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**Pradhan Mantri Kisan Samman Nidhi (PM-KISAN) and  
the Adoption of Modern Agricultural Technologies  
in Uttar Pradesh, India**

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## **Abstract**

The Pradhan Mantri Kisan Samman Nidhi (PM-KISAN) scheme aims to provide income support to farmers to facilitate timely access to inputs by easing their liquidity needs. This study, based on 1,406 farmers of Uttar Pradesh and using a binary choice model, examines the scheme's targeting accuracy and the correlates of farmers' spending patterns. Triple difference with matching estimators are used to identify the differential impact of PM-KISAN on Krishi Vigyan Kendras (farm science centers, or KVKs) beneficiaries. Results show that PM-KISAN reached to one-third of all the farmers in the first three months 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 on the adoption of modern cultivars.

**Keywords:** Adoption, Cash transfer, Credit, Krishi Vigyan Kendra, Probit, Triple Difference, Propensity Score Matching

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## Acronyms

DCT	direct cash transfer
FLD	frontline demonstration
ICAR	Indian Council of Agricultural Research
KVK	Krishi Vigyan Kendra (farm science center)
OFT	on-farm testing
PM-KISAN	Pradhan Mantri Kisan Samman Nidhi (a government income support program)
TD	triple difference
TDM	triple difference with matching

## 1. Introduction

Adoption of modern technologies is one of the most promising strategies to increase farm incomes. Among the constraints to technology adoption, the most prominent are lack of information and lack of credit (Varshney, Joshi, and Dubey 2019). In addition, Banerjee and colleagues (2017) showed that access to formal credit significantly increases investment in existing small businesses. In India, more than half of 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, or PM-KISAN) in December 2018 to ease the liquidity constraints of Indian farmers for procuring inputs is quite salient. Although the scheme is pitched as a general cash transfer for farmers, its role in the adoption of modern technologies remains an important research question that this paper addresses.

In general, the effects of cash transfers on outcomes such as household consumption, educational attainment, and health are well analyzed (Gertler 2004; Fiszbein and Schady 2009; Adato and Bassett 2009). However, the impacts of cash transfers on the agriculture sector are comparatively less studied—including, importantly, their impact on technology adoption (examples include Sadoulet, de Janvry, and Davis 2001; Gertler, Martinez, and Rubio-Codina 2006; Haushofer and Shapiro 2016; and Tirivayi, Knowles, and Davis 2016). 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 investment in productive activity. In this context, Gertler, Martinez, and Rubio-Codina (2006) and Handa and others (2018) have shown that small monthly cash transfers may lead to increased consumption even after beneficiaries leave the program. Haushofer and Shapiro (2016) showed that a large unconditional transfer to poor households may increase future earnings by encouraging investments in livestock. Sadoulet, de Janvry, and Davis (2001) showed a multiplier effect of cash transfers.<sup>1</sup> All of these studies imply that a productive investment in the short run may lead to sustained long-term impacts. How does PM-KISAN fare in this area?

Conceptually, a cash transfer can encourage farmers to spend the amount on productive activities for several reasons.<sup>2</sup> First, it may help in easing incumbent credit and liquidity constraints

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<sup>1</sup> The study estimated a multiplier of 2.5 for conditional cash transfers in Mexico.

<sup>2</sup> See Section 5 for more detail.

on purchasing agricultural inputs, extremely pertinent in India, where, according to our survey,<sup>3</sup> more than 50 percent of farmers rely on informal credit and one-fifth purchase inputs on credit. Adesina (1996) found that access to credit encourages fertilizer use. Second, cash transfers increase the net incomes of farmers and thus, in turn, may enhance their risk-taking capacity, leading them to undertake riskier but comparatively more productive investments. Yet cash transfer beneficiaries' investment in productive activities may be limited in developing countries (Maluccio 2010). We attempt to examine this issue by looking at heterogeneity in impact estimates.

Specifically, we ask whether farmers who have more information on investments related to productive activities respond differentially to a direct cash transfer (DCT) than those with less information. It is likely that a DCT would increase investment activity by comparatively informed farmers first. Studying heterogeneity in impact estimates of DCTs in the agriculture sector contributes to a small but growing literature on the heterogeneous impact of DCTs (see, for example, Galiani and McEwan 2013).

There are two main objectives of the study. The first is to assess the alignment of PM-KISAN with its objectives by examining its coverage, its targeting accuracy, and the spending patterns of the beneficiary farmers. The second is to examine PM-KISAN's role in stimulating the adoption of modern cultivars for paddy cultivation among comparatively informed farmers, defined in this study as beneficiaries of farm science centers, known as Krishi Vigyan Kendras (KVKs).<sup>4</sup> Our analysis is based on a primary survey of 1,406 farmers in Uttar Pradesh, India. A binary choice model is used to study the targeting accuracy of PM-KISAN and the correlates of spending. The differential impact of the scheme is examined by applying the triple difference with matching (TDM) procedure.

Our implementation and coverage results reveal that (1) the scheme reached one-third of all the farmers in only first three months of its implementation, (2) there seems to be no evidence of selection bias in choosing PM-KISAN beneficiaries based on attributes such as caste and land size, and (3) 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

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<sup>3</sup> See Section 3 for details.

<sup>4</sup> KVK farmers have access to frontier technologies and information about their implementation procedures.



provides evidence that the scheme has augmented the KVKs' impact on the adoption of modern cultivars. Note that the outcome assessed pertains simply to the choice of seed type, and not the final outcomes—such as agricultural productivity and farmers' incomes—because the scheme is only recently implemented.<sup>5</sup>

This paper makes the following contributions. First, it is the incipient study to evaluate the implementation of the PM-KISAN scheme and its association with spending patterns. Second, it captures the differential impacts of cash transfers. Most important, it studies the impacts of cash transfers on the adoption of technologies, an area that has received scant attention in the literature (Gertler 2004; Fiszbein and Schady 2009; Adato and Bassett 2009). Hence, the paper contributes to the literature that explores the mechanisms for income enhancement as a consequence of cash transfers (Sadoulet, de Janvry, and Davis 2001; Gertler, Martinez, and Rubio-Codina 2006).

The remainder of the paper is organized as follows: Section 2 presents background about the PM-KISAN scheme 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 of paddy cultivars; Section 5 begins with the framework to study the role of DCTs in the adoption of modern technologies, and then formulates the triple difference (TD) specification to estimate the differential impacts of the PM-KISAN scheme; Section 6 presents the results; and Section 7 concludes.

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<sup>5</sup> Seed choice is assessed to capture the immediate impact of the scheme on the choice of seeds in the subsequent season after the implementation of the scheme. See “Conceptual Framework” in Section 5 for more detail on outcomes.

## 2. Background

### *Pradhan Mantri Kisan Samman Nidhi (PM-KISAN)*

PM-KISAN is a central government-funded scheme launched in December 2018 to help farmers purchase various agricultural inputs. Payments under the scheme started in February 2019. It provides to each eligible farmer's family 6,000 rupees (Rs) per year in three installments of Rs 2,000 each.<sup>6</sup> Initially, farmers with less than 2 hectares of land were eligible;<sup>7</sup> subsequently, beginning in June 2019, the scheme was extended to all farmers—totaling 140 million across India. Money is transferred directly to the beneficiary's bank account.<sup>8</sup> According to government data, the scheme had reached 50 million farmers nationwide by September 15, 2019.<sup>9</sup> The highest number of beneficiaries comes from Uttar Pradesh (28 percent, 17 million farmers), followed by Maharashtra (10 percent), Andhra Pradesh (9 percent), and Gujarat (7 percent).

### *Krishi Vigyan Kendra (KVK)*

KVK was launched by the Indian Council of Agricultural Research (ICAR) in 1974 in Pondicherry District, with the main goal of providing 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.<sup>10</sup> KVKs are financed fully by the government of India through ICAR.<sup>11</sup> The mandate of the KVKs is to (1) conduct on-farm testing (OFT) for the assessment of agricultural technologies across different farming systems, (2) carry out frontline demonstrations (FLDs) to demonstrate the implementation of frontier technologies, (3) increase the capacity development of farmers and extension workers, and (4) work as a knowledge and resource center for the agricultural economy of the district.

The total budget of KVKs in India was only Rs 6.86 billion in 2016/2017. Gulati and colleagues (2018) showed that India spends 0.7 percent of its agricultural gross domestic product on research, education, extension, and training. Out of this amount, 0.54 percent goes for

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<sup>6</sup> *Family* is defined as a husband, wife, and minors.

<sup>7</sup> Institutional landholders and farmers with any member of the family holding a constitutional post, such as a former or present minister or member of parliament, are excluded from receiving benefits.

<sup>8</sup> It is about 0.6 percent of total gross domestic product of the country.

<sup>9</sup> Data were accessed on September 17, 2019, from the government's PM-KISAN portal.

<sup>10</sup> The total number of KVKs in India is 703. It is also important to note that the larger districts have more than one KVK; for instance, Gorakhpur District in Uttar Pradesh has two KVKs.

<sup>11</sup> KVKs are attached to state agricultural universities, ICAR institutes, related government departments, and nongovernmental organizations working in the agriculture sector.

agriculture research and education, and a meager 0.16 percent goes to extension and training (Gulati et al. 2018). Varshney, Joshi, and Dubey (2019) showed that KVKs have huge local spillovers and KVK beneficiaries are more informed about frontier technologies, both of these effects resulting in greater adoption of KVK-promoted technologies.

### 3. Data

We conducted a primary survey in Uttar Pradesh, a state with more than 200 million people, where each farmer accounts for less than 1 hectare of land. The major crops grown in the state are wheat (41 percent), paddy (24 percent), sugarcane (9 percent), pearl millet (4 percent), and maize (3 percent) (Varshney, Joshi, and Dubey 2019). In Uttar Pradesh, wheat is sown mainly in November, in the rabi season, and the scheme was launched in December 2018, so that the majority of cultivar choice decisions had already been made prior to the introduction of the scheme. In paddy, sowing starts in June and July—in the year in question, after introduction of the scheme. Therefore, we consider paddy for analysis.

Our sample comes from three agroecological zones of Uttar Pradesh: western plain, midwestern plain, and northeastern plain. The survey was carried out between May and July 2019 by the South Asia Regional Office of the International Food Policy Research Institute, New Delhi, and supported by ICAR. We include 9 districts covering 10 KVKs of Uttar Pradesh. Five districts were selected from the northeastern plain, 3 from the western plain, and 1 from the midwestern plain. We selected villages randomly by stratifying them into two categories: KVK and non-KVK villages, the former being those where any type of intervention, such as FLDs, OFTs, or training programs, were conducted by KVKs. To select households, the complete household listing was compiled for each selected village.

Then we formed four quintiles, based on households' total cultivable land. From each quintile, five households were randomly selected. The total sample of size 1,406 includes wheat, paddy (723), and sugarcane farmers. Our household module included household, demographic, area, and crop production information for the reference year 2017/2018, as well as the household's social mapping in the village.<sup>12</sup>

The variable *PM-KISAN* captures farmers' access to the PM-KISAN scheme and how they spend the benefits received under the scheme. Our survey can capture the disbursal of the benefits for only the first three months of implementation due to the timing of the implementation of the survey.

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<sup>12</sup> Our household module gathered information on the relationships (friend, neighbor, and so on) of each farmer with the remaining 19 surveyed farmers in the same village. This approach provides a complete social mapping of all surveyed farmers among themselves. This mapping forms the basis for capturing any spillovers of information flows among farmers through social network channels, allowing the identification of indirect (network-based) beneficiaries of KVK benefits.

*KVK* captures farmers' access to FLDs, OFTs, and training programs conducted by KVKs about frontier agriculture technologies. Our survey considers only those villages where KVKs conducted interventions in 2016/2017 and 2017/2018, but not for 2015-16 or before. *Adoption* includes a recall-based information on the adoption of paddy cultivars from 2014/2015 to 2019/2020.

Table 1 summarizes the timeline of KVK and PM-KISAN interventions across KVK and non-KVK villages. KVK villages had interventions from 2016/2017 through 2019/2020. Note that we have labeled villages as KVK intervention villages in 2019/2020 if KVK visited them in either 2016/2017 or 2017/2018 or 2018/2019. This is done because once farmers get benefits from KVKs, they are likely to get regular updates on new technologies from the KVKs. Non-KVK villages are those where there was no intervention in any of these periods. Regarding PM-KISAN, in both sets of villages, PM-KISAN was implemented only in 2018/2019 and 2019/2020. The timeline of events forms the basis of the identification strategy that we discuss in Section 5.

Table 2 presents the statistical profile of all surveyed farmers (including wheat, paddy, and sugarcane cultivators). Overall, three-fourths of farmers were dependent on agriculture, and the majority were small and marginal landholders with limited access to formal credit.

## 4. Descriptive Results

### *PM-KISAN and Its Implementation*

Figure 1 presents the percentage of farmers who received benefits from the PM-KISAN scheme through April 30, 2019 (that is, within the first three months of implementation).<sup>13</sup> Our result shows that 29.3 percent of our sample of farmers received PM-KISAN benefits.<sup>14</sup>

Before implementation of the scheme, concerns were raised about potential selection bias in choosing PM-KISAN beneficiaries. Therefore we run a probit model to test for factors associated with selection.<sup>15</sup> Table 3 presents the results, without and with district fixed effects, respectively. Coefficients of social, economic, and agricultural characteristics are all insignificant, with the exception of a dummy variable for male head of household.<sup>16</sup> Further, the variables (such as distance to a post office) that capture farmers' access to formal credit systems are correlated with the likelihood of receiving PM-KISAN benefits. In addition, the results show that 93 percent of nonbeneficiary farmers have already applied to the scheme, indicating awareness.<sup>17</sup>

Referring back to Figure 1, 60 percent of farmers who benefited from PM-KISAN received one installment, and 40 percent received two installments. The spending pattern of PM-KISAN beneficiaries is presented in Figure 2, disaggregated by installment. Our result shows that 52 percent of those who received the first installment spent it on agriculture, 26 percent on consumption, 7 percent on education and health, and the remaining 16 percent on other incidental expenses (such as festivals, marriages, and the like). Second-installment recipients spent 39 percent on consumption, followed by agriculture (23 percent) and education and medical needs (19 percent).

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<sup>13</sup> The scheme started implementation in Uttar Pradesh on February 15, 2019.

<sup>14</sup> These results are consistent with government disbursement data.

<sup>15</sup> In the probit specification, the left-hand-side variable takes the value 1 if the farmer received PM-KISAN and 0 otherwise. Right-hand-side variables include social, economic, and agricultural characteristics of farmers. We also include village-level variables, in terms of distance, that capture farmers' access to banks and other government institutions.

<sup>16</sup> Although the male dummy is statistically significant, its economic significance is low, because the share of female heads of household is only 5 percent.

<sup>17</sup> According to government data, the scheme had reached more than two-thirds of intended beneficiaries by September 15, 2019.

Given this significant spending in the agriculture sector, we explore whether this easing of liquidity constraints has implications for the adoption of modern technologies.<sup>18</sup> Table 4 presents probit coefficients for farmers who spent benefits received under the PM-KISAN scheme in the agriculture sector. Land size, agriculture dependency, access to banks, and access to KVKs are correlated with spending the DCT on agriculture. Results show that PM-KISAN has likely eased credit and liquidity constraints for farmers, and that farmers with better access to KVKs are more likely to spend on agriculture. Figure 2 presents the spending patterns, alongside the timing of installments in Figure 3. Farmers receiving PM-KISAN benefits in the peak agricultural season are more likely to spend in agriculture; in the off-season, they are more likely to spend on consumption.

### ***Krishi Vigyan Kendra and Its Beneficiaries***

Figure 4 estimates the percentage of farmers in our sample who benefited, either directly or indirectly, from KVK (see Varshney, Joshi, and Dubey 2019 for more details). Survey data reveal that 36 percent of our sample of farmers were exposed to KVKs through FLDs (27 percent), OFTs (10 percent), or training programs (26 percent).

### ***Adoption of Paddy Cultivars***

Figure 5 compares the adoption of paddy cultivars for the periods 2015/2016 and 2019/2020.<sup>19</sup> We define *modern* cultivars as those released after 2005. Our results reveal that the adoption of modern paddy cultivars has gone up, from 53 percent to 57 percent. Figure 6 presents adoption patterns by specific cultivar, comparing the periods 2015/2016 and 2019/2020. *Arize-6444*, a hybrid cultivar (modern) shows a significant increase in adoption, from 5.1 percent to 7.5 percent. *BPT-5204* (old) saw a significant decline, from 18.3 to 12.0 percent. For *PB-1509* (modern), however, adoption has gone down, from 13.6 to 12.5 percent. For *Pusa-1121* (modern), adoption has increased significantly, from 8.0 to 11.3 percent. For *Sarju-52* (old), adoption has decreased significantly,

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<sup>18</sup> The left-hand-side variable takes a value of 1 for those who spent benefits in the agriculture sector and 0 otherwise. Right-hand-side variables include social, economic, and agricultural characteristics of farmers, timing of receiving benefits, and so on. See Table 4 for the complete list of variables. We run this regression only for recipients of the first installment but not for second-installment recipients because of small sample size.

<sup>19</sup> “2015/2016” refers to the kharif season (June to September) of 2015. We chose the year 2015/2016 for comparison because there was no KVK or PM-KISAN intervention in any of the villages in that year.

from 13.0 to 8.9 percent. For *Gorakhnath-509* (modern), adoption has increased from 1.5 percent to 6.1 percent. For *Swarna-Sub 1* (modern), adoption has gone up from 0.6 to 1.5 percent.

The next section describes the identification strategy we use 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 benefits, and farmers are free to spend their DCT anywhere. However, the intended objective of the scheme is to augment farmers' income and to ease credit and liquidity constraints so they can invest in productive activities, such as procuring agricultural inputs.

The literature clearly points out that availability of credit helps in the adoption of modern technologies (Feder, Just, and Zilberman 1985). Cash transfers may also increase the net income of farmers, raising their risk-taking ability. Zimmermann (2015) examined an increase in income from workfare programs may shift farmers' cropping choices toward riskier but higher-return crops. Finally, cash transfers may also help farmers gain access to crop insurance as a risk-coping mechanism, which, in turn, could 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, labor, and 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 nonbeneficiaries of PM-KISAN, nonuniversal coverage of KVKs, and the recall-based panel on paddy cultivars for the pre- and postintervention years (2015/2016 and 2019/2020). Although PM-KISAN is intended as a universal scheme, it had reached only 29.3 percent of farmers in our sample through April 2019, creating a counterfactual group. At the same time, farmers' decision on the type of cultivar (modern or old) to plant was made subsequently, in the month of May or June 2019. Therefore, the study captures the immediate impact of PM-KISAN. In case of KVK, its nonuniversal coverage, likewise, makes available a counterfactual. With pre- and postintervention information on outcome variables, along with the availability of counterfactuals for both interventions, PM-KISAN and KVK, it is possible to identify the differential impact of PM-KISAN and KVK in the TD framework (see Ravallion 2007 for a review of the TD method).

The TD approach identifies the differential impacts of two interventions if the parallel trends assumption is satisfied. If confounding factors are time variant, however, then the parallel trends assumption may not be satisfied. One of the most common reasons the assumption is not satisfied is that the two groups of farmers are very different from each other in terms of characteristics (social, economic, and agricultural), causing them to grow along differential time trends. Table 5 confirms this phenomenon: the unmatched characteristics of the treatment and control group reveal that the groups are different in terms of plot characteristics, such as soil fertility and irrigation source, as well as the location of institutions such as output markets, agriculture extension departments, banks, and KVKs.

To address this concern, we employ TDM, whereby 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 (Heckman, Ichimura, and Todd 1997). We then compare the outcomes of the treatment group with the weighted average of outcomes across the matched control group (in our case, KVK beneficiaries versus nonbeneficiaries). This procedure 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 nonbeneficiary farmers results in insignificant differences 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 nonbeneficiary farmers, and vice versa. Then we derive farmer-level matching weights using a kernel matching procedure (see Caliendo and Kopeinig 2008 for more detail).

We estimate the following TD specification:

$$\begin{aligned}
 Y_{idkt} = & \gamma_0 + \gamma_1 PMK_{idkt} + \gamma_2 TIME_t + \gamma_3 KVKB_{idkt} + \\
 & + \gamma_4 (PMK_{idkt} * KVKB_{idkt}) + \gamma_5 (KVKB_{idkt} * TIME_t) + \gamma_6 (PMK_{idkt} * TIME_t) \\
 & + \gamma_7 (PMK_{idkt} * TIME_t * KVKB_{idkt}) + \{\eta_k\} + \varepsilon_{idkt},
 \end{aligned} \tag{1}$$

where  $i$  stands for an individual farmer,  $d$  for district,  $k$  for agroecological region, and  $t$  for year (either 2019/2020 or 2015/2016).  $Y$  is the adoption of a modern paddy cultivar, and takes a value of 1 if the farmer adopts a modern cultivar and 0 otherwise.  $PMK$  is a dummy variable for being a PM-KISAN beneficiary (1 if yes, 0 otherwise),  $KVKB$  is a dummy variable for being a KVK beneficiary (1 if yes, 0 otherwise), and  $TIME$  is a dummy variable for 2019/2020.  $\{\eta_k\}$  represents agroecological region fixed effects, taking a value of 1 for the eastern region and 0 otherwise.  $\varepsilon$  is the error term.

Estimating Equation (1) with matching weights in the common support region makes  $\gamma_7$  the triple interaction term—that is, the TDM estimator. The coefficient  $\gamma_7$  can be interpreted as the differential impact of PM-KISAN on KVK beneficiaries vis-à-vis nonbeneficiaries. The coefficient  $\gamma_6$  is interpreted as the impact of PM-KISAN on nonbeneficiaries. And  $\gamma_5$  is the impact of KVK on nonbeneficiaries of PM-KISAN.

To test for the 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 (2014/2015 and 2015/2016, respectively) and verifying that the assumption holds during these periods.

## 6. Econometric Results

Table 6 presents the differential impacts of PM-KISAN and KVK on the adoption of modern paddy cultivars. KVK beneficiaries saw a 36-percentage-point higher adoption of modern cultivars, compared with nonbeneficiaries. This result is consistent with the adoption literature, which talks about the complementary roles of credit and information in the adoption of modern technologies (Feder, Just, and Zilberman 1985). In the context of a conditional cash transfer (known as PROCAMPO) in Mexico, Sadoulet, de Janvry, and Davis (2001) found that technical assistance to farmers raised the multiplier effect of the conditional cash transfer through returns on productive assets.

We may also interpret the coefficient  $\gamma_7$  as the impact of KVK on PM-KISAN beneficiaries vis-à-vis nonbeneficiaries of PM-KISAN. The result reveals that PM-KISAN beneficiaries saw a 36-percentage-point higher adoption of modern technologies when they accessed KVKs, implying that the presence of PM-KISAN has magnification effects on KVK.

As noted earlier, the coverage of KVKs is not universal. At the all-India level, Kumar and others (2019) noted that fewer than 10 percent of farmers have direct access to KVKs. Therefore, it is important to look at the impact of PM-KISAN on nonbeneficiaries of KVK, which is given by the coefficient  $\gamma_6$ . Our result shows an insignificant impact of PM-KISAN on nonbeneficiaries of KVK, clearly emphasizing the role of both credit and information in 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 the Million Farmers School, which improve farmers' awareness of frontier technologies.<sup>20</sup>

The coefficient  $\gamma_5$  in Equation (1) is interpreted as the impact of KVK on farmers who do not receive PM-KISAN benefits. There is a positive and significant (32-percentage-point) impact of KVK on nonbeneficiaries of PM-KISAN for the adoption of paddy cultivars. Recall that 70 percent of Uttar Pradesh farmers in our sample are not beneficiaries of PM-KISAN. A positive impact of KVKs was also documented in a study conducted on all farmers concerning modern wheat cultivars in the same state (Varshney, Joshi, and Dubey 2019). Internationally, Kondylis, Mueller, and Zhu (2017) also showed the positive impact of lab-to-farm extension design (similar to KVKs) on the adoption of modern technologies.

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<sup>20</sup> The Million Farmers School is an Uttar Pradesh government intervention to provide training about frontier technologies to 1 million farmers.

To sum up, the result reveals that PM-KISAN is significantly stimulating the impact of KVKs on the adoption of modern cultivars by easing both cash and liquidity constraints for farmers. Lessons learned from this investigation suggest that the agricultural extension system (including KVKs), combined with PM-KISAN, can serve as a significant pathway to encourage farmers to make productive investments. Gertler, Martinez, and Rubio-Codina (2006) likewise showed that rural Mexican households invested part of their cash transfers in productive agricultural assets such as livestock and in turn saw an increase in agricultural income (10 percent). The PROCAMPO conditional cash transfer in Mexico, once it is complemented with technical assistance, can result a multiplier as high as 2.5 (Sadoulet, de Janvry, and Davis 2001).

### ***Robustness Checks***

As tests of robustness, we test for (1) identification assumption, (2) choice of definition of outcomes, (3) choice of matching algorithms, and (4) treatment definition of KVK. For the identification assumption, we test for parallel trends in the treatment and control groups. We assume 2014/2015 as the baseline year and 2015/2016 as the endline year. The years 2014/2015 and 2015/2016 experienced no intervention related to either KVK or PM-KISAN. Therefore, we run specification 1—that is, Equation (1)—to test for the parallel trend assumption in the differential impact of PM-KISAN and KVK. Table 6, column 6, shows that the coefficients  $\gamma_5$ ,  $\gamma_6$ , and  $\gamma_7$  are insignificant. Hence, the identifying assumption of no systematic trend in the treatment and control groups holds.

With regard to the choice of definition of outcomes, we also consider the variety age,<sup>21</sup> and the result shows a broadly similar pattern in terms of the sign of the coefficient. As for using a different matching algorithm, the results are robust to the nearest-neighbor and radius-matching methods.<sup>22</sup> Finally, to test our definition of KVK treatment, we ran our analysis with treatment defined as all farmers who reside in a KVK village (instead of only direct KVK beneficiaries), using those living in villages without a KVK as the control group. The result reveals lower magnitudes of effect than when we define direct KVK beneficiaries as the treatment group.<sup>23</sup>

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<sup>21</sup> Result not presented to save space; available on request.

<sup>22</sup> Result not presented to save space; available on request.

<sup>23</sup> Result not presented to save space; available on request.

## 7. Conclusions and Policy Implications

This paper has two major objectives. The first is to examine the implementation of the PM-KISAN scheme and to explore the spending patterns of beneficiaries. The other is to examine the role of PM-KISAN in augmenting the impact of KVKs on the adoption of modern cultivars.

We find that the PM-KISAN scheme reached 29.3 percent of Uttar Pradesh farmers within three months of its implementation. The paper also tests for selection bias on the part of the government in choosing PM-KISAN beneficiaries. Our result shows no evidence of selection bias in terms of social, economic, or agricultural characteristics of farmers. Therefore we can conclude that the concerns raised about the PM-KISAN scheme and its implementation have been well addressed in Uttar Pradesh from the beginning. Banking infrastructure created through the national Pradhan Mantri Jan Dhan Yojana financial inclusion program (Chowhan and Pande 2014) and the timely preparation of a database of farmers by the state government played a key role in the appropriate implementation of PM-KISAN. However, it is still the early days, and there is a need for more evaluations across states with complete rollout.

Our findings on the utility of income support suggest that the spending patterns of farmers are well aligned with the objectives of the PM-KISAN scheme. Our evidence suggests that more than 50 percent of farmers who received the benefits in the peak agricultural season spent their money in the agriculture sector, and more than 60 percent of farmers who received the money in the off-season spent the money for consumption, education, and medical purposes. Moreover, the results show that spending PM-KISAN money in the agriculture sector is correlated with the farmer's dependency on the agricultural sector, farm size, and poor access to credit facilities.

Our study establishes evidence that the PM-KISAN scheme has significantly stimulated the KVK's impact on the adoption of modern paddy cultivars. In particular, the study shows that PM-KISAN has increased the adoption of modern cultivars among KVK beneficiaries by 36 percentage points, as compared with nonbeneficiaries. Lessons learned from this research suggest that the agricultural extension system (including KVKs), along with PM-KISAN, can serve to encourage farmers to make productive investments in agriculture.

If farmers invest some part of the PM-KISAN cash transfer in productive investments, it can have implications for a permanent increase in income in the longer term (Sadoulet, de Janvry,

and Davis 2001). From a policy perspective, this study establishes 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 to make productive investments in the agriculture sector. Therefore, 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 events in sample villages**

Year	Intervention: KVK		Intervention: PM-KISAN	
	KVK villages	Non-KVK villages	KVK villages	Non-KVK villages
2014/2015	No	No	No	No
2015/2016	No	No	No	No
2016/2017	Yes	No	No	No
2017/2018	Yes	No	No	No
2018/2019	Yes	No	Yes	Yes
2019/2020	Yes	No	Yes	Yes

**Source:** Indian Council of Agricultural Research–International Food Policy Research Institute survey, 2019.

**Note:** PM-KISAN was implemented in February 2019. Agricultural years start in July and end the following June (for example, 2014/2015 starts in July 2014 and ends in June 2015). “Yes” indicates there were at least some beneficiaries in the village. “No” indicates there was no beneficiary in the village.

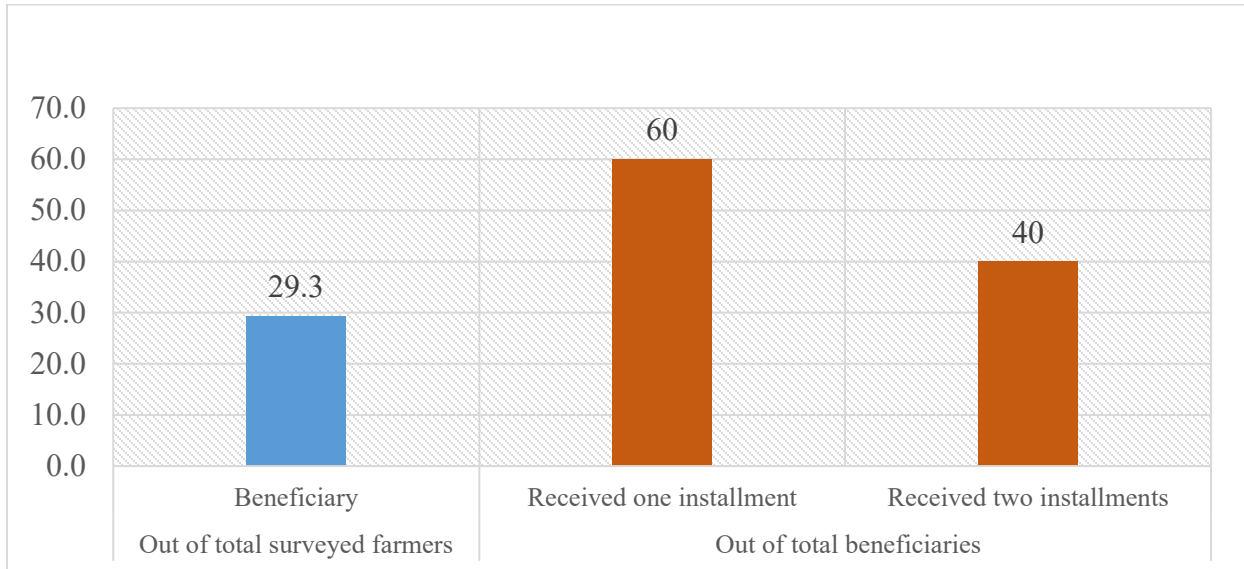
**Table 2: Statistical profile of surveyed farmers, Uttar Pradesh**

Characteristic	Statistics			
	Mean	Std. Deviation	Minimum	Maximum
Male (yes = 1)	0.94	0.24	0	1
Age (years)	42	12	18	78
Age squared (years)	1,921	1,065	324	6,084
Education (years)	6.92	4.74	0	22
Scheduled 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 agricultural activity (yes = 1)	0.20	0.40	0	1
Nonfarm self-employment/salary (yes = 1)	0.08	0.27	0	1
Other income (includes remittances/pensions) (yes = 1)	0.02	0.13	0	1
Below poverty line (yes = 1)	0.39	0.49	0	1
Land owned (hectares)	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	1,406	n.a.	n.a.	n.a.

**Source:** Indian Council of Agricultural Research–International Food Policy Research Institute survey, 2019

**Note:** Survey was carried out between May and July 2019. n.a. = not applicable.

**Figure 1: Percentage of farmers who benefited from PM-KISAN**



**Source:** Indian Council of Agricultural Research–International Food Policy Research Institute Survey, 2019

**Note:** Data include only those beneficiaries who received PM-KISAN benefits in the first three months of its implementation in Uttar Pradesh.

**Table 3: Estimating probit coefficients for PM-KISAN beneficiaries**

Characteristic	(1)	(2)
	Beneficiary = 1, and 0 otherwise	Beneficiary = 1, and 0 otherwise
Male (yes = 1)	-0.385*** (0.144)	-0.388*** (0.144)
Age (years)	-0.003 (0.020)	-0.010 (0.020)
Age squared (years)	0.000 (0.000)	0.000 (0.000)
Education (years)	0.010 (0.009)	0.007 (0.009)
Scheduled 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 agricultural activity = 1)	0.119 (0.295)	0.144 (0.295)
Income source (nonfarm self-employment/salary = 1)	0.435 (0.306)	0.483 (0.306)
Below poverty line (yes = 1)	-0.134* (0.081)	-0.072 (0.091)
Land owned (hectares)	-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	1,328	1,328

**Source:** Indian Council of Agricultural Research–International Food Policy Research Institute survey, 2019.

**Note:** The left-hand side takes a value of 1 if the farmer is a PM-KISAN beneficiary, and 0 otherwise. The analysis sample for this regression is those farmers who own less than 2 hectares of land. Standard errors in parentheses.

\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

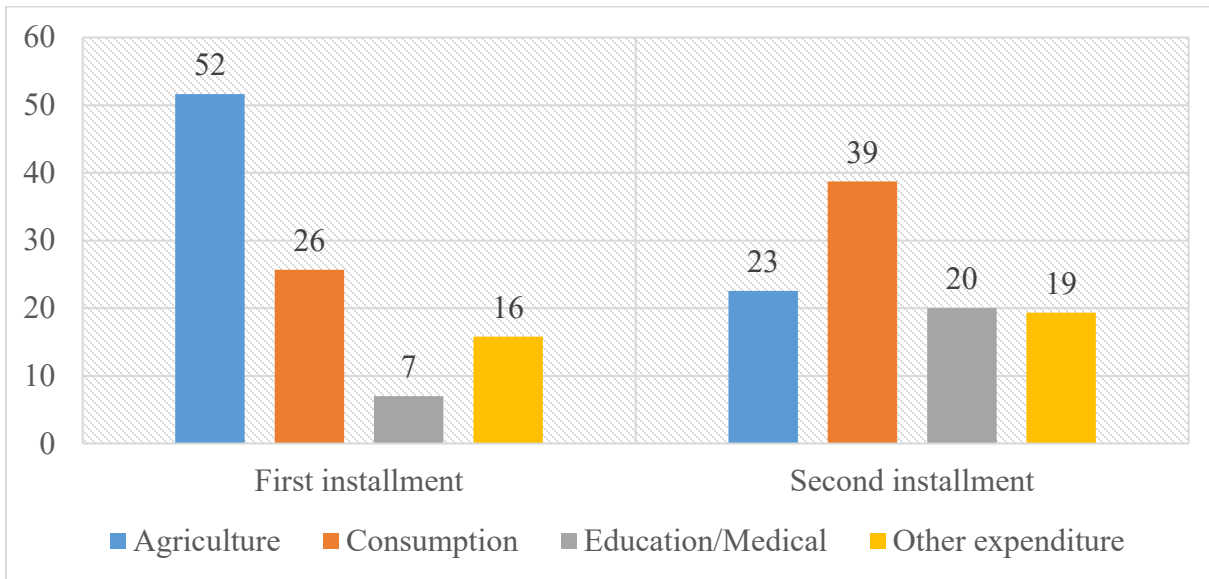
**Table 4: Estimating probit coefficients for farmers who spent benefits received under the PM-KISAN scheme in the agriculture sector**

Characteristic	(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 (years)	-0.004 (0.042)	-0.029 (0.044)
Age squared (years)	-0.000 (0.000)	0.000 (0.000)
Education (years)	0.026 (0.017)	0.013 (0.018)
Scheduled 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 (other = 1), base category		
Income source (cultivation = 1)	0.013 (0.630)	-0.030 (0.664)
Income source (other agricultural activity = 1)	-0.232 (0.638)	-0.251 (0.677)
Income source (nonfarm self-employment/salary = 1)	-0.151 (0.652)	-0.300 (0.694)
Below poverty line (yes = 1)	-0.190 (0.171)	-0.106 (0.188)
Land owned (hectares)	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

**Source:** Authors.

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

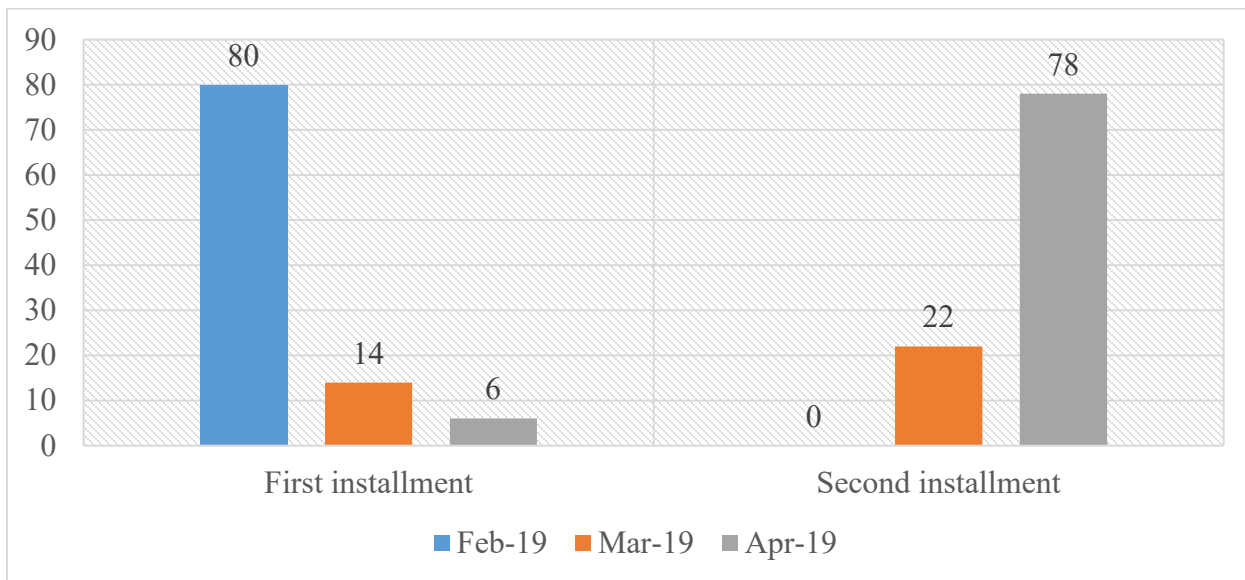
**Figure 2: Spending pattern of PM-KISAN beneficiaries, percentages of farmers, by installment**



**Source:** Indian Council of Agricultural Research–International Food Policy Research Institute Survey, 2019

**Note:** “Other expenditure” includes incidental expenses such as festivals, marriages, and

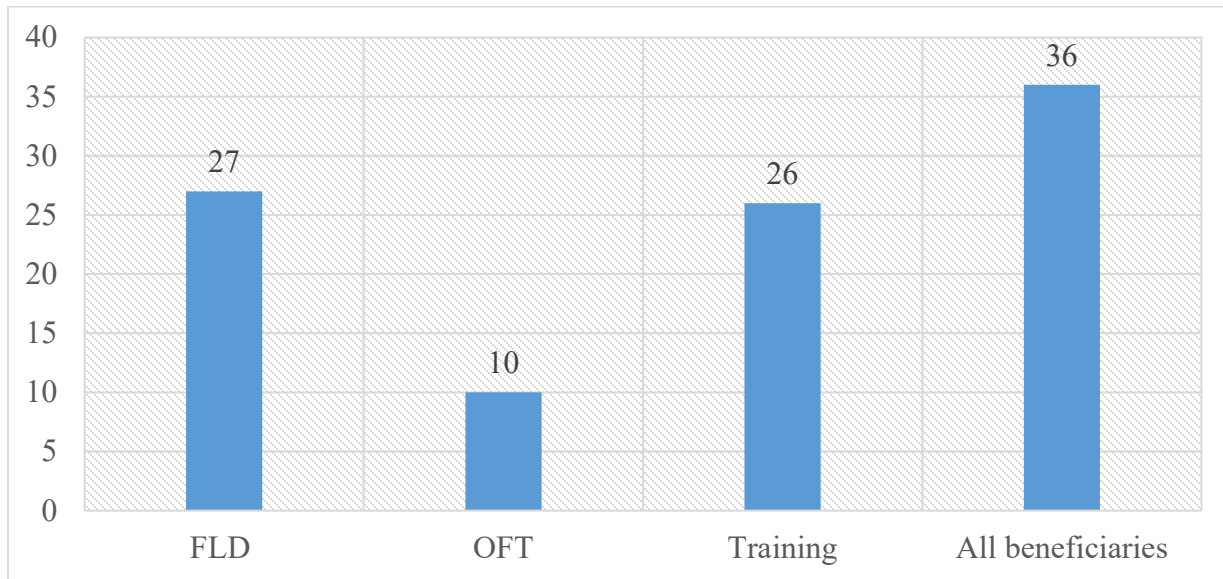
**Figure 3: Timing of PM-KISAN installments, percentage of farmers**



**Source:** Indian Council of Agricultural Research–International Food Policy Research Institute Survey, 2019

**Note:** PM-KISAN provides total financial benefits for each eligible farmer’s family of Rs 6,000 per year in three installments of Rs 2,000 each. The third installment had not yet been disbursed by the time of the primary survey.

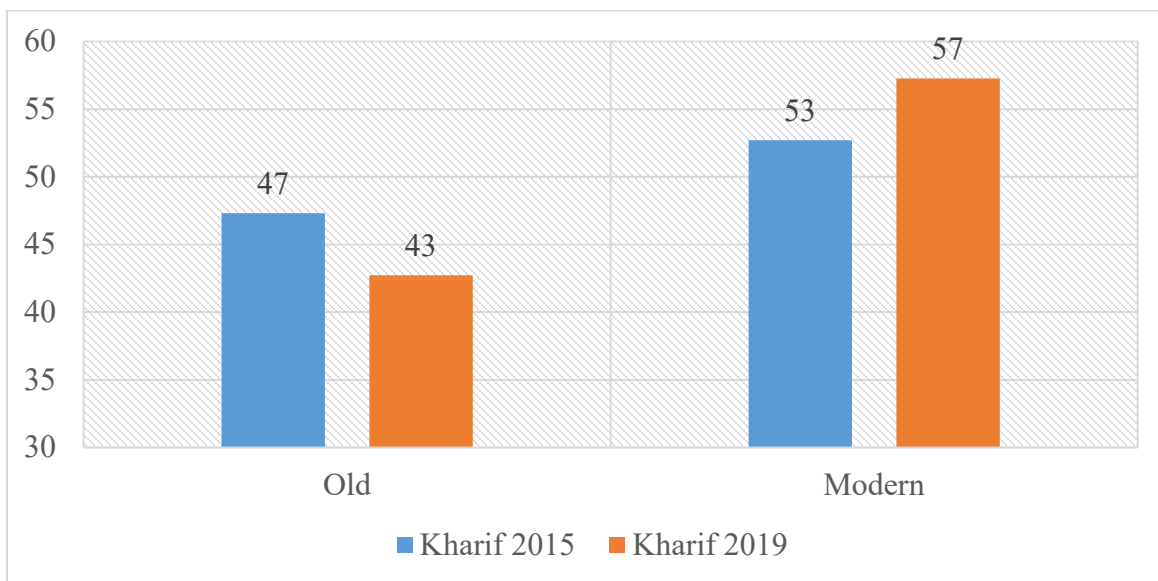
**Figure 4: KVK beneficiaries, percentage of farmers**



**Source:** Indian Council of Agricultural Research–International Food Policy Research Institute Survey, 2019

**Note:** FLD = frontline demonstration; OFT = on-farm testing. “KVK beneficiaries” includes both direct and indirect beneficiaries. Indirect beneficiaries are those who, by their own self-curiosity, get benefits in terms of knowledge of frontier technologies through KVKs, as well as those who benefit through the KVK beneficiaries who are in their social network. KVKs carry out FLDs to demonstrate the implementation of frontier technologies, perform OFT for the assessment of agricultural technologies across different farming systems, and increase the capacity development of farmers and extension workers to create awareness about frontier technologies.

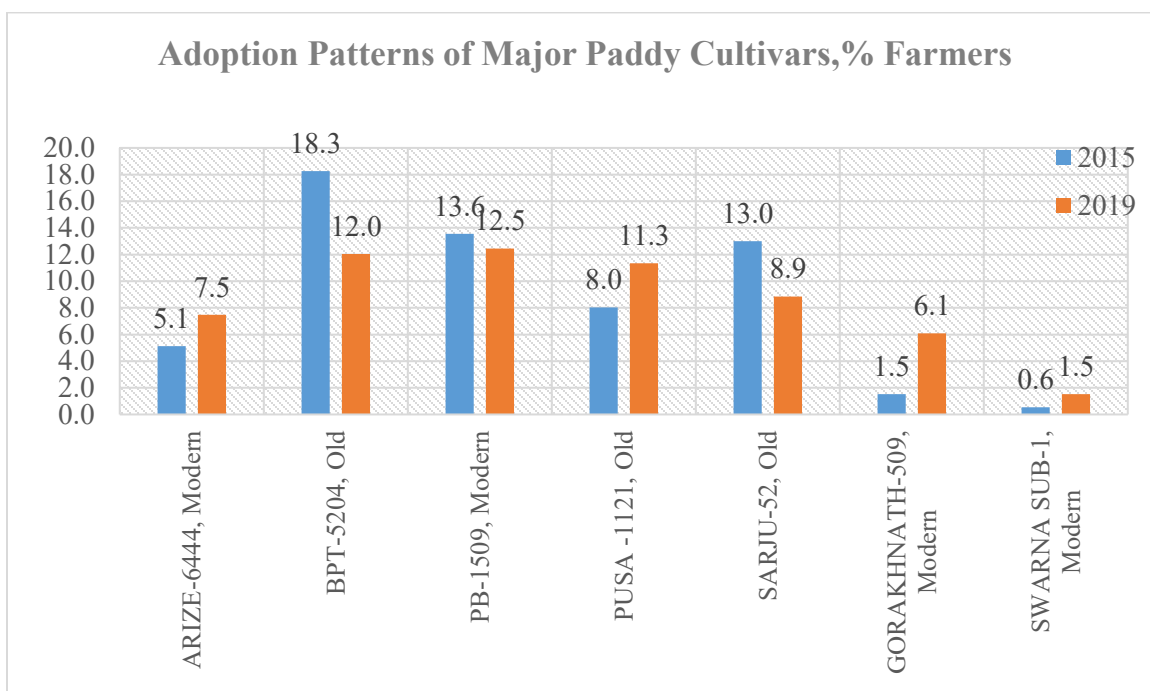
**Figure 5: Adoption of paddy cultivars, percentage of farmers**



**Source:** Indian Council of Agricultural Research–International Food Policy Research Institute Survey, 2019

**Note:** “Modern” cultivars are those released after 2005, and “old” cultivars are those released in 2005 or before. The kharif season is June to September.

**Figure 6: Adoption of major paddy cultivars, percentages of farmers**



**Source:** Indian Council of Agricultural Research–International Food Policy Research Institute Survey, 2019

**Note:** *Arize-6444* is a hybrid cultivar.



**Table 5: Unmatched and matched characteristics of those paddy farmers who received KVK benefits versus those who did not**

Covariates	Unmatched		$p >  t $	Matched		$p >  t $
	Mean			KVK beneficiary	Nonbeneficiary y	
	KVK beneficiary	Nonbeneficiary y				
Male (yes = 1)	0.97	0.94	0.16	0.96	0.98	0.18
Age (years)	43	43	0.53	43	42	0.36
Age squared (years)	2022	1967	0.57	2028	1927	0.33
Education (years)	8.03	7.13	0.04	7.88	9.39	0.00
Scheduled 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 (hectares)	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 color (brown = 1)	0.22	0.17	0.18	0.21	0.17	0.30
Soil color(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 tube well = 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	

**Source:** Authors.

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

**Table 6: Differential impact of PM-KISAN and KVK on the adoption of a modern paddy cultivar, triple difference with matching estimates**

Variable	Main regressions (2019/2020 and 2015/2016)		
	(1)	(2)	(3)
PM-KISAN, $\gamma_1$	-0.064 (0.069)	0.188* (0.104)	0.190* (0.100)
KVKB, $\gamma_2$	0.003 (0.049)	-0.095 (0.094)	-0.071 (0.090)
TIME, $\gamma_3$	-0.028 (0.049)	-0.280** (0.124)	-0.280** (0.123)
KVKB*PM-KISAN, $\gamma_4$	0.007 (0.105)	-0.223* (0.134)	-0.217* (0.130)
KVKB*TIME, $\gamma_5$	0.080 (0.070)	0.321** (0.135)	0.321** (0.134)
PM-KISAN*TIME, $\gamma_6$	-0.057 (0.097)	-0.290 (0.179)	-0.290 (0.183)
PM-KISAN*KVKB*TIME, $\gamma_7$	0.104 (0.147)	0.359* (0.214)	0.359* (0.217)
Constant, $\gamma_0$	0.564*** (0.034)	0.663*** (0.086)	0.682*** (0.088)
Region fixed effects	No	No	Yes
Matching	No	Yes	Yes
Number of observations	1,052	960	960
	Preintervention trends (2015/2016 and 2014/2015)		
	(4)	(5)	(6)
PM-KISAN, $\gamma_1$	-0.059 (0.068)	0.058 (0.111)	0.065 (0.098)
KVKB, $\gamma_2$	-0.017 (0.048)	-0.138* (0.081)	-0.057 (0.074)
TIME, $\gamma_3$	-0.066 (0.048)	-0.072 (0.112)	-0.072 (0.107)
KVKB*PM-KISAN, $\gamma_4$	0.073 (0.102)	-0.034 (0.138)	-0.015 (0.126)
KVKB*TIME, $\gamma_5$	0.020 (0.069)	0.043 (0.124)	0.043 (0.118)
PM-KISAN*TIME, $\gamma_6$	-0.005 (0.097)	0.130 (0.152)	0.130 (0.137)
PM-KISAN*KVKB*TIME, $\gamma_7$	-0.066 (0.147)	-0.189 (0.192)	-0.189 (0.177)
Constant, $\gamma_0$	0.630*** (0.033)	0.735*** (0.072)	0.801*** (0.069)
Region fixed effects	No	No	Yes
Matching	No	Yes	Yes
Number of observations	1,052	960	960

**Source:** Authors.

**Note:** The left-hand side takes a value of 1 if the paddy farmer adopted a modern cultivar, and 0 otherwise. PM-KISAN takes a value of 1 if the farmer is a PM-KISAN beneficiary, and 0 otherwise. KVKB takes a value of 1 if the farmer is a KVK beneficiary, and 0 otherwise. TIME takes a value of 1 for 2019/2020 and 0 for 2015/2016. The region fixed effects dummy takes a value of 1 for the eastern region, and 0 otherwise. Column 1 presents the regression without matching. Columns 2 and 3 present the regression incorporating matching weights in the common support region. The upper panel presents the main regression that compares treatment and control over the period 2015/2016 and 2019/2020. The lower panel presents the preintervention trends and compares the treatment and control groups over the period 2014/2015 and 2015/2016. All regressions are performed using specification 1 as described in the text. Matching is performed using the covariates listed in Table 5. Regression standard errors in parentheses. \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

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