# **Supplemental online material**

Table A: Review of empirical studies on impact of zero-tillage adoption on crop production costs

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Author (s) | Country | Data  | Method | Main findings |
| Teklewold et al. (2013) | Ethiopia | Farm household survey | Multinomial ESR | Adoption of conservation tillage significantly increased pesticide application and labor demands. |
| El‐Shater et al. (2016) | Syria | Farm survey of 621 wheat farmers | PSM and ESR | Negative relationship found between quantity of fertilizer use, quantity of labor use and zero tillage adoption. The major benefits of the adoption of ZT come from tillage and labor cost savings. |
| Jaleta et al. (2016) | Ethiopia | Survey of 12 peasant associations  | Probit and ESR models | Minimum tillage reduces total labor use, and draft power use (oxen-days/ha) for land preparation. |
| Tessema et al. (2018) | Ethiopia | Households survey | 2 step estimation procedure, probit model, OLS | Conservation tillage increases herbicide use but reduces female and male labor requirements. |
| Keil et al. (2020)  | India | Panel dataset from 961 farm households | ESR | Adoption of zero tillage leads to reduction of total variable per-unit production cost |
| Montt and Luu (2020) | Eastern and Southern Africa  | Longitudinal farm data of 3,617 households | Multinomial logit and ERS models | Conservation tillage increases labor requirements in households. However, minimum tillage saves working time during land preparation and weed control. |
| Yigezu and El‐Shater (2021) | Morocco | Survey of 995 households | ESR model | Zero tillage has no effect on the total amount of agricultural labor use. |
| Erenstein et al. (2008) | India & Pakistan | Survey of 400 households in India and 458 households in Pakistan | Descriptive analysis | Resource-saving effects in diesel, tractor time and cost savings for wheat cultivation. Water savings are less pronounced than expected from on-farm trial data. |
| Krishna & Veettil (2014) | India | Survey of 180 households | Production function and semi-parametric technical efficiency estimation methods | Wheat productivity increases by 5%, paid-out variable cost reduces by 14%, while the resource use efficiency indirectly increases by 1% |

Table B: Descriptive statistics of variables by adopters and non-adopters of zero tillage methods

|  |  |  |  |
| --- | --- | --- | --- |
| Variables | 2016 (N=1363) | 2019 (N=1425) | Pooled 2016 and 2019 (N=2788) |
| ZT plots (N=93) | non-ZT plots (N=1270) | mean differ | ZT plots (N=290) | non-ZT plots (N=1135) | mean differ | ZT plots (N=383) | non-ZT plots (N=2405) | mean differ |
| **Outcome variables** |
| Total payment for hired labor (US$/ha)  | 5.199 | 10.584 | -5.385 | 8.891 | 6.199 | 2.692 | 7.994 | 8.514 | -0.052 |
| Machinery costs for land preparation and seeding (US$/ha)  | 11.272 | 36.898 | -25.626\*\*\* | 31.281 | 39.426 | -8.146 | 26.422 | 38.091 | -11.670\*\*\* |
| Machinery costs for weeding (US$/ha)  | 3.714 | 7.395 | -3.681 | 13.935 | 9.919 | 4.017 | 11.453 | 8.586 | 2.867 |
| Herbicide costs (US$/ha) | 7.940 | 7.213 | 0.727 | 31.644 | 19.497 | 12.147\*\*\* | 25.750 | 12.956 | 12.794\*\*\* |
| Total machinery, labor and herbicide costs (US$/ha) | 28.124 | 62.089 | -33.955\*\*\* | 84.192 | 75.283 | 8.909 | 70.250 | 68.257 | 1.993 |
| **Household head characteristics**  |
| Age of household head (years) | 54.516 | 55.887 | -1.371 | 56.928 | 56.001 | 0.927 | 56.342 | 55.941 | 0.401 |
| Education level of household head (categorical, 1=illiterate…7=university) | 4.677 | 4.308 | 0.370\*\*\* | 4.245 | 4.210 | 0.035 | 4.350 | 4.262 | 0.088 |
| Female household head (dummy, 1=female) | 0.247 | 0.195 | 0.052 | 0.197 | 0.267 | -0.070\*\* | 0.209 | 0.229 | -0.02 |
| Household head employment in agriculture (dummy, 1 = occupation in agriculture) | 0.559 | 0.324 | 0.235\*\*\* | 0.431 | 0.313 | 0.118\*\*\* | 0.462 | 0.319 | 0.143\*\*\* |
| Household head’s ethnicity (dummy, 1 = Kyrgyz) | 0.914 | 0.776 | 0.138\*\*\* | 0.783 | 0.766 | 0.017 | 0.815 | 0.772 | 0.042\* |
| **Household farm characteristics**  |
| Number of household members that can work in agriculture (above 10 and under 65 years old) | 4.032 | 4.435 | -0.403\*\* | 4.766 | 4.520 | 0.246\*\* | 4.587 | 4.475 | 0.113 |
| Asset index | 0.425 | 0.398 | 0.027\* | 0.356 | 0.353 | 0.003 | 0.373 | 0.377 | -0.004 |
| Household owns a tractor (dummy, 1=yes) | 0.032 | 0.050 | -0.018 | 0.052 | 0.030 | 0.022\* | 0.047 | 0.041 | 0.006 |
| Number of livestock units owned by household | 4.750 | 3.262 | 1.487\*\*\* | 2.766 | 2.278 | 0.488\* | 3.247 | 2.798 | 0.450\* |
| Household received remittance last year (dummy, 1=yes)  | 0.065 | 0.151 | -0.087\*\* | 0.217 | 0.228 | -0.011 | 0.180 | 0.188 | -0.007 |
| Household applied chemical fertilizer last year (dummy, 1=applied) | 0.129 | 0.261 | -0.132\*\*\* | 0.221 | 0.253 | -0.032 | 0.198 | 0.257 | -0.059\*\* |
| Household experienced a weather shock last year (dummy, 1=yes) | 0.849 | 0.613 | 0.237\*\*\* | 0.186 | 0.154 | 0.032 | 0.347 | 0.396 | -0.049\* |
| Household experienced an agricultural shock last year (dummy, 1=yes) | 0.204 | 0.376 | -0.171\*\*\* | 0.155 | 0.070 | 0.085\*\*\* | 0.167 | 0.232 | -0.065\*\*\* |
| Plot under grains and legumes (dummy, 1=yes) | 0.538 | 0.302 | 0.235\*\*\* | 0.338 | 0.357 | -0.019 | 0.386 | 0.328 | 0.058\*\* |
| Plot under vegetables (dummy, 1=yes) | 0.043 | 0.426 | -0.383\*\*\* | 0.245 | 0.277 | -0.032 | 0.196 | 0.356 | -0.160\*\*\* |
| Plot under a mix of crops (grain, legumes and vegetables) (dummy, 1=yes) | 0.097 | 0.071 | 0.026 | 0.007 | 0.026 | -0.019\* | 0.029 | 0.050 | -0.021 |
| **Location characteristics**  |
| Distance to main road from dwelling (km) | 0.381 | 0.531 | -0.150\* | 0.945 | 0.734 | 0.211\*\*\* | 0.808 | 0.627 | 0.181\*\*\* |
| Distance from dwelling to plot (km)  | 2.085 | 1.425 | 0.660\*\* | 1.398 | 1.117 | 0.281 | 1.565 | 1.280 | 0.285\* |
| Number of land plots owned by household | 2.323 | 1.939 | 0.383\*\*\* | 1.776 | 2.033 | -0.257\*\*\* | 1.909 | 1.983 | -0.075\*\*\* |
| Plot size (ha) | 1.090 | 0.665 | 0.425\*\*\* | 1.007 | 0.739 | 0.268\* | 1.027 | 0.700 | 0.327\*\*\* |
| **Institutional settings**  |
| Amount of credit received by household last year (US$)  | 441.183 | 193.236 | 247.9\*\*\* | 624.287 | 266.337 | 357.950\*\*\* | 579.826 | 227.735 | 352.091\*\*\* |
| *Provinces* |
| Issyk Kul | 0.419 | 0.141 | 0.278\*\*\* | 0.241 | 0.163 | 0.078\*\*\* | 0.285 | 0.151 | 0.133\*\*\* |
| Djalal Abad | 0.118 | 0.220 | -0.101\*\* | 0.155 | 0.212 | -0.057\*\* | 0.146 | 0.216 | -0.070\*\*\* |
| Naryn | 0.161 | 0.066 | 0.095\*\*\* | 0.041 | 0.049 | -0.008 | 0.070 | 0.058 | 0.012 |
| Batken | 0.172 | 0.121 | 0.051 | 0.217 | 0.098 | 0.119\*\*\* | 0.206 | 0.110 | 0.096\*\*\* |
| Osh | 0.075 | 0.274 | -0.199\*\*\* | 0.152 | 0.329 | -0.177\*\*\* | 0.133 | 0.300 | -0.167\*\*\* |
| Talas | 0.011 | 0.084 | -0.073\*\* | 0.017 | 0.084 | -0.066\*\*\* | 0.016 | 0.084 | -0.068\*\*\* |
| Chuy | 0.043 | 0.094 | -0.051 | 0.176 | 0.065 | 0.111\*\*\* | 0.144 | 0.080 | 0.063\*\*\* |

Note: \*\*\*, \*\* and \* are significant at 1%, 5% and 10% level, respectively.

Table C: Falsification test for instrumental variable which is “distance to the main road”

|  |  |  |
| --- | --- | --- |
| Variables | Joint significance test | p-value |
| Zero tillage adoption (probit model regression) | χ2 (1)=7.68 | 0.006 |
| Total payment for hired labor (US$/ha) (ln)  | F(1, 2759) = 0.00 | 0.963 |
| Machinery costs for land preparation and seeding (US$/ha) (ln) | F(1, 2759) = 0.12 | 0.726 |
| Machinery costs for weeding (US$/ha) (ln) | F(1, 2759) = 0.40 | 0.529 |
| Herbicide costs (US$/ha) (ln) | F(1, 2730) = 0.40 | 0.526 |
| Total machinery, labor and herbicide costs (US$/ha) (ln) | F(1, 2730) = 0.42 | 0.519 |

Source: Authors calculation based on LiK data 2016 and 2019.

Table D: Second stage endogenous switching regression estimates for the outcome variables (production costs).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|   | Total payment for hired labor (US$/ha) (ln) | Machinery costs for land preparation and seeding (US$/ha) (ln) | Machinery costs for weeding (US$/ha) (ln) | Herbicide cost (ln) (US$/ha) | Total machinery, labor and herbicide costs (US$/ha) (ln) |
| *ZT plots* | *nZT plots* | *ZT plots* | *nZT plots* | *ZT plots* | *nZT plots* | *ZT plots* | *nZT plots* | *ZT plots* | *nZT plots* |
| Age of household head (years) | 0.002 | -0.007 | 0.026 | 0.001 | 0.021 | -0.009\* | -0.009 | -0.012\*\* | -0.003 | -0.009 |
|  st.err | 0.012 | 0.005 | 0.017 | 0.007 | 0.014 | 0.005 | 0.020 | 0.005 | 0.020 | 0.008 |
| Education level of household head (categorical, 1=illiterate…7=university) | 0.059 | 0.030 | 0.052 | -0.033 | 0.071 | 0.004 | -0.015 | 0.019 | 0.025 | -0.028 |
|  st.err | 0.045 | 0.020 | 0.058 | 0.030 | 0.048 | 0.022 | 0.068 | 0.024 | 0.082 | 0.035 |
| Female household head (dummy, 1=female) | 0.078 | 0.030 | -0.304 | 0.105 | 0.109 | -0.012 | -0.150 | 0.079 | -0.388 | 0.169 |
|  st.err | 0.157 | 0.057 | 0.209 | 0.093 | 0.156 | 0.064 | 0.239 | 0.074 | 0.289 | 0.107 |
| Household head employed in agriculture (dummy, 1 = occupation as agriculture) | 0.338 | 0.154 | 0.684 | 0.464\*\*\* | -0.151 | 0.395\*\*\* | 0.412 | 0.186 | 1.066\*\* | 0.442\*\*  |
|  st.err | 0.307 | 0.099 | 0.437 | 0.165 | 0.379 | 0.121 | 0.450 | 0.130 | 0.525 | 0.191 |
| Number of household members that can work in agriculture (above 10 and under 65 years old) | 0.031 | -0.013 | 0.173 | 0.052 | -0.099 | 0.033 | -0.290\*\* | 0.051 | -0.020 | 0.044 |
|   st.err | 0.099 | 0.032 | 0.149 | 0.050 | 0.123 | 0.033 | 0.130 | 0.034 | 0.177 | 0.055 |
| Household head’s ethnicity (dummy, 1 = Kyrgyz) | -0.203 | -0.162\*\* | 0.218 | 0.272\*\*\* | -0.016 | -0.049 | -0.365 | -0.061 | -0.026 | 0.174 |
|   st.err | 0.199 | 0.063 | 0.235 | 0.096 | 0.201 | 0.066 | 0.325 | 0.079 | 0.358 | 0.113 |
| Assets index | -0.725 | -0.841\*\* | -0.995 | 0.301 | 0.071 | 0.198 | -0.596 | 0.288 | -0.471 | 0.408 |
|  st.err | 0.942 | 0.328 | 1.379 | 0.516 | 1.136 | 0.370 | 1.466 | 0.378 | 1.705 | 0.559 |
| Household owns a tractor (dummy, 1=yes) | 0.010 | 0.005 | 0.014 | 0.287 | -0.466 | -0.010 | 1.322 | 0.218 | 1.059 | 0.361 |
|  st.err | 0.758 | 0.162 | 0.641 | 0.350 | 0.489 | 0.259 | 0.837 | 0.186 | 0.892 | 0.379 |
| Plot size, (ha) | 0.057 | 0.057\*\*\* | 0.011 | -0.030 | 0.013 | 0.070\*\*\* | -0.038 | -0.020 | -0.013 | -0.020 |
|   | 0.038 | 0.019 | 0.033 | 0.020 | 0.024 | 0.016 | 0.031 | 0.016 | 0.050 | 0.023 |
| Household received remittances last year (dummy, 1=yes) | -0.399 | 0.092 | -1.079\*\* | 0.246 | -0.011 | -0.058 | 0.027 | -0.166 | -0.539 | 0.115 |
|  st.err | 0.277 | 0.091 | 0.439 | 0.154 | 0.329 | 0.102 | 0.427 | 0.109 | 0.507 | 0.164 |
| Household experienced a weather shock last year (dummy, 1=yes) | 0.026 | 0.093 | 0.790\*\* | 0.544\*\*\* | -0.110 | 0.084 | 0.152 | 0.207\* | 0.734 | 0.551\*\*\* |
|  st.err | 0.249 | 0.087 | 0.363 | 0.134 | 0.274 | 0.094 | 0.342 | 0.105 | 0.451 | 0.153 |
| Household experienced an agricultural shock last year (dummy, 1=yes) | 0.040 | -0.241\*\*\* | 0.463 | -0.187 | 0.458 | 0.121 | -0.579 | -0.072 | 0.239 | -0.155 |
|  st.err | 0.326 | 0.080 | 0.415 | 0.154 | 0.336 | 0.097 | 0.380 | 0.108 | 0.476 | 0.167 |
| Distance from dwelling to plot (km) | 0.070\*\* | 0.081\*\*\* | 0.110\*\*\* | 0.111\*\*\* | 0.056 | 0.074\*\*\* | 0.002 | 0.027\*\* | 0.066 | 0.119\*\*\* |
|  st.err | 0.033 | 0.015 | 0.039 | 0.018 | 0.039 | 0.015 | 0.032 | 0.012 | 0.045 | 0.018 |
| Household applied chemical fertilizers last year (dummy, 1=applied) | 0.379 | 0.306\*\*\* | 0.377 | 0.868\*\*\* | 0.876\*\* | 0.259\*\*\* | 0.531 | 0.803\*\*\* | 1.059\*\* | 1.233\*\*\* |
|  st.err | 0.321 | 0.078 | 0.455 | 0.128 | 0.407 | 0.091 | 0.420 | 0.101 | 0.520 | 0.138 |
| Number of land plots owned by household | -0.029 | -0.071\* | -0.275 | 0.088 | -0.069 | 0.055 | -0.079 | -0.063 | -0.363 | -0.005 |
|  st.err | 0.136 | 0.039 | 0.188 | 0.064 | 0.159 | 0.046 | 0.198 | 0.047 | 0.224 | 0.074 |
| Number of livestock units owned by households | -0.026 | 0.007 | -0.064 | -0.014 | -0.079\*\* | -0.002 | 0.096\*\* | 0.032\*\*\* | -0.051 | 0.004 |
|  st.err | 0.032 | 0.011 | 0.048 | 0.016 | 0.031 | 0.009 | 0.037 | 0.012 | 0.058 | 0.018 |
| Amount of credits received by household last year (logarithm, US$) | 0.018 | 0.022 | 0.023 | -0.015 | 0.008 | -0.008 | 0.056 | -0.036\*\* | 0.071 | -0.021 |
|  st.err | 0.038 | 0.014 | 0.054 | 0.023 | 0.029 | 0.016 | 0.048 | 0.016 | 0.068 | 0.025 |
| Plot under grains and legumes (dummy, 1=yes) | 0.018 | 0.039 | 1.261\*\*\* | 1.774\*\*\* | 0.279 | 0.367\*\*\* | -0.189 | -0.135 | 1.250\*\*\* | 1.565\*\*\* |
|  st.err | 0.154 | 0.075 | 0.223 | 0.105 | 0.196 | 0.084 | 0.217 | 0.088 | 0.285 | 0.121 |
| Plot under vegetables (dummy, 1=yes) | -0.362 | -0.342\*\*\* | 0.070 | 0.656\*\*\* | 0.050 | -0.032 | 0.625 | -0.299\*\*\* | 0.511 | 0.346\*\*\* |
|   | 0.336 | 0.070 | 0.499 | 0.114 | 0.375 | 0.081 | 0.412 | 0.087 | 0.522 | 0.131 |
| Plot under a mix of crops (grain, legumes and vegetables) (dummy, 1=yes) | 0.337 | -0.431\*\*\* | 2.185\*\*\* | 2.076\*\*\* | 0.554 | 0.060 | -0.931 | -0.458\*\*\* | 1.301\*\* | 1.489\*\*\* |
|  st.err | 0.557 | 0.108 | 0.598 | 0.181 | 0.492 | 0.126 | 0.632 | 0.130 | 0.623 | 0.196 |
| Djalal-Abad | -0.271 | -0.223\*\* | -1.932\*\*\* | -0.783\*\*\* | -0.290 | -0.894\*\*\* | -0.422 | -1.444\*\*\* | -1.850\*\*\* | -1.451\*\*\* |
|  st.err | 0.378 | 0.095 | 0.574 | 0.176 | 0.438 | 0.135 | 0.538 | 0.139 | 0.630 | 0.199 |
| Naryn | -0.049 | 0.119 | -1.191\*\* | -0.841\*\*\* | -0.455 | -0.775\*\*\* | -0.427 | -1.035\*\*\* | -1.249\*\* | -1.181\*\*\* |
|  st.err | 0.273 | 0.124 | 0.507 | 0.196 | 0.347 | 0.129 | 0.344 | 0.144 | 0.552 | 0.216 |
| Batken | 0.060 | -0.014 | -0.021 | -0.635\*\*\* | 0.092 | -0.362\*\*\* | 0.409 | -0.696\*\*\* | 0.624 | -0.974\*\*\* |
|  st.err | 0.223 | 0.060 | 0.311 | 0.145 | 0.266 | 0.110 | 0.397 | 0.135 | 0.435 | 0.180 |
| Osh | 0.575 | -0.226\*\* | -0.393 | -0.062 | 0.271 | -1.022\*\*\* | 0.767 | -1.174\*\*\* | 0.236 | -0.740\*\*\* |
|  st.err | 0.622 | 0.112 | 0.775 | 0.210 | 0.617 | 0.154 | 0.790 | 0.160 | 0.887 | 0.233 |
| Talas | -0.003 | 0.413\*\* | -2.291 | -0.523\* | -0.462 | -0.638\*\*\* | -0.725 | -1.135\*\*\* | -2.240 | -0.975\*\*\* |
|  st.err | 1.062 | 0.168 | 1.546 | 0.283 | 1.198 | 0.207 | 1.351 | 0.197 | 1.694 | 0.305 |
| Chuy | 0.392 | 0.473\*\*\* | -0.607 | -0.463\*\*\* | -0.220 | -0.166 | 0.170 | -0.699\*\*\* | -0.270 | -0.776\*\*\* |
|  st.err | 0.335 | 0.111 | 0.526 | 0.170 | 0.381 | 0.126 | 0.490 | 0.144 | 0.618 | 0.208 |
| Survey year (2019=1) | 0.447 | -0.173\* | 2.545\*\* | -0.173 | 0.809 | 0.305\*\*\* | -0.995 | 0.368\*\*\* | 1.611 | -0.022 |
|  st.err | 0.717 | 0.097 | 1.106 | 0.161 | 0.750 | 0.104 | 1.076 | 0.127 | 1.343 | 0.175 |
| Mean of age of household head | 0.002 | 0.014\*\*\* | -0.010 | -0.004 | -0.016 | 0.010 | 0.020 | 0.012\*\* | 0.030 | 0.007 |
| st.err | 0.013 | 0.005 | 0.019 | 0.008 | 0.017 | 0.006 | 0.023 | 0.006 | 0.023 | 0.009 |
| Mean of household head employed in agriculture | -0.330 | 0.030 | -0.012 | 0.015 | 0.386 | -0.187 | -0.618 | 0.071 | -0.562 | 0.075 |
| st.err | 0.254 | 0.113 | 0.482 | 0.191 | 0.406 | 0.135 | 0.418 | 0.147 | 0.540 | 0.216 |
| Mean number of household members that can work in agriculture | 0.003 | 0.018 | 0.009 | -0.013 | 0.189 | 0.009 | 0.332\*\* | -0.039 | 0.188 | -0.018 |
| st.err | 0.111 | 0.035 | 0.172 | 0.054 | 0.144 | 0.036 | 0.146 | 0.039 | 0.194 | 0.060 |
| Mean of assets index | 0.538 | 0.775\* | 1.073 | -0.755 | 0.063 | -0.450 | 0.833 | -0.228 | 1.985 | -0.504 |
| st.err | 1.128 | 0.400 | 1.732 | 0.650 | 1.398 | 0.475 | 2.049 | 0.487 | 2.324 | 0.730 |
| Mean of household owns a tractor | -0.293 | -0.226 | -0.499 | 0.317 | -0.489 | 0.084 | -2.032\*\* | -0.341 | -2.306\*\* | -0.090 |
| st.err | 0.818 | 0.225 | 0.964 | 0.451 | 0.648 | 0.343 | 1.024 | 0.267 | 1.139 | 0.506 |
| Mean of household received remittances last year | -0.018 | 0.006 | 0.831 | -0.255 | -0.721 | -0.001 | -0.136 | 0.070 | -0.302 | -0.199 |
| st.err | 0.438 | 0.121 | 0.615 | 0.197 | 0.482 | 0.131 | 0.528 | 0.145 | 0.657 | 0.213 |
| Mean of household experienced a weather shock last year | 0.128 | -0.069 | -0.603 | -0.140 | -0.227 | 0.112 | 0.049 | -0.383\*\*\* | -0.422 | -0.412\*\*  |
| st.err | 0.346 | 0.112 | 0.506 | 0.182 | 0.406 | 0.127 | 0.473 | 0.144 | 0.628 | 0.210 |
| Mean of household experienced an agricultural shock last year | 0.398 | 0.311\*\*\* | -0.619 | 0.421\*\* | -1.013\*\*\* | -0.056 | -0.230 | -0.211 | -0.712 | 0.353 |
| st.err | 0.354 | 0.115 | 0.439 | 0.207 | 0.363 | 0.128 | 0.460 | 0.157 | 0.547 | 0.235 |
| Mean of amount of credit received by household last year (ln) | 0.003 | 0.009 | 0.035 | 0.053\* | -0.042 | 0.050\*\* | 0.016 | 0.090\*\*\* | 0.028 | 0.088\*\*\* |
| st.err | 0.041 | 0.018 | 0.079 | 0.030 | 0.044 | 0.022 | 0.060 | 0.023 | 0.089 | 0.033 |
| Mean of household applied chemical fertilizers last year | 0.587 | 0.373\*\*\* | 0.727 | 0.328 | 0.123 | 0.414\*\*\* | 0.652 | 0.609\*\*\* | 0.972 | 0.657\*\*\* |
| st.err | 0.511 | 0.132 | 0.678 | 0.214 | 0.549 | 0.149 | 0.685 | 0.160 | 0.791 | 0.228 |
| Mean of number of livestock units owned by household | 0.034 | 0.007 | 0.124\*\* | 0.025 | 0.099\*\*\* | -0.006 | -0.110\*\*\* | -0.024\*\* | 0.092 | 0.019 |
|  st.err | 0.032 | 0.015 | 0.055 | 0.019 | 0.036 | 0.012 | 0.042 | 0.012 | 0.066 | 0.022 |
| year (2019)\*mills1 | -0.107 |   | -0.042 |   | -0.296 |   | 0.872 |   | 0.424 |   |
| st.err | 0.393 |   | 0.625 |   | 0.410 |   | 0.544 |   | 0.709 |   |
| mills1 | 0.628 |   | 2.515\*\* |   | 0.488 |   | -0.660 |   | 1.887 |   |
| st.err | 0.828 |   | 1.203 |   | 0.920 |   | 1.206 |   | 1.374 |   |
| year (2019)\*mills2 |   | -1.354\*\*\* |   | -2.702\*\*\* |   | -1.705\*\*\* |   | -1.251\*\*\* |   | -3.460\*\*\* |
| st.err |   | 0.439 |   | 0.710 |   | 0.492 |   | 0.459 |   | 0.791 |
| mills2 |   | 2.486\*\*\* |   | 3.803\*\*\* |   | 3.312\*\*\* |   | 2.282\*\*\* |   | 4.490\*\*\* |
| st.err |   | 0.703 |   | 1.119 |   | 0.790 |   | 0.734 |   | 1.253 |
| \_cons | -1.678 | 0.191 | -6.501\*\* | 0.804\*\* | -1.378 | 0.630\*\*\* | 1.178 | 1.471\*\*\* | -5.434 | 1.883\*\*\* |
| st.err | 1.891 | 0.193 | 2.819 | 0.348 | 2.215 | 0.240 | 2.975 | 0.287 | 3.296 | 0.402 |
| **R2** | **0.253** | **0.172** | **0.395** | **0.331** | **0.246** | **0.128** | **0.307** | **0.183** | **0.351** | **0.293** |
| **N** | **383** | **2405** | **383** | **2405** | **383** | **2405** | **373** | **2365** | **373** | **2365** |

Note: \*\*\*, \*\* and \* are significant at 1%, 5% and 10% level, respectively.

Table E: Propensity score matching (PSM) estimation (ATET) results (impact of zero tillage adoption)

|  |  |  |
| --- | --- | --- |
| Outcome variable | ATT (average treatment effect on the treated) | z-value |
| Coefficient | Standard error |
| Total payment for hired labor (USD $/ha) (ln) | 0.170\*\* | 0.071 | 2.400 |
| Machinery costs for land preparation and seeding (USD $/ha) (ln) | -0.292\* | 0.159 | -1.840 |
| Machinery costs for weeding (USD $/ha) (ln) | 0.120 | 0.110 | 1.080 |
| Herbicide cost (USD $/ha) (ln) | 0.128 | 0.126 | 1.010 |
| Total cost (USD $/ha) (ln) | -0.311\* | 0.167 | -1.860 |

Note: \*\*\*, \*\* and \* are significant at 1%, 5% and 10% level, respectively