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Impact Assessment of Seed Village Programme by Using Difference in Difference (DiD) Approach in Telangana, India

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Abstract: Seed village programmes are becoming popular in developing countries due to their potential to supply of affordable seed to farmers in a timely manner. Under the programme, the profitability of seed growing farmers is important as it incentivizes them to grow more seed for distribution of seed to other farmers. This paper tried to analyze the impact of the seed village programme on profitability of seed growing farmers of paddy crop by using Difference-in-Difference approach. The study was conducted during the year 2020 in India. A significant increase in profitability of seed growing farmers compared to non-seed farmers was noticed due to the SVP scheme. It was observed that after the introduction of SVP, there was about 69.01% increase in profits of seed-farmers compared to only 5.63% among non-seed-farmers. Age, education, acreage under seed production and farming experience contributed 71.6% of the total variation in the higher profits through SVP in paddy crop, leaving the rest to extraneous factors. The difference-in-difference regression results showed that, with the introduction of the SVP in India, there was an increase in the profits of seed growing farmers by INR 13,032/acre (186 USD). These results show that most of the seed growing farmers are in favor of the growing seed under SVP and benefited from this programme.

Keywords: seed village programme (SVP); quality seed production; difference-in-difference; paddy; impact assessment; farm income

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1. Introduction

Use of quality seed is the main determining factor for enhancing crop productivity and farm incomes. The use of quality seed in agriculture improve yields significantly by about 30–40%, especially in developing countries [1–4]. However, shortage of quality seed during the sowing season is a recurring phenomenon in India, as the government's capacity to produce sufficient seed is limited and private seed is costly and available for only a few crops. Despite of the implementation of organized seed programmes since mid-1960s, the Seed Replacement Rate (SRR: the percentage of area sown by using certified/quality seeds out of the total area of crop planted) has only reached about 20% while the desirable SRR is 33% in India. The remaining 80% of the cropped area was sown with farm saved seeds [5]. The use of farm-saved seeds continuously leading to genetic degeneration of the seeds resulted in reduced yields and plant vigor within 2–3 years; accordingly, farmers have to replace farm-saved seeds with certified seed to maintain yields and vigor [6]. The use of certified seeds can improve seed germination and seedling emergence, increase crop

yield, and reduce the cost of agriculture production [7]. Many studies indicated that higher SRR is essential for maintaining crop vigor and higher yields and returns [5,8]. In the recent past, private seed companies increased seed prices exorbitantly with monopolistic market power, leading to higher input costs and reduced incomes to farmers, which are unbearable to small landholding farmers [9,10]. It is, therefore, necessary to improve the stock of farm saved quality (certified) seeds for ready availability during the sowing season at lower prices. For this, seed production, seed distribution and other connected aspects will have to be improved and strengthened at the farmer's level to provide them with guaranteed quality seed supply at affordable prices. The Indian government is giving high priority to the strengthening of the seed production chain, the development of infrastructure, and the promotion and multiplication of new varieties of seeds to be available for farmers at an affordable price through the implementation of the seed production plan [11]. Although government agencies like Seed Development Corporation are involved in seed production and distribution, their capacity is limited and their cost of operations are huge due to their centralised operations. Hence, to produce and distribute quality seed to smallholder farmers locally at affordable prices, the government depends on decentralised seed production and distribution through the Seed Village Programme (SVP) [12–15]. The institutional framework of decentralised seed production and distribution under SVP is given in Figure 1.

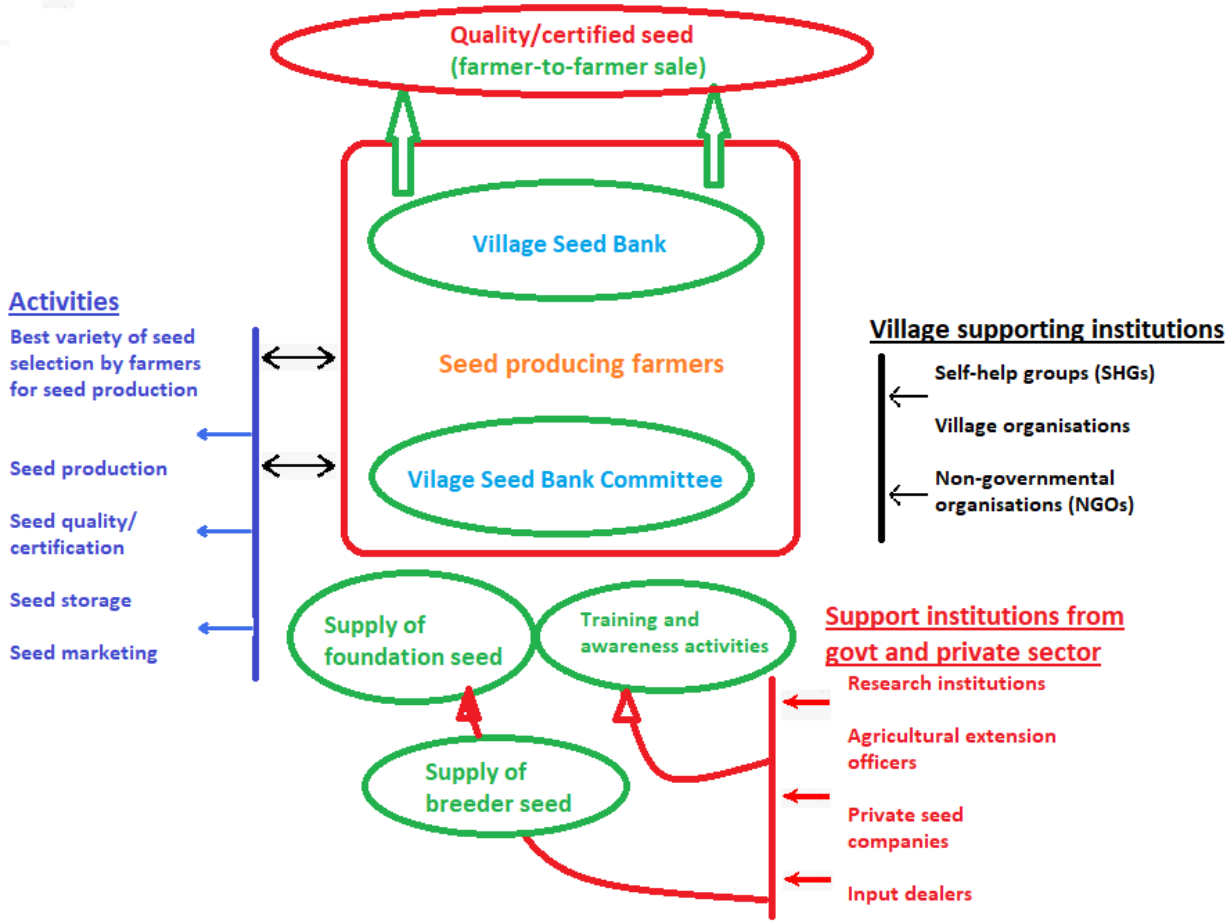

Figure 1. Various institutions involved in the decentralised seed production under Seed Village Programme (SVP).

As a part of seed production plan, the government of India started SVP across the country in 2005. Under SVP, a group of farmers in a village are encouraged to produce quality seeds of various crops and cater to the needs of themselves, fellow farmers of the village, and farmers of neighboring villages in appropriate time and at affordable cost

through farmer-to-farmer sale. The SVP is picked up in recent years, but its success is not uniform, and required seed production targets are not achieved. It is successful in a handful of states like Telangana Karnataka, Maharashtra, Andhra Pradesh (India is divided in to 28 sub-national units: states), while in other states, it is not yet picked up [16]. Hence, this study was undertaken in Telangana state mainly to understand whether seed growing farmers are able to reap profits when compared to non-seed farmers. Seed villages are selected based on suitability of weather for seed production and demand and supply gap in local seed varieties in each state. The progress under the SVP from 2015 to 2019 in the state was given in Table 1. It indicates a substantial amount was spent for the implementation of the SVP. There are about 3219 seed villages in the state (Table 1). Each seed village covers about 25 acre (10 ha) covering minimum of 50 farmers [11]. In the implementation of SVP, many institutions and agencies are involved. Under the SVP, State Seed Farms operated by government are producing foundation seeds (foundation seeds are offsprings of the Breeder seed), which can be clearly traced to the breeder seed. The foundation seed is supplied to seed growing farmers at 50 percent subsidy on cost of foundation seeds [17] to produce quality/certified seed and to sell to the neighboring farmers in the village. Trainings are given to the farmers on crucial crop stages. To encourage farmers to participate in the SVP, subsidy assistance was given for procuring seed storage bins, subsidy was also given to seed processing machinery and seed cleaning, packaging and distribution [18].

Table 1. Funds utilization and progress of work under SVP.

Year	No. of Seed Villages	Seed Production Budget (INR Million)	Seed Production Area (Acre)	Foundation Seed Produced (Quintal)	Training Budget (INR in Million)	Number of Training Conducted	Total Budget (INR Million)	Total Expenditure (INR/Acre)
2016	2754	68.0	68,855	26,948	20.7	1378	88.7	1288
2017	2919	72.1	72,985	28,565	21.9	1460	94.0	1288
2018	3065	75.7	76,635	29,993	23.0	1533	98.7	1288
2019	3219	79.5	80,465	31,493	24.1	1610	103.6	1288

Source: Strengthening of Seed Production chain and infrastructure development: Task Force Report submitted to NITI Aayog (Source: [11]) 1 Indian National Rupee (INR) = 60 USD.

This paper is an attempt to assess the impact of the SVP in terms of seed growing farmer's profitability (yield×price-cost) and suggest strategies for increasing seed-farmers profitability, so that they are encouraged to continue seed growing, which in turn increase quality seed availability and sales to the neighboring farmers in the seed villages, which enhances the seed replacement rate, increases neighbouring farmers' production and incomes, and meets the objective of SVP. The paper used a unique methodology of Difference-in-Difference approach to quantify the impact of SVP and determine factors which contributes to higher profitability of seed farmers in Telangana.

2. Data and Methodology

SVP was implemented from 2015 to 2019; this assessment study was conducted after completing 5 years of the programme in 2019, which is a good enough time for administration to rectify any initial bottlenecks in the programme implementation and demonstrate visible impacts. In Telangana state, paddy is the major crop with more than 40% of the cropped area, and there is a huge shortage of paddy seed during the sowing time. Hence the study specifically chosen paddy seed-farmers for studying the impact of SVP on their profitability in production of seed under SVP.

The multistage random sampling framework is followed for selection of sample farmers in Telangana state (location of the study area marked in green in Figure 2). The state is sub-divided into 31 districts. Only three districts where the SVP is implemented since 2015 and continuing implementation up to 2019 were selected. The selected districts were Nazamabad, Warangal, and Nalgonda. From each district two sub-districts (Sub-

district administrative unit: mandals comprising 30−40 villages) were selected randomly, from each mandal two villages were selected randomly and from each village all paddy farmers list is taken and categorized as treatment (seed-farmers under SVP) and control (non-seed farmers in SVP villages). Then from each category 10 farmers were selected randomly. Entire sampling framework is given in Table 2. Altogether, our sample of farmers comprises 120 treatment and 120 control farmers. The observations were taken both before and after the introduction of SVP. To take observations before introduction of SVP, the year 2014 was considered while for recording observations after SVP, the study team considered year 2019. Observations such as yield, profits, and cost of cultivation along with different socio-techno-economic data were recorded before and after for both treatment and control groups. The data is for the post-rainy season for both 2014 and 2019.

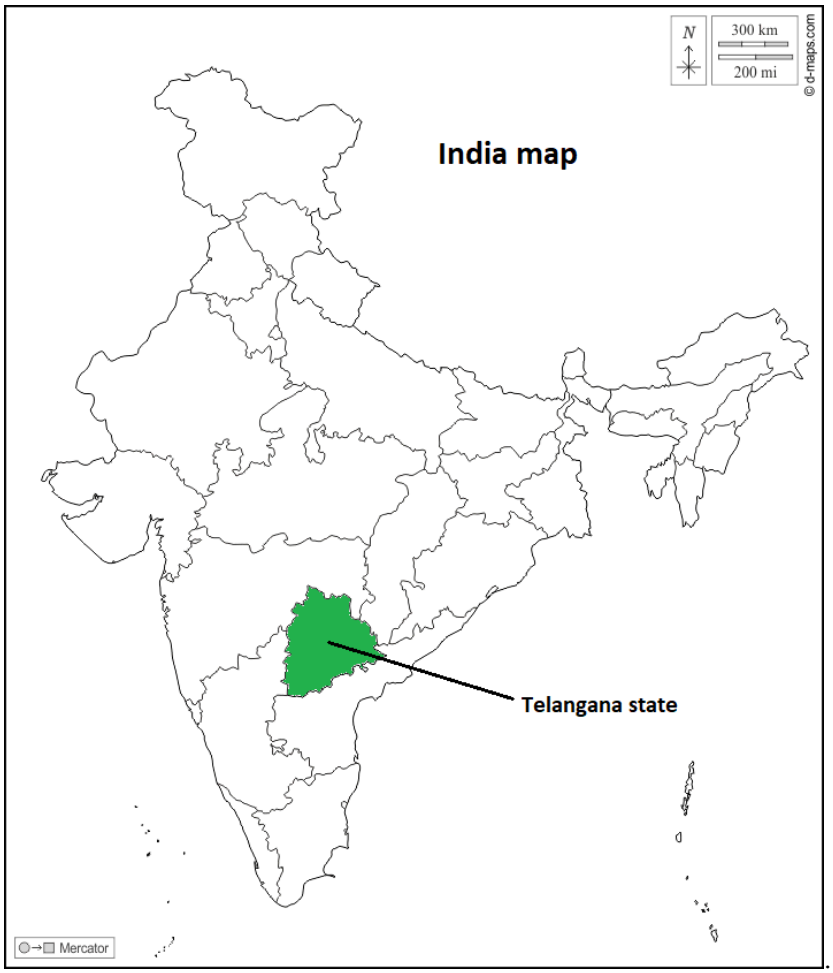

Figure 2. India map with demarcation of Telangana state in green.

Data was collected for each selected respondent on aspects such as crop yield, total cost of cultivation, sale quantity, sale price, to whom they have sold, how much they have sold as seed and as grain, quality of the grain/seed, and certification for both before and after the introduction of SVP by using a pre-tested questionnaire. The collected data was used to analyze the trends in yield, profitability and cost of cultivation. The Difference-in-Differences regression tool was applied to yield, profitability, and cost of cultivation to know the impact of SVP (by using double difference: before/after and with/without). Focus group discussions were organized to collect information from key informants on the implementation bottlenecks, organizational structure, process flow, and perceptions.

Table 2. Sampling framework in Telangana state.

Districts	Mandals	Villages	Seed Growing Farmers (Treatment)	Non-Seed Farmers (Control)	Total
Nizamabad	Morthad	Village 1	10	10	20
		Village 2	10	10	20
	Verni	Village 1	10	10	20
		Village 2	10	10	20
Warangal	Rajavaram	Village 1	10	10	20
		Village 2	10	10	20
	Koppuru	Village 1	10	10	20
		Village 2	10	10	20
Nalgonda	Miryalaguda	Village 1	10	10	20
		Village 2	10	10	20
	Shaligouraram	Village 1	10	10	20
		Village 2	10	10	20
Total farmers			120	120	240

Note: The observations on profitability was recorded from the sample farmers for the years 2014 (Pre-SVP) and 2019 (Post-SVP).

Focus group interactions were conducted with the implementing agencies such as government officials, scientists of agricultural universities, seed certification agency, and grassroots level field staff and also with progressive farmers at different SVP implementing areas. In these group interactions, various facets of the SVP were explored along with problems faced by them in implementation of the programme at different levels.

The Difference-in-Difference (DiD) approach was used to compare the beneficiaries with non-beneficiaries in terms of economic benefits and social benefits [19–23]. DiD is a quasi-experimental design that makes use of longitudinal data from treatment (beneficiaries) and control (non-beneficiaries) groups to obtain an appropriate counterfactual to estimate a causal effect of SVP. DiD is typically used to estimate the effect of a specific intervention or treatment (here implementation of SVP) by comparing the changes in outcomes (here profits from seed cultivation under SVP) over time between seed-farmers (the treatment group) and non-seed farmers (the control group).

In the DiD approach, the interaction term between time and treatment group dummy variables shows the impact of the treatment after the introduction of the seed programme as shown in Figure 3 and Table 3 and Equation (1). In this β_3 indicates the increase in profits per acre of seed-farmers when compared to the profits per acre of non-seed farmers after discounting for initial differences in profitability. We have used data for 2014 (before SVP) and 2019 (after SVP). In the Difference-in-Difference approach, comparison groups can start at different levels of the outcome. Hence, it focuses on change rather than absolute levels [24]. The study uses robust standard errors to account for autocorrelation between pre/post while running regression.

$$Y = \beta_0 + \beta_1 \times [\text{Time}] + \beta \times [\text{Intervention}] + \beta_3 \times [\text{Time} \times \text{Intervention}] + \varepsilon \quad (1)$$

In Figure 3, A indicates profit of the control group in base year 2014; B indicates control group profit after introduction of SVP in year 2019; C indicates, base year profit before the introduction of SVP in year 2014; and D indicates profit of treatment group after introduction of SVP in year 2019.

The Table 3 presents interpretation of Difference-in-Difference (DiD) regression coefficients. In the absence of treatment, the unobserved differences between treatment and control groups are the same over time (β_2). The actual impact of the SVP programme is indicated by $\beta_{3,}$ which is the difference in the outcome after discounting for the initial difference between treatment and control.

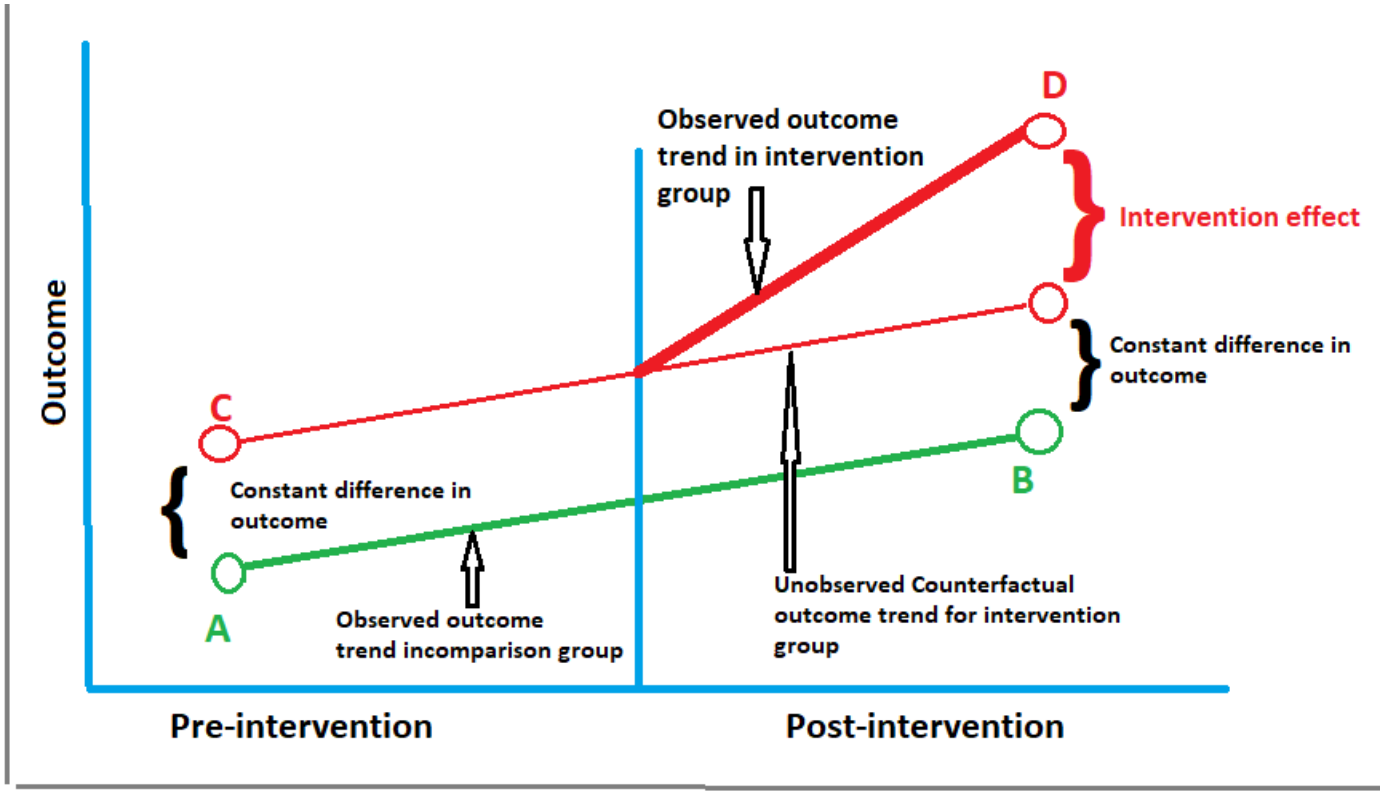

Figure 3. Targeted variables-profit per acre per season (1 acre = 0.4 hectare).

Table 3. Interpretation of difference-in-difference regression parameters.

Coefficient	Calculation	Interpretation
β_0	A	Base year average (year 2014)
β_1	B–	Impact in control group (non-seed farmers)
β_2	C–A	Difference between the two groups in base year before SVP scheme (in year 2014)
β_3	(D–B)–(C–A)	The difference in the impact of the programme over time between seed-farmers and non-seed farmers

Robustness Check

Assumption: DiD estimation require that intervention is unrelated to the outcome at the base year (allocation of treatment was not determined by outcome). Treatment and control groups have parallel trends in the outcome. The parallel trend assumption is important and requires that in the absence of treatment, the difference between the 'treatment' and 'control' group is constant over time. The visual inspection of profitability of seed-farmers and non-seed farmers (before the introduction of the SVP scheme between 2010 and 2013) shows that the profitability move in parallel and did not violate the parallel trend assumption. Hence, the DiD approach is suitable for assessing the impact and results will be robust.

3. Results and Discussion

3.1. Components and Institutional Framework under SVP

There are five components under SVP as mentioned below.

(a) Financial assistance for distribution of foundation seeds at 50 percent cost of the seed for production of quality seed to the seed producing farmers.

(b) Assistance was given to research stations and extension agencies to train the farmers on seed production technology with INR 15,000/- for a group of 50 to 150 farmers in the villages.

(c) To encourage farmers to develop storage capacity, subsidy was given to the extent of 33% of cost of seed storage bin (costing INR 10,000) for farmers for procuring seeds storage bin of 20 quintal capacity.
(d) Monitoring by the seed inspection team.
(e) Overseeing production process and monitoring of sales.
(f) Linking seed producing farmers to seed markets so that seed growers will get higher prices.

The entire institutional framework, activities conducted, and roles and responsibilities of each institute (institutes/agencies are marked in yellow) are mapped in Figure 4. There are multiple agencies involved in SVP with specific responsibilities. The synergies and active collaboration among these institutions are essential for functioning of the seed village in an appropriate way to achieve twin objectives of (i) increasing availability of quality seed at affordable prices to farmers and (ii) increase profitability of seed growing farmers. This paper will focus on the 2nd aspect, that is, the profitability of seed growing farmers, as only profitable farmers will continue to produce seed and cater to the needs of the neighbouring farmers by providing the quality seed. In the SVP, quality seed production was a joint effort by various organizations including government agricultural department, extension agencies, non-governmental organizations involved in SVP, research stations, and scientists. Every institute has its own roles and responsibilities in SVP. The SVP aimed at the production of quality seed and the removal of supply bottlenecks in seeds for farmers, replacing old seed varieties with new and high-yielding varieties, strengthening existing seed storage plants, constructing new ones, and procuring seed processing equipment and seed test laboratories. It was proposed to strengthen the seed supply chain by supplying breeder seed to State Farms to produce foundation seed, and the foundation seed will be supplied to seed-growing farmers for multiplication to produce certified and truthful seeds.

3.2. Profitability of Seed-Farmers

The main target variable to study the impact is profitability per acre of seed farmers. The profitability is calculated in two steps. First Gross farm income, also referred to as total revenue or gross farm receipts, is calculated as price of output multiplied by production volume sold. Profit is gross farm income minus all costs associated with production. In this paper, profitability is always measured per acre. It is expected that after the introduction of the SVP scheme, SVP seed-farmers are needed to produce certified or truthful seed out of foundation seed provided under the SVP scheme, and this will increase farm profitability as farmers get more price if they sold their production as seed when compared to selling the production as grain in the food market. Farmers generally sold their production in grain markets at ongoing market prices (generally lower) before the introduction of the SVP scheme. The management practices and cost of cultivation of seed and non-seed farmers are almost the same except that the seed-farmers needs to maintain isolation distance from other fields and also need to do rouging. Rouging refers to the act of identifying and removing plants with undesirable characteristics from agricultural fields. The rouging is done to maintain purity of the seed. Although there is extra supervision costs and also slight reduction in yields among seed-farmers, there is no significant difference in yields and costs between seed farmers and non-seed farmers. Yet the price received by seed farmers is generally 35 to 40% higher than the non-seed farmers. The impact of the SVP scheme is mainly derived from higher price realized by seed-farmers, as they are now selling their output as seed rather than grain. However, it is noted that all seed-farmers are not able to sell their entire output as seed, on average about 70−80% of the output was sold as seed, and the remaining was sold as grain at the ongoing market rates. After the introduction of the SVP scheme in 2014, there was a huge increase in profit for seed growing farmers (69.01%) compared to the profit before the SVP. However, profits of the non-seed farmers increased just by 5.63% after the SVP compared to before SVP (Figure 5). In the year 2019, seed farmers received an average INR 2414/quintal (40.23 USD), whereas non-seed farmers received Rs.1815/quintal (30.25 USD). Indicating seed-farmers sold at 33% higher price

than the non-seed farmers. The average profit received by seed-farmers after SVP (INR 37,254/acre = 532 USD) is significantly higher compared to non-seed producing farmers (Figure 6).

Figure 4. Different agencies involved and their roles in existing Seed Village Programme (authors drawing).

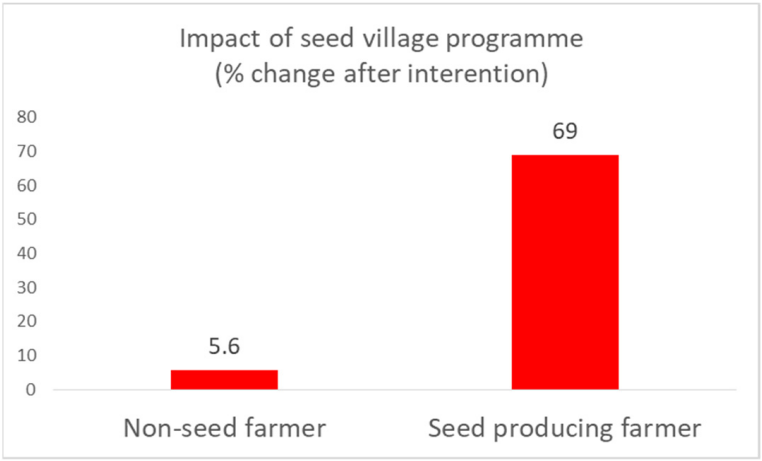

Figure 5. The impact of SVP on seed-farmers in terms of percent profit increase (percent change in profitability).

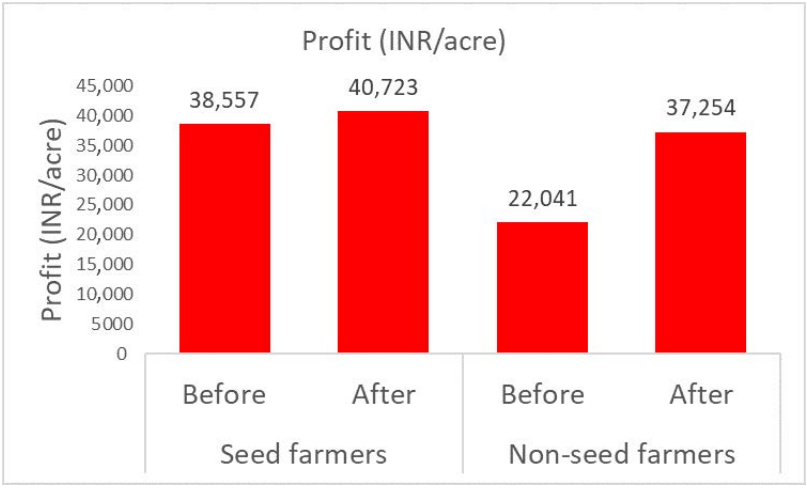

Figure 6. The profit/acre for seed farmers and non-seed farmers before and after seed village programme.

However, the sale price of the seed-farmers (INR 2414/quintal) is less than the price of the private seed companies' seeds (INR 4500/quintal). Due to their packaging and branding strategies, the private company seeds fetch higher price in the market. In general, private companies pricing strategy needs to be adjusted to recover higher seed production and marketing costs, as they incur extra transportation costs from seed production centres (which are far away) to seed use centers, as well as branding and packaging costs. Whereas seed-farmers under SVP sold seed within the village for neighbouring farmers with negligible transport, packaging, branding, and marketing expenses. With SVP, as expected, seed-farmers got higher profits, even though they sold their seed at lower prices compared to private companies. There is a significant unfulfilled demand that exists for seed produced under SVP.

Before SVP, the majority of farmers depended on private seed companies or government for paddy seed in the study areas. Some farmers who cannot afford to purchase the private seed were using their own farm-saved seeds. The government supplied seed is in short supply; many times there is also delay in supply of seed at the village level, and farmers have no option except to purchase from private seed companies at exorbitant prices or use their low quality own-farm saved seeds. Before SVP, farmer-to-farmer exchange of seed existed among farmers to some extent among smallholding farmers. However, in recent years farmers have tried to buy either from private companies or from the government, as they do not want to take a chance with low quality farm-saved seed, as they believe that quality of farm-saved seed is low. However, SVP gave an opportunity for farmers to purchase quality and reliable seed from their neighbouring seed farmers at a low price. Now, the Indian government is also encouraging SVP through tax benefits for seed processing, equipment, and other infrastructure.

In the difference-in-difference regression, the interaction term between time and intervention (β_3) (seed farmers = 1; non-seed farmers = 0) indicates the impact of SVP on profit per acre. It shows that in the case of seed farmers, profitability was higher by INR 13,032/acre(186 USD) compared to non-seed farmers (Table 4). The results show that, clearly SVP significantly benefited seed farmers.

Impact of SVP = Treatment profitability (After-before) – Control profitability (After-before) as per the Table 3.

$$= (37{,}245.3 - 22{,}041.7) - (407{,}28.3 - 38{,}557.4) = 13{,}032.1$$

Therefore, the impact of SVP on farmers profit/acre/season = INR 13,032 (USD 186).

The interaction between treatments and time (β_3) variable shows a positive and significant impact of INR 13,032.12/acre/season (186 USD) increase among seed farmers after the participation in the SVP scheme (Table 4). Therefore, the DiD regression results

are confirming the tabular results, which indicates that the seed farmers under SVP are clearly benefited under the programme with no additional costs.

Table 4. Difference-in-Difference Regression of profitability per acre.

Explanatary Variables	Unstandardized Coefficients	*t*-Test
(Constant)	38,557.4	5.2
Time (year) ($\beta_{1)}$	2170.8	4.06
Intervention (seed farmer = 1;non-seed farmer = 0) (β_2)	−16,515.7 *	−5.6
Interaction between time and intervention (β_3)	13,032.1 *	7.0
Adj. R^2	0.854	
Number of observations	105	

Note: Dependent variable = profit (INR/acre/season); * significant at 0.05 level of significant.

3.3. Determinant's of Increase in Farmer's Profitability

In addition to the SVP programme, farmers' profits are determined by various socio-economic conditions such as the age of the farmers, education level of the farmer, caste group (social group; socially disadvantaged groups like SC/STs have fewer connections with extension workers), area under seed production, irrigation facilities, and number of years of farming experience. In developing countries such as India, these characteristics are important. The description and expected signs of all the variables included in multiple regression analysis are given in Table 5. The results of the regression analysis are given in Table 6.

It is observed from Table 6, that the linear regression analysis gave the R^2 (Co-efficient of multiple determination) value of 0.716. Hence, it could be inferred that independent variables viz; Impact of SVP, age, education, seed, landholding, and farming experience put together contributed 71.6 percent of the total variation in profitability of the seed-farmers, leaving the rest to extraneous factors. The calculated 't' value for each of the partial regression coefficients ''b'' value was presented. According to 't'- test criterion, the multiple regression results reconfirming that DiD results that the SVP is effective in increasing seed farmers' profits. As expected, the age of the farmers is having negative influence on profitability, while education (indicator of human capital), years of experience (another indicator of crop specific agricultural knowledge), irrigation (indicator of physical capital), and area allocated for seed production (indicator for scale) are having positive influence on farmers' profits. These independent variables together had contributed most to variation (71.6%) in the profitability with respect to paddy crop.

Table 5. Explanatory variables description and Expected sign.

Variables	Description	Expected Sign	Mean	Std. Deviation
Dependent variable				
Profit per acre per season (INR)	Profit per acre per season (INR/acre)		30,656.9	7871.6
Indepdent variables				
Treatment (seed-farmer = 1; non-seed-farmer = 0)	Seed-farmers = 1; non-seed farmer = 0	+	0.67	0.47
Time (before = 0; after = 1)	After SVP observations are for year 2019; before SVP observations are for year 2014	+	0.50	0.50

Table 5. *Cont.*

Treatment (X) Time	Impact of SVP after accounting for initial difference in control and treatment	(+)	0.33	0.47
Age (years)	Age of the seed growing farmers (years)	−	41.4	7.9
Education (literate = 1; illiterate = 0)	If the respondents are illiterate = 0, literate = 1)	+	0.6	0.4
Caste (SC/ST = 1; else = 0)	If the farmer belong to SC/ST = 1 and other caste = 0). SC/ST communities are historically disadvantaged in India	+/−	0.70	0.39
Seed landholding (acre)	Landholding by the respondents for seed production (Acre)	+	4.08	2.78
Farming experience (years)	The experience possessed by the respondents in farming (years)	+	18.32	8.69
Irrigation (yes = 1; no = 0)	Irrigated area = 1; rainfed area = 0	+	0.60	0.30

Table 6. Linear Multiple Regression analysis with socio-economic profile characteristics of farmers on profitability (INR/acre/season).

Variable	Standardized Coefficients	t-Statistics
(constant)		7.12
Treatment (seed farmer = 1; non-seed farmer = 0)	−0.892	6.54
Time (before = 0; after = 1)	0.138	3.05
Impact of SVP (Treatment (X) time)	0.214 *	4.09
Age (years)	−0.192 *	−2.99
Education (literate = 1; illiterate = 0)	0.048 *	2.75
Caste (SC/ST = 1; else = 0)	0.016	0.60
Seed landholding (acre)	0.063 *	2.19
Farming experience (years)	0.149 *	2.35
Irrigation (yes = 1; no = 0)	0.033	1.25
R^2	0.761	
F value	123.5	

* Significant at 0.05 level of probability.

4. Lessons for Replication in Other States and Countries

The SVP is successful in the study area mainly due to the implementation of the programme with a multi-agency approach. In the SVP, the state government department of agriculture and the agricultural university scientists together with local communities are actively involved since the beginning of the programme from identification of seed villages, training of field staff, identification varieties and crops for seed multiplication and awareness and training programmes to motivate farmers to shift to seed production, supply of foundation seed for seed multiplication to the identified farmers, frequent visits for quality control and maintaining quality standards in collaboration with government department of agriculture is crucial. The local NGOs are active in creating awareness among the farmers about the importance of seed villages and exposing malpractices by private seed companies and advantages of farmer-to-farmer seed sales in terms of reduced costs and ensuring reliability of supply of quality seeds of locally suitable varieties. To

replicate the similar success stories of SVP, other states and countries have to (i) adopt multi-agency approach, (ii) maintain quality standards and build trust, (iii) involving NGOs for awareness programmes and community mobilization for seed banks, and (iv) active participation crop scientists in helping farmers in selection of crops and varieties for seed multiplication under SVP. The proposed model SVP is depicted in Figure 7, which highlights roles and responsibilities of various agencies such as government policies at macro-level, research institutions, agricultural extension machinery of department of agriculture, and seed farmers.

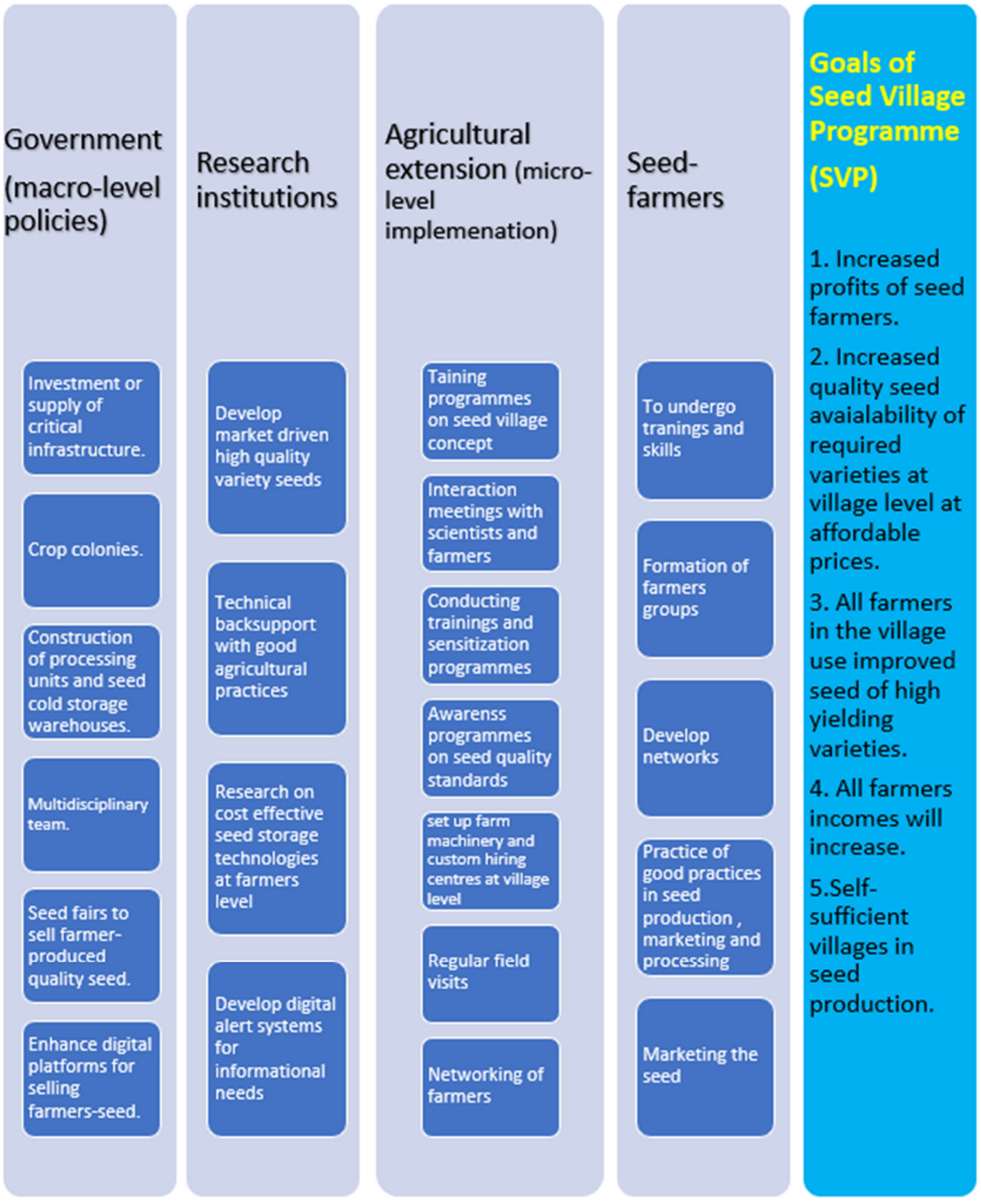

Figure 7. Proposed model Seed Village Programme institutional framework (Source: Focus group discussions).

5. Conclusions and Policy Suggestions

Indian government is implementing many agricultural development schemes for incentivising the farmers to adopt new technology. The paper examined the Seed Village Programme (SVP) implemented in India with a focus on whether the SVP increase seed growing farmers' profits, which may incentivize more farmers to grow crops for seed production purposes to increase availability of affordable seed in a timely manner. Due to SVP there was a significant increase in seed farmers' profits. The mean profit per acre after SVP (INR 37,254 = USD 532) was much higher than before-SVP (INR 22,041 = USD 314) among the seed growing farmers compared to non-seed growing farmers. After the introduction of the SVP in 2014 in India, there was about 69% increase in farmer's profit per acre for SVP seed-farmers compared to their profit before-SVP, and to non-seed farmers the increase is only 5.63% when compared to before-SVP. The results of the tabular analysis are confirmed with the Difference-in-Difference approach. The paper also analysed the various factors contributing to increase in seed farmers' profits in addition to involvement in the SVP by using multiple regression analysis. The independent variables viz; age education, area under seed production, irrigated area, and farming experience put together contributed 71.6 per cent of the total variation in profitability of seed farmers, leaving the rest to extraneous factors. The results clearly depicted that the seed-farmers are getting higher profit through seed production and sale of the produced seeds at higher prices under this scheme. This is because the scheme provides the foundation seeds of popular local varieties of paddy to the seed producing farmers (beneficiaries) with 50 percent subsidy along with support in terms of trainings and supervision by the departmental officials. The produced seed is having high demand in the same and nearby villages.

Before the SVP, farmers were used to selling paddy as a grain at market rate which is much below the price received when they sell their produce as seed. With this scheme, now farmers are able to produce certified seed at the same cost of cultivation and obtain maximum benefits. However, focus group interactions reveals that, still, some of the seed farmers under SVP are unable to sell seeds because of low quality of production, as well as their lack of technical skills and marketing skills. Accordingly, there was a need to improve the system through buy back arrangements with the government, whereby produced seed is procured by the government at premium prices and sold in locations where there is demand. There is a need for an integrated approach by involving multiple agencies such as local research stations, departments of agriculture, and government agencies with specific roles and responsibilities as shown in Figure 5. The government should formulate policies that help seed farmers in adopting good management practices in seed production, labeling, and marketing; in case seed farmers are unable to sell their seeds in local markets, the government should buy the product back. The government can sell this procured seed at subsidized prices for the farmers by identifying locations where there is high demand for the particular variety of the seed. This can be a two-way beneficial strategy as it will not only help seed farmers to increase their profits; it will also ensure availability and use of the quality seed of desirable variety across the country. To ensure this, there is a need for enhanced investments in seed processing and storage infrastructure at village level and also regional level by forming regional seed hubs with better infrastructure by constructing post-harvest processing, storage facilities. Further, these seed villages are incentivized through zero taxation, establishment of seed processing units on subsided rates, etc. With the proposed changes in the seed village scheme, this scheme is capable of further enhancing seed availability at farmer and village level, in turn this will increase farmers' incomes across the country. The effective implementation of SVP raised seed farmers' profitability by 65% in the project area, and it also improved the quality of seed available within and nearby villages, which increased the seed replacement rate and average yields at village level even in the remotest parts of the country and reduced dependence on the government produced seeds, which are suffering from non-availability of seeds in time and also high costs due to logistic and transport costs from reaching seed producing centres to the villages.

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