figure A1, A indicates the profit of the control group before PKVY, B indicates the profit of control group after PKVY, C indicates the profit of treatment group before PKVY and D shows the profit of the treatment group after PKVY.

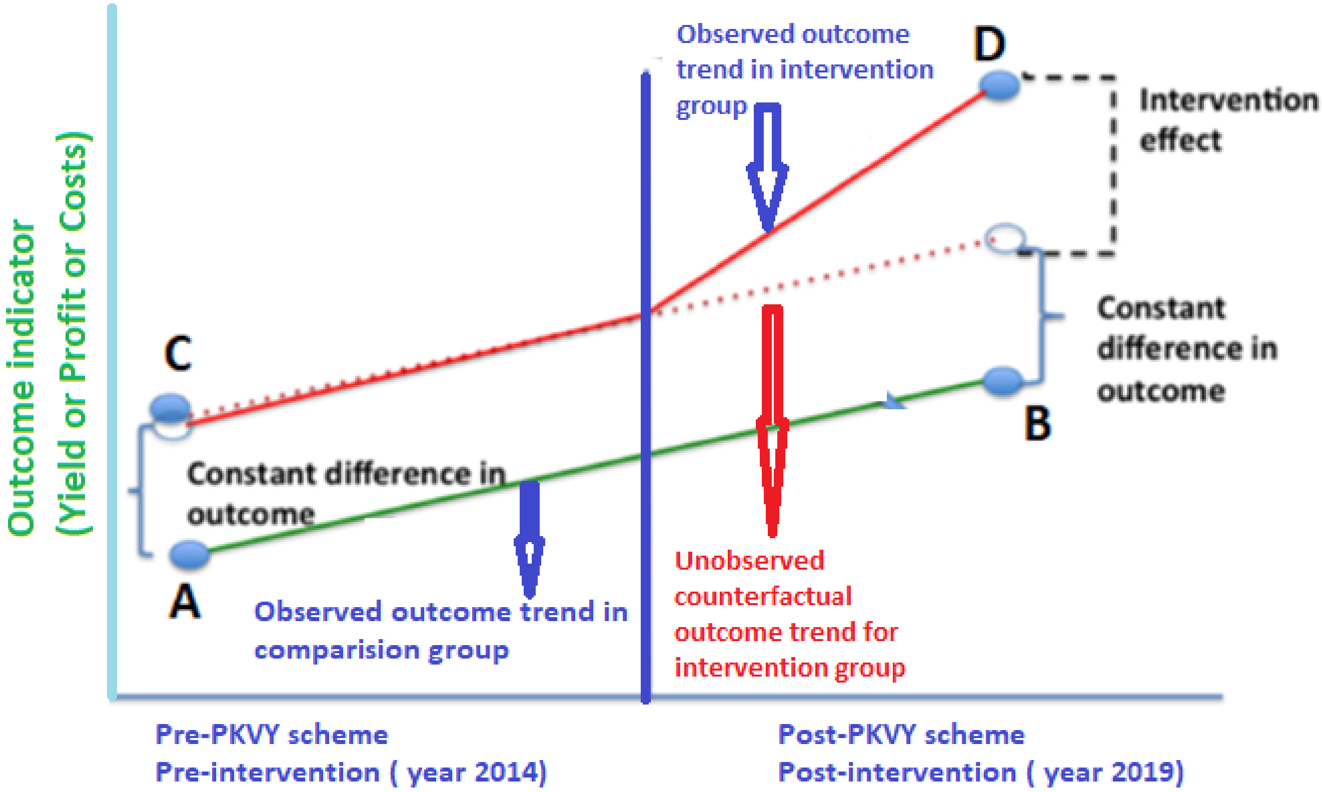

Figure A1. Difference-in-Difference conceptual diagram. Modified version. Source: https://www.publichealth.columbia.edu/research/population-health-methods/difference-difference-estimation (accessed on 1 January 2022).

Table A1. Interpretation of the Difference-in-Difference regression parameters.

	Calculation	Interpretation
B_0	A	Base year outcome control group (year 2014)
B_1	B–A	Time trend in control group (conventional agriculture)
B_2	C–A	Difference between the two groups in pre-intervention (in year 2014)
B_3	(D–B)–(C–A)	Impact of organic agriculture: Difference in change of outcome over time with the adoption of organic agriculture, after discounting initial differences.

Note: Modified version. Source: https://www.publichealth.columbia.edu/research/population-health-methods/difference-difference-estimation (accessed on 1 January 2020).

Table 3 presents the interpretation of the DID regression coefficients. In the absence of treatment, the unobserved differences between the treatment and control groups were the same over time (β_2). The actual impact of the PKVY scheme is indicated by β_3, which is the difference in the outcome due to treatment after discounting for the initial difference between treatment and control groups.

Appendix A.2. Economic Surplus Approach

Once we assessed farmer-level impacts, we used the economic surplus model to assess the economy-wide effects considering the food security issues. The economic surplus approach is widely used to evaluate technology's impact on households' economic welfare. Economic surplus (ES = CS + PS), an indicator of total welfare, consists of two related measures: consumer surplus (CS) and producer surplus (CS). Therefore, a change in interest due to a technological change or an intervention is the total change in the consumer and producer surpluses (ΔES = ΔCS + ΔPS). A graphical representation of the basic model for the welfare effects/impacts in a closed economy is provided in Figure A2. In the figure, D represents the demand for a homogeneous product, and S represents the supply curve of the product. The initial equilibrium price and quantity are P and Q, respectively. Then, the triangle PeD represents the total consumer surplus, the difference between the willingness to pay of the consumer for a product without forgoing it and what she pays in exchange for the product. The triangle OeP denotes the total producer surplus, the difference between what a producer receives after selling the product in the market and her willingness to sell the same product at a particular price [60,61]. Hence, the triangle OeD represents the total economic surplus accrued to the society. The three different excesses (producer surplus, consumer surplus and economic surplus) are sensitive to changes in demand or supply elasticity. We assumed a closed economy model with a parallel supply shift for organic farming, as shown in Figure A3.

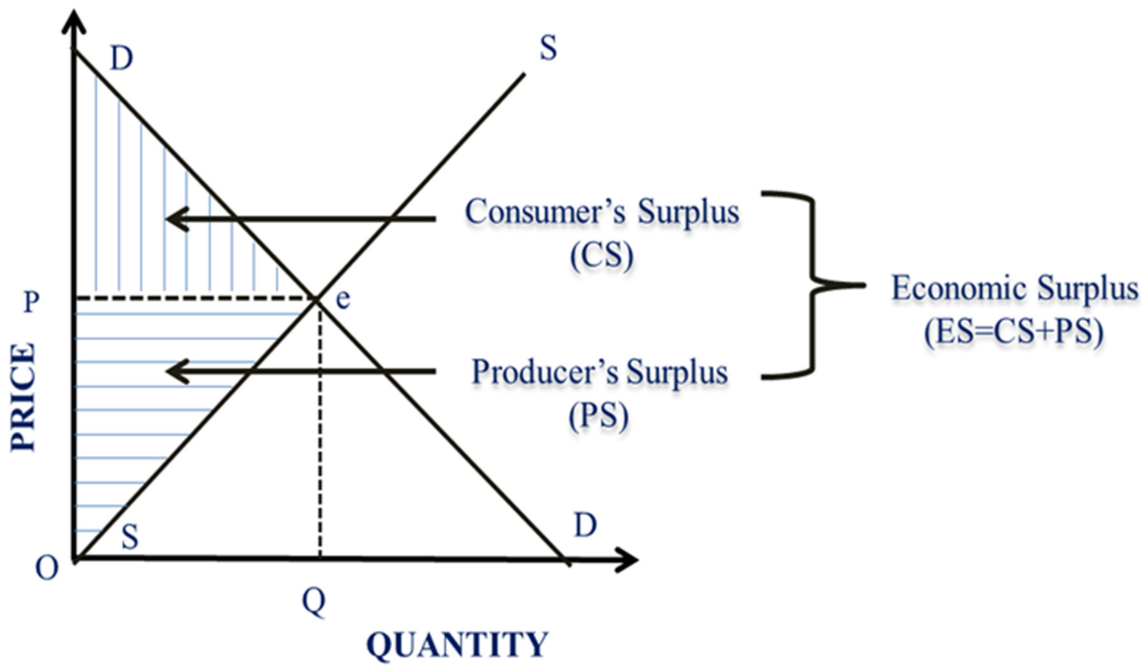

Figure A2. Concept of economic surplus. Source: Adopted from [61].

Closed Economy with Parallel Supply Shift

Alston showed that a closed economy with a parallel supply shift with the improved technology [60]. The annual changes in total economic surplus (ΔTS) can be measured as:

$$\Delta CS = P_0 Q_0 Z\,(1 + 0.5Z\eta)$$

$$\Delta PS = P_0 Q_0\,(K - Z)\,(1 + 0.5Z\eta)$$

where

P_0 = Base price of the commodity,
Q_0 = base quantity,
η = absolute value of the price elasticity of demand,
ε = elasticity of supply,
$Z = K\,\varepsilon/(\varepsilon + \eta)$ is the reduction in price relative to its initial value due to a supply shift.

K_t= Vertical shift of the supply function during a period "t "expressed as a proportion of the initial price, calculated as:

$$\mathrm{Kt} = \left[\frac{\mathrm{E\ (Y)}}{\varepsilon} - \frac{\mathrm{E(C)}}{1+\mathrm{E(Y)}}\right]\rho\mathrm{At}(1-\delta\mathrm{t}) \quad (1)$$

where

E(Y) = proportionate yield change per hectare with organic agriculture,

E(C) = proportionate variable input cost change per hectare,

P = probability of research success (in this case organic farming and ρ =1 were assumed)

A_t = proportion of the area affected by the technology reflecting a rate of adoption (organic farming in this case),

δ_t = depreciation rate of the technology (rate of annual depreciation of the technology).

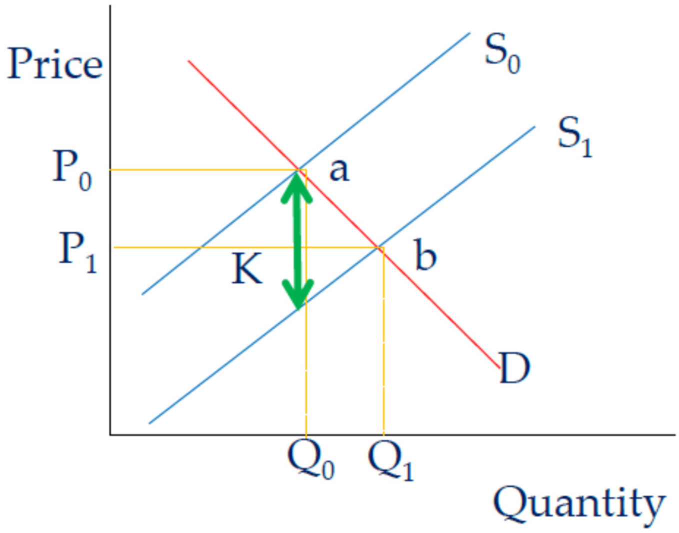

Figure A3. Changes in the total economic surplus due to a change in the parallel supply shift in a closed economy. Source: Adopted from [61].

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