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Pradhan Mantri Kisan Samman Nidhi (PM-KISAN) and the Adoption of Modern Agricultural Technologies

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Abstract

Pradhan Mantri Kisan Samman Nidhi (PM-KISAN) scheme aims to provide income support to farmers for easing their liquidity needs to facilitate timely access to inputs. This study based on 1406 farmers of Uttar Pradesh (UP), using binary choice model, examines the targeting accuracy and correlates of spending pattern of farmers. Triple difference with matching (TDM) estimators are used to identify the differential impact of PM-KISAN on Krishi Vigyan Kendra (KVK) beneficiaries. Results show that the scheme reached to one-third farmers in first three months itself of its implementation. Moreover, the study finds no selection bias based on social, economic and agricultural characteristics. The scheme has significantly helped those who are relatively more dependent on agriculture and have poor access to credit. Moreover, scheme has significantly stimulated the KVK's impact for the adoption of modern cultivars.

Keywords: Adoption, Cash transfer, Credit, Krishi Vigyan Kendra, Probit, Triple Difference with Matching

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1. INTRODUCTION

Adoption of modern technologies is one of the most promising strategies to increase farm incomes. Among the constraints in technology adoption, the most prominent ones are: lack of information and credit.[2] Banerjee et al. (2017) also show that access to formal credit significantly increased the investment in existing small businesses. In India, more than half of the farming households do not have access to formal credit. In such a situation, the introduction of a cash transfer scheme (Pradhan Mantri Kisan Samman Nidhi, PM-KISAN) in December 2018 to ease liquidity constraints of farmers for procuring inputs is quite salient. While the scheme is pitched as a general cash transfer for the farmers, it's role in the adoption of modern technologies remains an important research question that this paper addresses.

In general, effects of cash transfers are well analyzed on outcomes such as household consumption, educational attainment, and health (Gertler, 2004; Fiszbein & Schady, 2009, Adato & Bassett, 2009). However, the impacts of cash transfers on the agriculture sector are comparatively less studied including importantly its impact on technology adoption.[3] In this context, PM Kisan presents a natural experiment to assess the effects of cash transfers. For any intervention to provide long-term impacts there must be some investments in productive activity. In this context, Gertler et al. (2006) and Handa et al. (2018) show that a small monthly cash transfers may lead to increased consumption even after beneficiaries left the program. Haushofer and Shapiro (2016) show that a large unconditional transfer to poor households may increase future earnings by encouraging investments in livestock. Sadoulet et al. (2001) show multiplier effect of cash transfers.[4] All these studies point towards a productive investment in the short-run lead to sustained long-term impacts. How does PM-KISAN fare in this context?

Conceptually, cash transfer can encourage farmers to spend the amount in the productive activities for several reasons.[5] First, it may help in easing incumbent credit and liquidity constraint in purchasing agricultural inputs, extremely pertinent in India where more than 50% farmers rely on informal credit and one-fifth farmers purchase inputs on credit.[6] Adesina (1996) finds that access to credit encourages fertilizer use. Secondly, cash transfer increases the net income of farmers and, thus in turn may enhance farmer's risks taking capacity leading to undertaking riskier but comparatively productive investments. Yet, cash transfer beneficiaries' investment in the

productive activities may be limited in developing countries.[7] We attempt to capture this issue by examining heterogeneity in impact estimates.

Specifically, we ask whether farmers who have more information on investments related to productive activities respond differentially to direct cash transfer (DCT). It is likely that DCT would increase investment of comparatively informed farmers first. Studying heterogeneity in impact estimates of DCT in agriculture sector contributes to a small but growing literature on the heterogeneous impact of DCT.[8]

There are two main objectives of the study. The first is to analyze the implementation of PM-KISAN by examining its coverage, and its targeting accuracy, also examining the spending patterns of the beneficiary farmers to assess the alignment of PM-KISAN with its objectives. Second, it examines PM-KISAN's role in stimulating the adoption of modern cultivars for paddy cultivation among comparatively informed farmers defined in this study as Krishi Vigyan Kendra (KVK) beneficiaries.[9] Our analysis is based on the primary survey of 1406 farmers in Uttar Pradesh, India. Binary choice model is used to study the targeting accuracy and correlates of spending. Differential impact of the scheme is examined by the application of triple difference with matching (TDM) procedure.

Our implementation and coverage result reveals: a) the scheme reached one-third farmers in first three months itself of its implementation, b) there seems to be no evidence of selection bias in choosing PM-KISAN beneficiaries based on attributes s like caste and land size, and c) the spending patterns show that farmers more dependent on agriculture, and with relatively poorer access to credit are more likely to spend the DCT in the agriculture sector. Finally, the paper provides evidence that the scheme has augmented the KVK's impact in the adoption of modern cultivars. Note that the outcome assessed pertains simply to the choice of seed type, and not the final outcomes i.e. agricultural productivity and farmer's incomes, as the scheme is only recently implemented.[10]

This paper makes the following contributions. First, it is the incipient study to evaluate the implementation of PM-Kisan scheme, and its association with spending patterns. Second, it captures the differential impact of cash transfers. Most importantly, it studies the impacts of cash transfers on the adoption of technologies that has received scant attention in the literature.[11].

Hence, the paper contributes to the literature that explores the mechanisms for income enhancement consequently to cash transfers.[12]

The remainder of the paper is organized as follows : section 2 presents the background about the PM-KISAN and KVKs, respectively; section 3 describes the study area, sampling design, and sample profile of farmers; section 4 presents the descriptive results for PM-KISAN and its implementation, the benefits received by farmers through KVKs, and adoption patterns for paddy cultivars; section 5 begins with the framework to study the role of DCT in the adoption of modern technologies, and formulates the triple difference specification to estimate the differential impact of scheme; section 6 presents the results; and section 7 concludes.

2. Background

PM-KISAN

Pradhan Mantri Kisan Samman Nidhi (PM-KISAN), a central government funded scheme launched in December 2018 to facilitate farmers in purchasing various agricultural inputs. The scheme started from February 2019. It provides to each eligible farmer's family Rs 6000 per annum in three installments of Rs 2000 each.[13] Initially, farmers with less than 2 hectares of land were eligible;[14] Subsequently, from June 2019 it was extended to all farmers i.e. 140 million farmers. Money is transferred directly to beneficiary's bank account.[15] According to government data, the scheme reached 50 million farmers by 15th September 2019.[16] Highest number of beneficiaries comes from Uttar Pradesh (28%, 17 million farmers) followed by Maharashtra (10%), Andhra Pradesh (9%), and Gujarat (7%).

Krishi Vigyan Kendra (KVK)

KVK was launched by ICAR in 1974 in Pondicherry district with the main goal to provide institutional support to agriculture and allied sectors with location- specific technologies through assessment, refinement, and demonstrations. KVKs are now available in every district of the country.[17] KVKs are financed fully by Indian Council of Agricultural Research (ICAR), government of India.[18] The mandate of KVKs is to (a) conduct "On-Farm Testing" (OFT) for the assessment of agricultural technologies across different farming systems, (b) carry out Front Line Demonstration (FLDs) to demonstrate the implementation of frontier technologies, (c) increase

the capacity development of farmers and extension workers, (d) work as a knowledge and resource center for the agricultural economy of the district.

The total budget of KVKs in India is only Rs 686 crore in 2016-17. Gulati et al. (2018) show that India spends 0.7% of agriculture GDP on research, education, extension and training. Out of this, 0.54% goes for agriculture research and education, and a meagre 0.16% goes to extension and trainings. Varshney et al. (2019) show that KVKs have large huge local spillovers, and KVK beneficiaries are more informed about frontier technologies that results in greater adoption of the technologies.

3. Data

We conducted a primary survey in Uttar Pradesh (UP). With more than 200 million people, each farmer accounts for less than one hectare land. The major crops grown in the state are wheat (41%), paddy (24%), sugarcane (9%), pearl millet (4%), and maize (3%).[19] Wheat in UP is sown mainly in November in the rabi season, and the scheme was launched in December 2018 where the majority of cultivar choice decisions were already taken prior to the introduction of the scheme. In paddy, sowing starts in June and July i.e. after the introduction of the scheme. Therefore, we consider paddy for analysis.

Our sample comes from three AEZs of UP, namely, western plain, mid-western plain, and north-eastern plain. The survey was carried out between May to July 2019 by IFPRI, the South Asia Regional Office, New Delhi, and supported by ICAR. We include 9 districts covering 10 KVKs of UP. Five districts were selected from north-eastern plain, 3 from western plain, and 1 from mid-western plain. We selected villages randomly by stratifying them into two categories: KVK and non-KVK villages, former where any type of intervention, such as FLDs or OFTs or training programs were conducted by KVKs. To select households, the complete household listing was compiled for each selected village.

The four quintiles based on total cultivable land were formed. From each quintile, five households were randomly selected. The total sample of size 1406 includes wheat, paddy (723) and sugarcane farmers. Our household module includes household, demographic, area, and production of crops for the reference year 2017–2018, and the household's social mapping in the village.[20]

a) *PM-KISAN*: It captures the farmers' access to PM-KISAN scheme and how they spend the benefits received under the scheme. Our survey can capture the disbursal of the benefits for first three months of implementation due to parliamentary elections in UP.
b) *KVK:* It captures the access of farmers' to FLDs, OFTs, and training programs conducted by KVKs about frontier agriculture technologies. Our survey considers only those villages where KVKs have conducted intervention in 2016-17 and 2017-18, but not for 2015-16 or before.
c) *Adoption*: It includes a recall-based information on the adoption of paddy cultivars from 2014-15 to 2019-20.

Table 1 summarizes the timeline of KVK and PM-KISAN interventions across KVK and non-KVK villages.[21] KVK villages had intervention starting from 2016-17 till 2019-20. Note that we have assigned the villages as KVK's intervention villages in 2019-20 where KVK visited in either 2016-17 or 2017-18 or 2018-19. It is done because once farmers get benefited from KVKs they are likely to get regular updates on new technologies from KVKs. In case of non-KVK villages, there was no intervention in either period. Regarding PM-KISAN, in both sets of villages PM-KISAN is implemented only in 2018-19 and 2019-20. The time line of events forms the basis of identification strategy that we discuss below in methodology.

Table 2 present sample profile of all farmers (including wheat, paddy and sugarcane cultivators). Overall, three-fourth farmers are dependent on agriculture and majority are small and marginal land holders and they have limited access to formal credit.

4. Descriptive Results

PM-KISAN and its Implementation

Figure 1 presents the percentage of farmers who received the benefits from PM-KISAN scheme till 30th April 2019 i.e. within 3 months of implementation.[22] Our result shows that 30% farmers received the benefits.[23] Before the implementation, the concerns were raised about the selection bias in choosing PM-KISAN beneficiaries. We run a probit model to test for factors associated with selection.[24]

Table 3 presents the results, 'without' and 'with' district fixed effects, respectively. Coefficients of social, economic, and agricultural characteristics are all insignificant, with an exception of male dummy.[25] Further, the variables (such as post office) that captures the farmer's

access to formal system are correlated with the likelihood of receiving PM-KISAN benefits. Further, the result shows that 93% non-beneficiary farmers have already applied to the scheme depicting awareness.[26]

Figure 1 presents the distribution of farmers who received one installment or two installments, 60% received one installment while 40% received two installments. The spending pattern of PM-KISAN beneficiaries is presented in figure 2, disaggregated by installments. Our result shows that 52% of those who received first installment spent it on agriculture and 26% on consumption, 7% on education and health, and the remaining 16% on other incidental expenses (such as festival, marriage). Second installment recipient spent 39% on consumption, followed by agriculture (23%) and education and medical (19%). Given a significant spending in the agriculture sector, we explore if this easing of liquidity constraints has implications for the adoption of modern technologies.[27]

Land size, agriculture dependency, access to banks, and access to KVKs are correlated with the spending the DCT on agriculture. PM-KISAN has likely eased credit and liquidity constraints for farmers. Also, farmers with better access to KVKs are more likely to spend on agriculture. Figure 3 presents the timing of installments along with the spending patterns in figure 2. Farmer's receiving PM-KISAN benefits in agricultural peak season are more likely to spend in agriculture, in off season they are more likely to spend on consumption.

Krishi Vigyan Kendra and Its Beneficiaries

Figure 4 estimates the KVK beneficiaries.[28] Survey data reveals that 36% farmers benefited from KVKs through FLDs (27%) or OFTs (10%) and training programs (26%).

Adoption of Paddy Cultivars

Figure 5 presents the adoption of paddy cultivars for the period 2015-16 and 2019-20.[29] We define modern cultivars as those which were released post. Then, we compare the adoption for the period 2015-16 and 2019-20.[30] Our result reveals that the adoption of modern paddy cultivars has gone up from 53% to 57%. We also present the cultivar wise adoption patterns for the period 2015-16 and 2019-20. By cultivars, *Arize-6444* a hybrid cultivar (modern) shows a significant increase in

its adoption from 5.1% to 7.5%. *BPT-5204* (old) saw a significant decline from 18.3 to 12%. For *PB-1509 (modern)*, the adoption has gone down from 13.6 to 12.5%. For *Pusa-1121 (modern)*, the result reveal that adoption has increased significantly from 8 to 11.3%. For *Sarju-52* (old), the result reveals that adoption has decreased significantly from 13 to 8.9%. For *Gorakhnath-509 (modern)*, the adoption has increased from 1.5% to 6.1% For *Swarna-Sub 1 (modern)*, the adoption has gone up from 0.6 to 1.5%. Next section formulates the identification strategy to pin-down the role of PM-KISAN and KVKs (if any) in the adoption of modern cultivars.

5. Empirical Strategy

Conceptual Framework

PM-KISAN does not impose any conditionality on farmers for receiving the benefits, and farmers are free to spend anywhere. However, the intended objective of the scheme is to augment farmer's income, and to ease credit and liquidity constraints for farmers to invest in productive activities such as procuring agricultural inputs.

In adoption of technology, literature clearly points out that the availability of credit helps in the adoption of modern technologies.[31].[32] The cash transfer may also increase the net income of farmers and, hence raise risk taking ability of farmers. Zimmermann (2015) tests that with an increase in income consequently to workfare programs may shift farmer's cropping choices toward riskier but higher return crops. Finally, cash transfer may also help in getting access to crop insurance as a risk coping mechanism which in turn have implications for adoption.

To capture the impact of cash transfers, the outcome indicators can be classified into three; first, the primary outcome that captures changes in overall agricultural spending/investments, second, the intermediate outcome such as changes in investment in specific inputs such as seed, fertilizers, pesticides, labour, irrigation and third, the final outcomes such as changes in production, yield and income. We are not able to capture the final outcomes due to data constraints.

Identification Strategy

Our identification strategy exploits the availability of non-beneficiaries of PM-KISAN, non-universal coverage of KVKs, and the recall-based panel on paddy cultivars for pre- and post-intervention years (2015-16 and 2019-20). Although, PM-KISAN scheme is a universal scheme it reached 30% farmers till April 2019 that enables the counterfactual group. At the same time, the decision on the type of cultivar (modern or old) farmer would choose is taken subsequently in the month of May and June of 2019. Therefore, the study captures the immediate impact of PM-

KISAN. In case of KVK, its non-universal coverage enables the availability of counterfactual. With pre- and post-intervention information on outcome variable along with the availability of counterfactuals for both interventions PM-KISAN and KVK, the identification of differential impact of PM-KISAN and KVK is possible in triple difference (TD) framework.

TD approach identifies the differential impact if it satisfies the parallel trends assumption. If confounding factors are time variant then parallel trends assumption may not be satisfied. One of the most prominent reasons is that the two groups of farmers are very different from each other in terms of characteristics (social, economic, and agricultural), and may grow with differential time trends. Table 5 confirms this: the unmatched characteristics of treatment and control group reveals that they are different in terms of plot characteristics such as soil fertility, irrigation source, and the location of institutions such as output market, agriculture extension department, bank, KVK.

To address this concern, we employ triple difference with matching (TDM) where we match each treated farmer with a weighted combination of control farmers such that the predicted probability of receiving the benefits is similar in both.[33] We then compare the outcomes for treatment with the weighted average of outcomes across matched control groups.[34]. This ensures comparing like with like in terms of the likelihood of being treated and makes it more likely that the identifying assumption holds. Table 5 reveals that matching KVK beneficiary with non-beneficiary farmers results in insignificant difference in social, economic, agricultural, plot and institutional characteristics.

Implementing the matching procedure essentially involves constructing the matching weights. This is done in the following steps; first, we define a common support region by dropping those beneficiary farmers whose propensity score is higher than the maximum or less than the minimum of non-beneficiary farmers, and vice versa. Then, we derive farmer level matching weights using a kernel matching procedure.[35]

We estimate the following triple difference specification.

$$Y_{idkt} = \gamma_0 + \gamma_1 PMK_{idkt} + \gamma_2 TIME_t + \gamma_3 KVKB_{idkt} +$$
$$+\gamma_4(PMK_{idkt} * KVKB_{idkt}) + \gamma_5(KVKB_{idkt} * TIME_t) + \gamma_6(PMK_{idkt} * TIME_t)$$
$$+ \gamma_7(PMK_{idkt} * TIME_t * KVKB_{idkt}) + \{\eta_k\} + \varepsilon_{idkt}$$

(Eq. 1)

where i stands for individual farmer, d for district, k for agro-ecological region, and t for year (either 2019-20 or 2015-16). Y is the adoption of modern paddy cultivar, and takes value 1 if farmer adopts modern cultivar and 0 otherwise. PMK is a dummy variable for being PM-KISAN beneficiary, $KVKB$ is a dummy variable for being KVK beneficiary and 0 otherwise, and $TIME$ is a dummy variable for 2019-20. $\{\eta_k\}$ represents agro-ecological region fixed effects where it takes value 1 for eastern region and 0 otherwise. ε is the error term.

Estimating the specification 1 with matching weights in the common support region makes γ_7 the triple interaction term i.e. triple difference with matching (TDM) estimator. The coefficient γ_7 can be interpreted as the differential impact of the PM-KISAN on KVK vis-à-vis non-KVK beneficiaries. Other coefficient γ_6 is interpreted as the impact of PM-KISAN on non-KVK beneficiaries. And γ_5 as the impact of KVK on non-PM-KISAN beneficiaries.

To test for identifying assumption, we test the assumption of parallel trends for the matched sample by looking at data from pre-PM-KISAN and pre-KVK years (2014-15 and 2015-16) and verifying that it holds during this period.

6. Econometric Results

Table 6 presents differential impact of PM-KISAN and KVK on the adoption of modern paddy cultivar. KVK beneficiaries saw 36 percentage point higher adoption of modern cultivar as compared to non-KVK beneficiaries. The result is consistent with the adoption literature that talks about the complimentary roles of credit and information in the adoption of modern technologies.[36] In the context of conditional cash transfer (PROCAMPO) in Mexico, Sadoulet et al. (2001) find that technical assistance to farmers raised the multiplier effect of conditional cash transfer through returns in productive assets.

We may also interpret the coefficient γ_7 as the impact of KVK on PM-KISAN vis-à-vis non-PM-KISAN beneficiaries. The result reveals that PM-KISAN beneficiaries saw 36 p.p. higher adoption of modern technologies when accessing KVKs. It reveals that the presence of PM-KISAN have magnification effects on KVK.

As noted earlier, the coverage of KVKs is not universal. Our descriptive result for UP reveals that only one-third farmers in UP have access to KVKs. At the all India level, Kumar et al.

(2019) note that there are less than 10% farmers have direct access to KVKs. Therefore, it is important to look at the impact on non-KVK beneficiaries which is given by the coefficient γ_6. Our result shows an insignificant impact of PM-KISAN on non-KVK beneficiaries. Clearly, emphasizing the role of both credit and information for the adoption of modern technologies. Thus, the magnifying impact of PM-KISAN can be realized by expanding the scope of public sector programs such as KVKs and Million farmer schools (MFS) that improves farmers' awareness about frontier technologies.[37]

We also present the coefficient γ_5 in equation 1 which is interpreted as the impact of KVK on non-PM-KISAN beneficiaries. There is a positive and significant (32 p.p) impact of KVK on non-PM-KISAN beneficiaries for the adoption of paddy cultivars. Recall that there are 70% farmers are non-PM KISAN beneficiaries in our sample. Positive impact of KVKs is also documented in a study conducted for all farmers for modern wheat cultivars in the same state.[38] Internationally, Kondylis et al (2017) also show the positive impact of lab-to-farm extension design (similar to KVKs) for the adoption of modern technologies.

To sum up, the result reveals that PM-KISAN is significantly stimulating the impact of KVKs for the adoption of modern cultivars by easing both cash and liquidity constraints for the farmers. Lessons learnt from here suggests that the agricultural extension system (e.g. KVKs) along with PM-KISAN can serve as a significant pathway to encourage farmers for making productive investments. Gertler et al. (2012) also show that rural Mexican households saved part of their cash transfers in productive agricultural assets such as livestock's and in turn saw an increase in agricultural income (10%). Conditional cash transfer (PROCAMPO) in Mexico once gets complemented with the technical assistance can result in to the multiplier of 2.5.[39]

Robustness Checks

As tests of robustness, we i) test for identification assumption, ii) choice of definition of outcomes, iii) choice of matching algorithms, and iv) treatment definition of KVK. For identification assumption, we test for the parallel trends for the treatment and control group. We assume 2014-15 as the baseline year and 2015-16 as the end line year. 2014-15 and 2015-16 experienced no intervention either related to KVK or for PM-KISAN. Therefore, we run specification 1 to test for

the parallel trend assumption for the differential impact of PM-KISAN and KVK. Table 6, column 6 shows that the coefficient γ_5 , γ_6 and γ_7 are insignificant. Hence, identifying assumption of no systematic trend in the treatment and control group holds.

With regard to the choice of definition of outcomes, we also consider the variety age,[40] and result broadly shows a similar pattern of result in terms of sign of the coefficient.

In terms of different matching algorithm, the results are robust to nearest neighbor and radius matching methods.[41] With regard to treatment definition for KVKs, we also define the treatment as those farmers who resides in the KVK villages (instead of KVK beneficiaries) and those who are not resident in the KVK village as the control group. The result reveals lower magnitudes compared to when we define beneficiaries as the treatment group.[42]

7. Conclusions and Policy Implications

This paper had two major objectives. The first is to examine the implementation of the PM-KISAN scheme, and to explore spending patterns of beneficiaries. Next, the study examines the role of PM-KISAN in stimulating the impact of Krishi Vigyan Kendra (KVK) for the adoption of modern cultivars.

We find that the scheme has reached 30% farmers within three months of its implementation. The paper also test for selection in choosing PM-KISAN beneficiaries. Our result shows no evidence of selection in terms of social, economic, and agricultural characteristics of farmer. Therefore, the concerns raised about the PM-KISAN scheme and its implementation is well addressed in UP, to begin with. Banking infrastructure created through Pradhan Mantri Jan Dhan Yojana (PMJDY),[43] and the timely preparation of farmer's database by the state government played a key role in the appropriate implementation of PM-KISAN. However, it is still early days and there is a need of more evaluations across states with complete rollout.

Our findings on utility of income support suggests that the spending patterns of farmers are well aligned with the objectives of the scheme. Evidence suggests that more than 50% farmers who received the benefits in agricultural peak season have spent their money in the agriculture sector, and more than 60% farmers who received the money in the off season spent the money on consumption, education and medical purposes. Moreover, the result shows that spending pattern

of farmers in the agriculture sector are correlated with the farmer's dependency on the agricultural sector, farm size, and to the poor access to credit facilities.

Our study establishes the evidence that the PM-KISAN has significantly stimulated the KVK's impact for the adoption of modern paddy cultivars. In particular, the study shows that PM-KISAN has increased 36 p.p. adoption of modern cultivars for KVK beneficiaries as compared to the non-KVK beneficiaries. Lessons learnt from this research suggests that the agricultural extension system (e.g. KVKs) along with PM-KISAN can serve to encourage farmers for making productive investments in agriculture.

If farmers invest some part of its cash transfer in productive investments, it can have implications for permanent increase in income in longer term.[44] From policy perspective, the study establishes the evidence on the significant role of PM-KISAN in stimulating the adoption of modern technologies through KVKs, which in turn, provides a pathway to encourage farmers for making productive investments in the agriculture sector. Therefore, the PM-KISAN shows a potential to break the cycle of intergenerational poverty and low income of farmers through investment in modern technology.

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Tables and Figures

Table 1: Summary of timeline of event in sample villages

Year	Intervention : KVK		Intervention : PM-KISAN	
	KVK villages	Non-KVK villages	KVK villages	Non-KVK villages
2014-15	No	No	No	No
2015-16	No	No	No	No
2016-17	Yes	No	No	No
2017-18	Yes	No	No	No
2018-19	Yes	No	Yes	Yes
2019-20	Yes	No	Yes	Yes

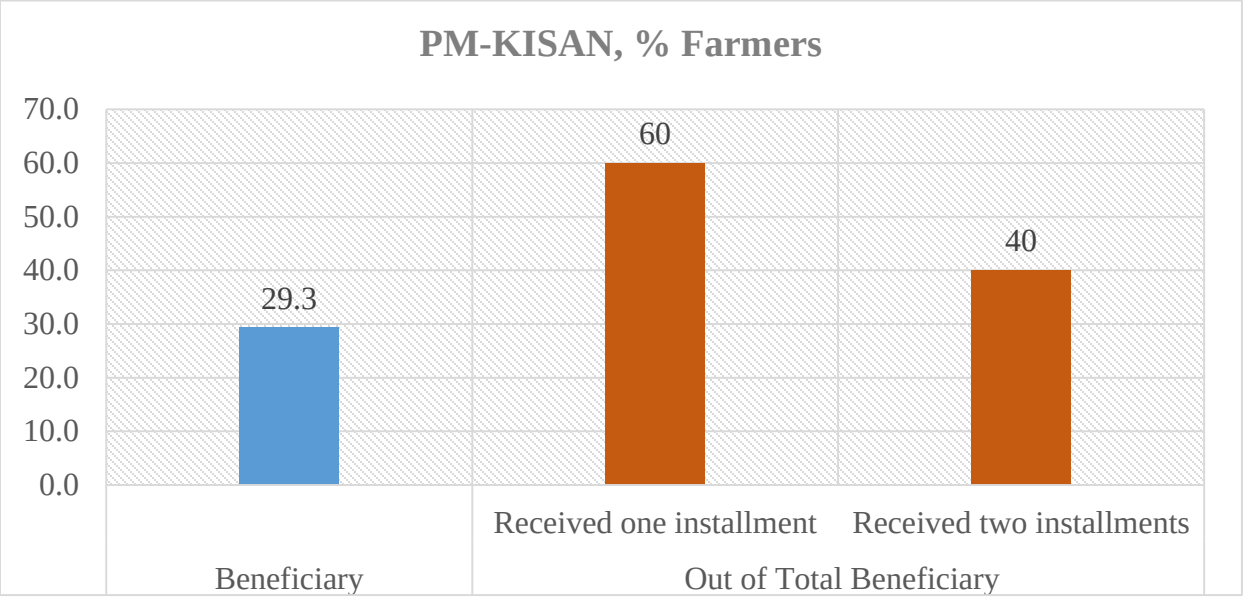
Source: ICAR-IFPRI Survey, 2019
Note: PM-KISAN is implemented in February 2019. The year 2014-15 starts from July 2014 and ends in June 2015.

Table 2: Sample profile of farmers, Uttar Pradesh

	Statistics			
	Mean	Std. Deviation	Minimum	Maximum
Male (Yes=1)	0.94	0.24	0	1
Age (Year)	42	12	18	78
Age square (Year)	1921	1065	324	6084
Education (Year)	6.92	4.74	0	22
Schedule caste/tribe (Yes=1)	0.17	0.37	0	1
Hindu (Yes=1)	0.91	0.29	0	1
Cultivation (Yes=1)	0.70	0.46	0	1
Other agriculture activity (Yes=1)	0.20	0.40	0	1
Non-farm self-employment/salaried (Yes=1)	0.08	0.27	0	1
Other includes remittances/pension (Yes=1)	0.02	0.13	0	1
Below poverty line (Yes=1)	0.39	0.49	0	1
Land owned (hectare)	0.51	0.62	0	8
Household Size (#)	5.63	2.40	1	25
Members involved in farming (#)	2.32	1.29	1	15
Kisan credit card (Yes=1)	0.43	0.50	0	1
Soil health card (Yes=1)	0.14	0.34	0	1
Crop insurance (Yes=1)	0.40	0.49	0	1
Number of observations	1406			

Source: ICAR-IFPRI Survey, 2019
Note: Survey was carried out between May to July 2019.

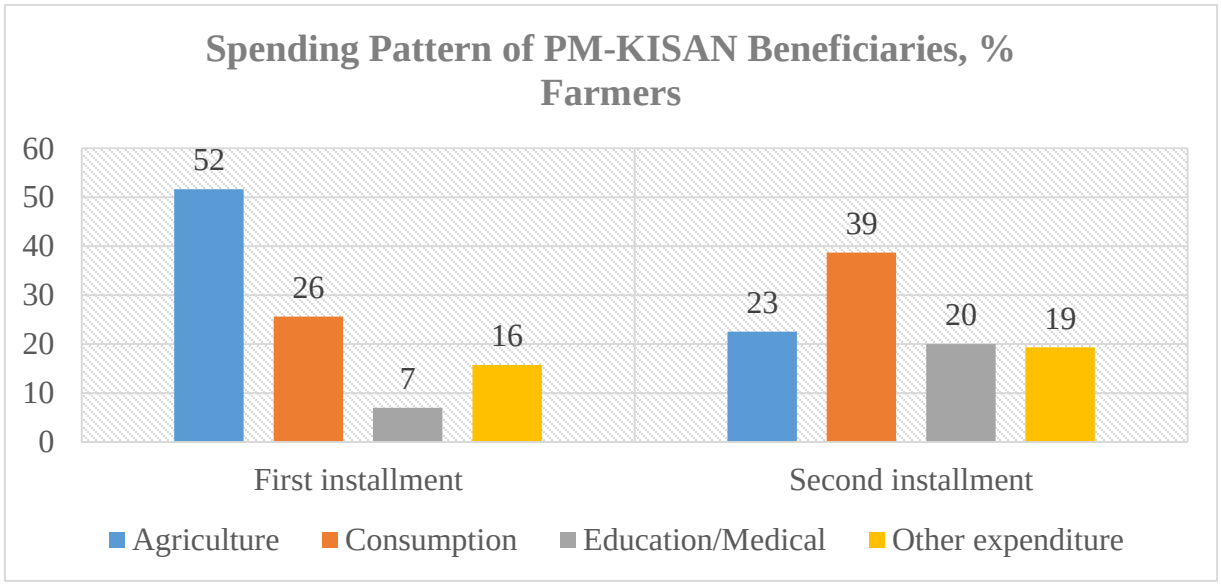
Figure 1: Farmers benefited from PM-KISAN, % farmers



Source: ICAR-IFPRI Survey, 2019

Notes: Data includes only those beneficiaries who received PM-KISAN benefits in the first three months of its implementation.

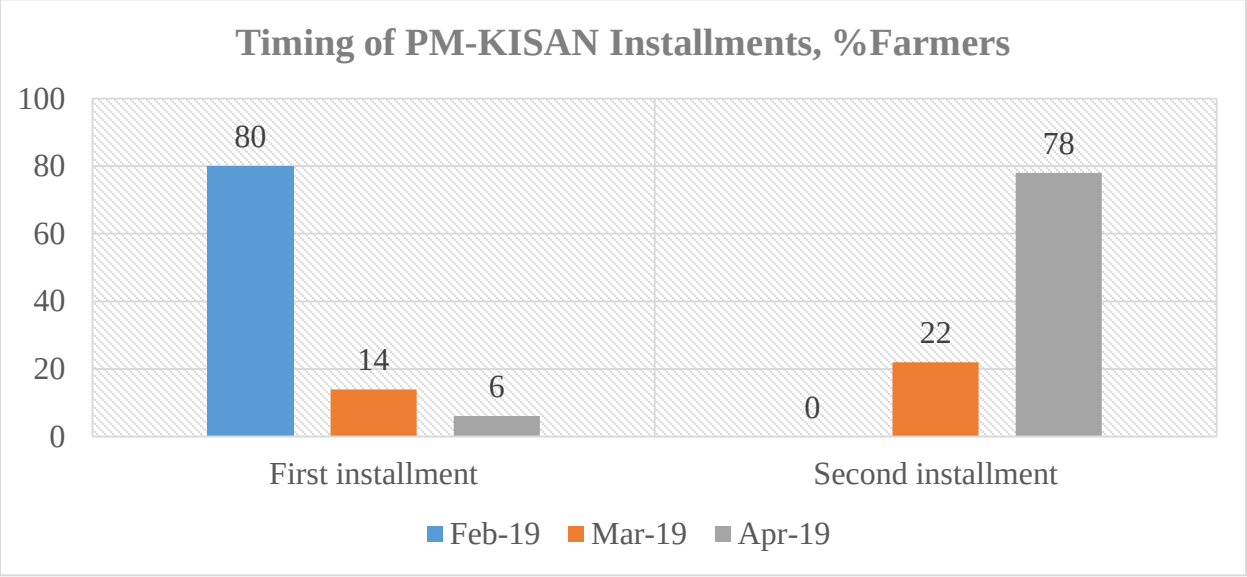
Figure 2: Spending pattern of PM-KISAN beneficiaries, % Farmers



Source: ICAR-IFPRI Survey, 2019

Note: Other expenditure includes incidental expenses such as festival, marriages etc

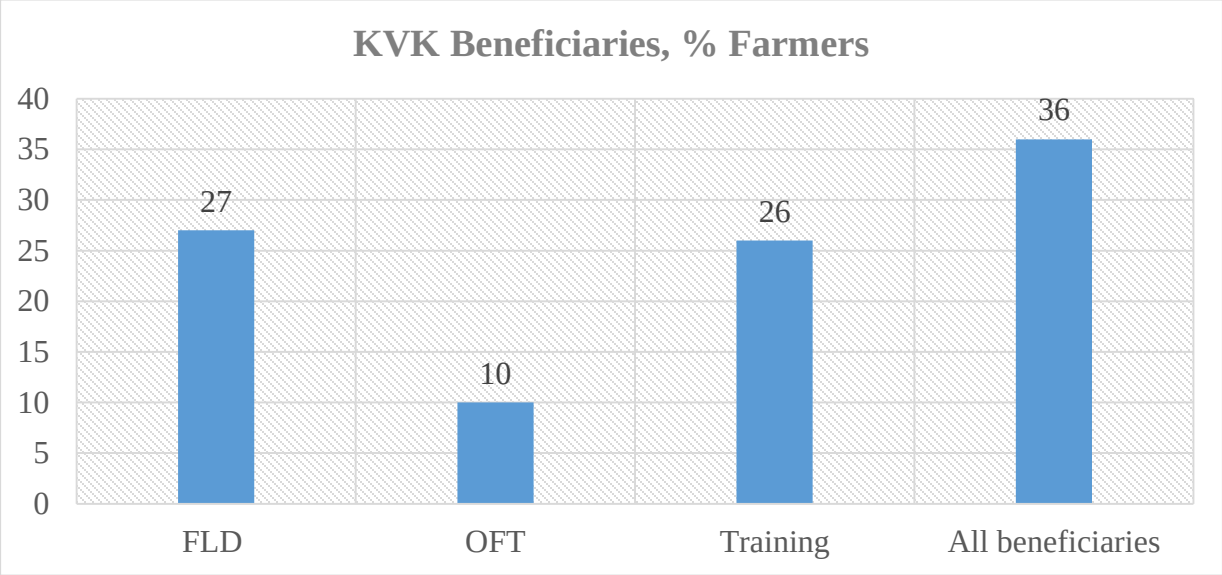
Figure 3: Timing of PM-KISAN installments, % farmers



Source: ICAR-IFPRI Survey, 2019

Note: PM-KISAN provides total financial benefits for each eligible farmer's family of Rs 6000 per annum in three installments of Rs 2000 each. Third installment is not disbursed by the time of primary survey.

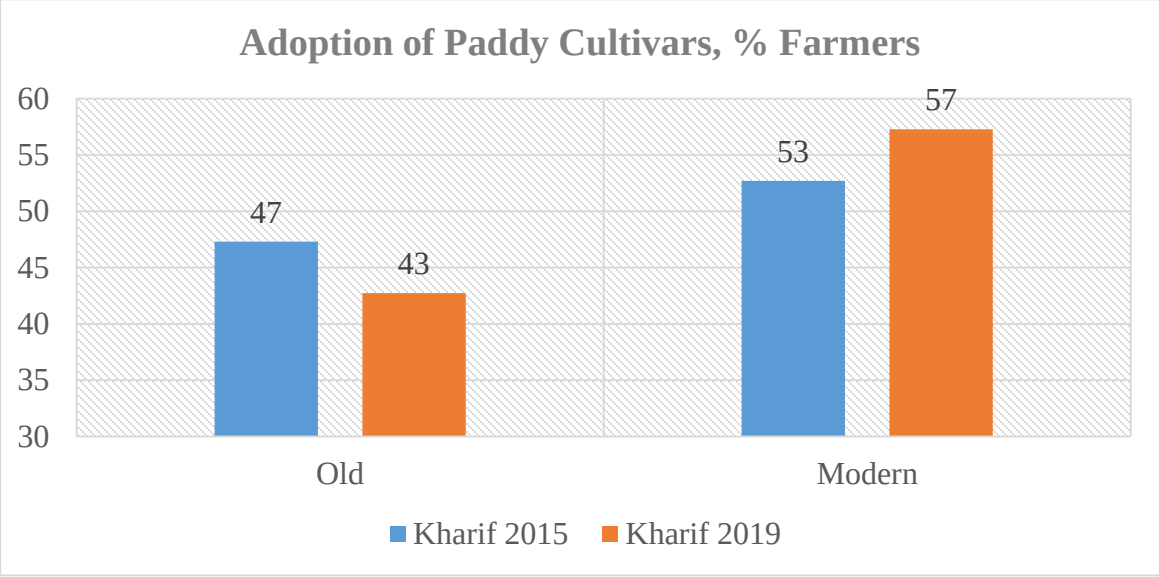
Figure 4: Krishi Vigyan Kendra (KVK), beneficiaries, % Farmers



Source: ICAR-IFPRI Survey, 2019

Notes: KVK Beneficiaries includes both direct and indirect beneficiaries. Indirect beneficiaries includes those by their own self-curiosity gets benefit in terms of knowledge of frontier technologies through KVKs and those who are benefited from KVK beneficiaries being in their social network. KVKs carry out FLDs to demonstrate the implementation of frontier technologies. "On-Farm Testing" (OFT) for the assessment of agricultural technologies across different farming systems, and also increase the capacity development of farmers and extension workers to create awareness about frontier technologies.

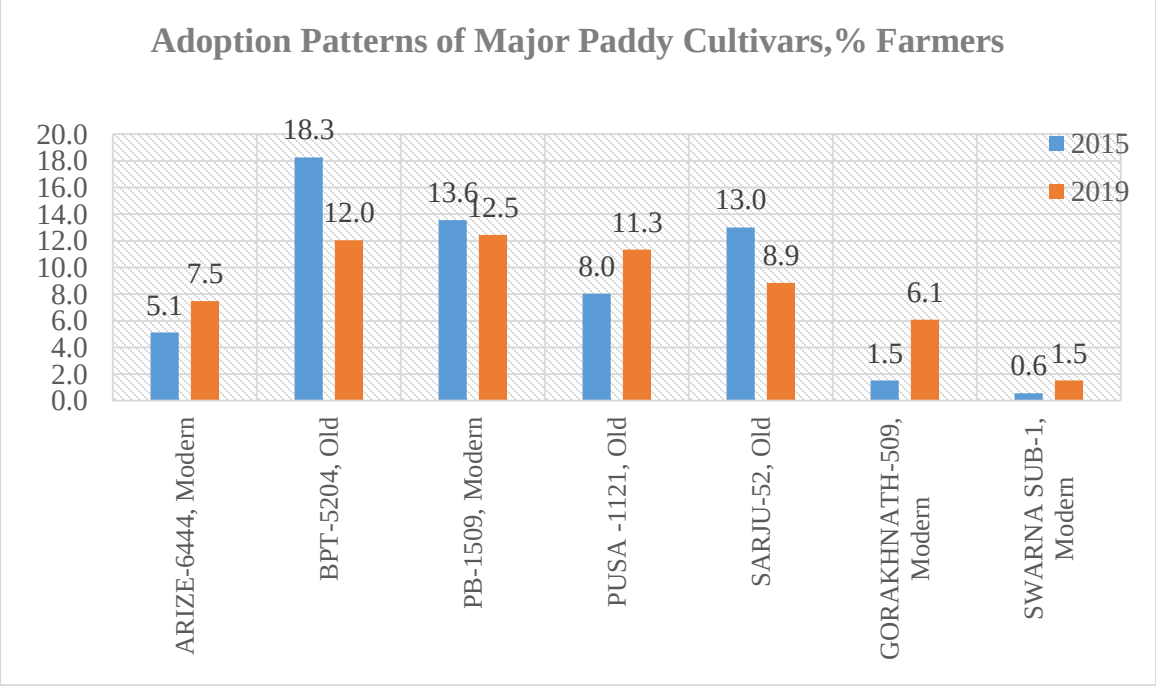
Figure 5: Adoption of paddy cultivars, % Farmers



Source: ICAR-IFPRI Survey, 2019

Note: Modern cultivars are those which were released post-2005 and old cultivars are those which were release in 2005 or before.

Figure 6: Adoption of major paddy cultivars, % Farmers



Source: ICAR-IFPRI Survey, 2019

Note: ARIZE-6444 is a hybrid cultivar.

Table 3: Estimating probit coefficients for PM-KISAN beneficiaries

	(1)	(2)
	Beneficiary=1, and 0 otherwise	Beneficiary=1, and 0 otherwise
Male (Yes=1)	-0.385*** (0.144)	-0.388*** (0.144)
Age (Year)	-0.003 (0.020)	-0.010 (0.020)
Age square (Year)	0.000 (0.000)	0.000 (0.000)
Education (Year)	0.010 (0.009)	0.007 (0.009)
Schedule caste/tribe (Yes=1)	0.099 (0.101)	-0.001 (0.107)
Hindu (Yes=1)	-0.112 (0.131)	-0.122 (0.135)
Income source (others=1), base category		
Income source (Cultivation=1)	-0.101 (0.291)	-0.093 (0.288)
Income source (Other agriculture activity=1)	0.119 (0.295)	0.144 (0.295)
Income source (Non-farm self-employment/salaried=1)	0.435 (0.306)	0.483 (0.306)
Below poverty line (Yes=1)	-0.134* (0.081)	-0.072 (0.091)
Land owned (hectare)	-0.158 (0.142)	-0.217 (0.150)
Household Size (#)	-0.032* (0.019)	-0.029 (0.020)
Members involved in farming (#)	0.025 (0.033)	0.027 (0.034)
Kisan credit card (Yes=1)	0.223 (0.163)	0.201 (0.159)
Soil health card (Yes=1)	-0.023 (0.116)	-0.026 (0.121)
Crop insurance (Yes=1)	0.141 (0.159)	0.157 (0.157)
Distance from nearest branch of bank (km)	0.018 (0.012)	0.016 (0.013)
Distance from nearest branch of post office (km)	-0.039** (0.016)	-0.047*** (0.018)
Constant	-0.001 (0.561)	0.084 (0.573)
District fixed effects	No	Yes
Number of observations	1328	1328

Source: ICAR-IFPRI Survey, 2019

Note: Left hand side takes value 1 if farmer is PM-KISAN beneficiary and 0 otherwise. The analysis sample for this regression is those farmers who own less than 2 hectare of land. Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 4: Estimating probit coefficients for farmers who spent benefits received under the PM-KISAN scheme on agriculture sector

	(1)	(2)
	Benefits spent on agriculture=1, and 0 otherwise	Benefits spent on agriculture=1, and 0 otherwise
Male (Yes=1)	0.096 (0.266)	0.117 (0.293)
Age (Year)	-0.004 (0.042)	-0.029 (0.044)
Age square (Year)	-0.000 (0.000)	0.000 (0.000)
Education (Year)	0.026 (0.017)	0.013 (0.018)
Schedule caste/tribe (Yes=1)	0.314* (0.184)	0.072 (0.209)
Hindu (Yes=1)	-0.505** (0.232)	-0.600*** (0.231)
Income source (others=1), base category		
Income source (Cultivation=1)	0.013 (0.630)	-0.030 (0.664)
Income source (Other agriculture activity=1)	-0.232 (0.638)	-0.251 (0.677)
Income source (Non-farm self-employment/salaried=1)	-0.151 (0.652)	-0.300 (0.694)
Below poverty line (Yes=1)	-0.190 (0.171)	-0.106 (0.188)
Land owned (hectare)	0.833*** (0.304)	0.815** (0.320)
Household Size (#)	-0.032 (0.044)	-0.037 (0.044)
Members involved in farming (#)	0.430*** (0.083)	0.526*** (0.097)
Kisan credit card (Yes=1)	-0.082 (0.282)	-0.161 (0.299)
Soil health card (Yes=1)	0.134 (0.219)	0.088 (0.236)
Crop insurance (Yes=1)	-0.426 (0.283)	-0.500* (0.297)
Time of receiving benefits (February 2019=1), base category		
Time of receiving benefits (March 2019=1)	0.328 (0.233)	0.245 (0.232)
Time of receiving benefits (April 2019=1)	0.215 (0.296)	0.055 (0.298)
Distance from nearest input/output market (km)	0.066** (0.026)	0.043 (0.034)
Distance from nearest branch of bank (km)	-0.068*** (0.025)	-0.099*** (0.031)
Distance from nearest branch of post office (km)	-0.027 (0.032)	-0.031 (0.038)
Distance from nearest KVK (km)	-0.005* (0.003)	-0.008** (0.004)
Constant	0.065 (1.215)	0.774 (1.281)
District fixed effects	No	Yes
Number of observations	373	373

Notes: The analysis sample for this regression includes only those farmers who received the benefits of PM-KISAN. Left hand side takes value 1 if farmer spends PM-KISAN income support in the agriculture sector and 0 otherwise. Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 5: Unmatched and matched characteristic of paddy farmers for those who received KVK benefits vs. those who not.

Covariates	Unmatched			Matched		
	Mean		p>|t|			p>|t|
	KVK beneficiary	Non-beneficiary		KVK beneficiary	Non-beneficiary	
Male (Yes=1)	0.97	0.94	0.16	0.96	0.98	0.18
Age (Year)	43	43	0.53	43	42	0.36
Age square (Year)	2022	1967	0.57	2028	1927	0.33
Education (Year)	8.03	7.13	0.04	7.88	9.39	0.00
Schedule caste/tribe (Yes=1)	0.08	0.14	0.04	0.09	0.09	0.92
Hindu (Yes=1)	0.91	0.88	0.28	0.91	0.70	0.00
Cultivation (Yes=1)	0.80	0.77	0.43	0.80	0.84	0.27
Below poverty line (Yes=1)	0.26	0.35	0.04	0.28	0.25	0.44
Land owned (hectare)	0.88	0.55	0.00	0.88	1.12	0.01
Household Size (#)	6.07	5.79	0.21	6.13	7.07	0.01
Members involved in farming (#)	2.52	2.45	0.52	2.55	2.75	0.18
Kisan credit card (Yes=1)	0.66	0.47	0.00	0.65	0.77	0.01
Soil health card (Yes=1)	0.28	0.09	0.00	0.24	0.20	0.38
Crop insurance (Yes=1)	0.64	0.44	0.00	0.63	0.74	0.02
Soil colour (Brown=1)	0.22	0.17	0.18	0.21	0.17	0.30
Soil colour(Yellow=1)	0.04	0.08	0.09	0.05	0.02	0.11
Soil fertility (Low=1)	0.01	0.04	0.07	0.01	0.01	0.69
Soil fertility (Medium=1)	0.93	0.92	0.80	0.93	0.96	0.16
Soil type (Sandy loam=1)	0.22	0.23	0.77	0.21	0.18	0.40
Soil type (Loam=1)	0.65	0.51	0.00	0.65	0.75	0.04
Soil type (Clay=1)	0.11	0.23	0.00	0.12	0.07	0.11
Irrigation source (Diesel Tubewell=1)	0.41	0.61	0.00	0.43	0.33	0.02
Irrigation source (Canal/pond=1)	0.04	0.06	0.36	0.05	0.04	0.64
Distance from the input market (km)	5.54	5.10	0.14	5.32	5.76	0.12
Distance from the output market (km)	5.38	4.61	0.02	5.15	5.60	0.15
Distance from the agriculture department (km)	9.77	8.14	0.00	8.31	10.03	0.00
Distance from nearest bank branch (km)	4.68	7.00	0.00	4.90	5.00	0.73
Distance from KVK (km)	19.79	37.60	0.00	19.40	26.74	0.00
Number of observations	230	575		214	266	

Notes: Analysis sample includes KVK-beneficiaries from the KVK villages and non-beneficiaries from non-KVK villages. Summary statistics for matched KVK beneficiaries vs. those who not are estimated using matching weights in the common support region.

Table 6: Differential impact of PM-KISAN and KVK beneficiaries on the adoption of modern paddy cultivar, TDM estimates

	Main regressions (2019-20 and 2015-16)		
	(1)	(2)	(3)
PM-KISAN, γ_1	-0.064	0.188*	0.190*
	(0.069)	(0.104)	(0.100)
KVKB, γ_2	0.003	-0.095	-0.071
	(0.049)	(0.094)	(0.090)
TIME, γ_3	-0.028	-0.280**	-0.280**
	(0.049)	(0.124)	(0.123)
KVKB*PM-KISAN, γ_4	0.007	-0.223*	-0.217*
	(0.105)	(0.134)	(0.130)
KVKB*TIME, γ_5	0.080	0.321**	0.321**
	(0.070)	(0.135)	(0.134)
PM-KISAN*TIME, γ_6	-0.057	-0.290	-0.290
	(0.097)	(0.179)	(0.183)
PM-KISAN*KVKB*TIME, γ_7	0.104	0.359*	0.359*
	(0.147)	(0.214)	(0.217)
Constant, γ_0	0.564***	0.663***	0.682***
	(0.034)	(0.086)	(0.088)
Region fixed effects	No	No	Yes
Matching	No	Yes	Yes
Number of observation	1052	960	960
	Pre-intervention trends (2015-16 and 2014-15)		
	(4)	(5)	(6)
PM-KISAN, γ_1	-0.059	0.058	0.065
	(0.068)	(0.111)	(0.098)
KVKB, γ_2	-0.017	-0.138*	-0.057
	(0.048)	(0.081)	(0.074)
TIME, γ_3	-0.066	-0.072	-0.072
	(0.048)	(0.112)	(0.107)
KVKB*PM-KISAN, γ_4	0.073	-0.034	-0.015
	(0.102)	(0.138)	(0.126)
KVKB*TIME, γ_5	0.020	0.043	0.043
	(0.069)	(0.124)	(0.118)
PM-KISAN*TIME, γ_6	-0.005	0.130	0.130
	(0.097)	(0.152)	(0.137)
PM-KISAN*KVKB*TIME, γ_7	-0.066	-0.189	-0.189
	(0.147)	(0.192)	(0.177)
Constant, γ_0	0.630***	0.735***	0.801***
	(0.033)	(0.072)	(0.069)
Region fixed effects	No	No	Yes
Matching	No	Yes	Yes
Number of observation	1052	960	960

Notes: Left hand side takes value 1 if paddy farmer adopt modern cultivar and 0 otherwise. PM-KISAN takes value 1 if farmer is PM-KISAN beneficiary and 0 otherwise. *KVKB* takes value 1 if farmer is KVK beneficiary and 0 otherwise. *TIME* takes value 1 for 2019-20 and 0 for 2015-16. Region fixed effects dummy takes value 1 for eastern region and 0 otherwise. Triple interaction (*PM-KISAN*KVKB*TIME)* measures the differential impact of PM-KISAN and KVK. Column 1 presents the regression without matching. Column 2 and 3 presents the regression incorporating matching weights in the common support region. Upper panel presents the main regression that compares treatment and control over the period 2015-16 and 2019-20. Lower panel presents the pre-intervention trends and compare the treatment and control over the period 2014-15 and 2015-16. All regressions are performed using specification 1 as described in the text. Matching is performed using covariates listed in table 5. Regression Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

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[2] Varshney et al. (2019).
[3] Examples include Sadoulet et al. (2001), Gertler et al. (2012), Haushofer and Shapiro (2016), and Tirivayi et al. (2016).
[4] The study estimated the multiplier of 2.5 for the conditional cash transfers of Mexico.
[5] See section 5, for more detail.
[6] Estimated using ICAR-IFPRI Survey, 2019.
[7] Maluccio (2010).
[8] See, Galiani, and McEwan (2013), for example.
[9] KVK farmers have access to frontier technologies and about its implementation procedure.
[10] It is done to capture the immediate impact of scheme the choice of seeds in the subsequent season after the implementation of the scheme. See conceptual framework in methodology section, for more detail on set of outcomes.
[11] Gertler, 2004; Fiszbein & Schady, 2009, Adato & Bassett, 2009
[12] Sadoulet et al. (2001), Gertler et al. (2012),
[13] Family defines husband, wife and minors.
[14] Institutional land holders, any member of family was a holder of the constitutional post, former or present minister or member of parliament etc. are excluded for receiving benefits.

[15] It is about 0.6% of total GDP of the country.
[16] Data is accessed from 17th September 2019 from PM-KISAN portal.
[17] The total number of KVKs in India is 703. It is also important to note that the larger districts have more than one KVKs. Gorakhpur district in UP has two KVKs.
[18] KVKs are attached to state agricultural universities, ICAR institutes, related government departments, and nongovernment organizations (NGOs) working in the agriculture sector.
[19] Varshney et al. (2019).
[20] Our household module gathers information on the relationships (friend, neighbor, and so on) for each farmer with the remaining 19 surveyed farmers of the same village. This approach provides a complete social mapping of each surveyed farmer among themselves. This forms the basis to capture the spillovers of information flows among farmers through social network channel, and the identification of *network* beneficiaries of KVKs benefits.
[21] In the table, Yes indicates there was at least some beneficiaries in the village. No indicates there was no beneficiary in the village.
[22] The scheme starts the implementation from 15th February 2019 in UP.
[23] Our results are comparable with the government disbursement data that also shows similar pattern of results.
[24] In the probit specification, left hand side variable takes vale 1 if farmer received PM-KISAN and 0 otherwise. Right hand side variable includes social, economic, and agricultural characteristics of farmers. We also include village level variables in terms of distance that captures the access to banks and other government institutions.
[25] Although, male dummy is statistically significant but its economic significance is low as the share of female head is only five %.
[26] According to government data, the scheme has reached to more than two-third beneficiaries till 15th September 2019.
[27] Left hand side variable takes value 1 for those who spend in the agriculture sector and 0 otherwise. Right hand side variable includes social, economic, and agricultural characteristics of farmers, timing of receiving benefits etc. See table 4 for complete list of variables. We run this regression only for first installments but not for the second installment recipients because of lack of sample size.
[28] See, Varshney et al. (2019) for more details.
[29] 2015-16 refers to kharif 2015.
[30] The choice of year 2015-16 for comparison is taken as there was no intervention in any of the villages in terms of either KVKs or PM-KISAN.
[31] Fedet et al. (1985)
[32] ICAR-IFPRI Survey, 2019.
[33] Heckman et al. (1997)

[34] We have conducted matching based on KVK beneficiaries vs. non-beneficiaries.
[35] See, Caliendo and Kopeinig, S.(2008), for more detail.
[36] Feder et al. (1985)
[37] MFS is a UP government intervention for provide training about frontier technologies to one million farmers.
[38] Varshney et al. (2019)
[39] Sadoulet et al. (2001)
[40] The results are not presented for lack of space and may be available on request.
[41] The results are not presented for lack of space and may be available on request.
[42] The results are not presented for lack of space and may be available on request.
[43] Chowhan and Pande (2014).
[44] Sadoulet et al. (2001)