**Supplementary material**

Table S1: Characteristics of surveyed households divided into three groups (treatment group, control-in group, and control-out group) before matching

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Characteristics | Treatment mean  (n=355) | Control-in mean  (n=452) | Control-out mean  (n=406) | t-test  (mean treatment – mean control-in) | t-test  (mean control-in mean control-out) |
| Continuous Variables | | | | | |
| Time to nearest market (minutes for one-way travel) | 62.73  (2.62) | 63.69  (2.17) | 85.31  (3.58) | -0.29 ns | -5.28 \*\*\* |
| Time to nearest CBSPa (minutes for one-way travel) | 10.73  (0.54) | 11.38  (0.63) | NA | -0.78 ns | NA |
| Total cultivable area (ha) | 0.51  (0.03) | 0.43  (0.03) | 0.56  (0.03) | 2.34 \*\* | -3.84 \*\*\* |
| Years growing maize | 35.96  (0.76) | 36.99  (0.67) | 35.58  (0.72) | -1.00 ns | 1.43 ns |
| Percentage of females in the household | 0.50  (0.009) | 0.49  (0.007) | 0.47  (0.01) | 0.46 ns | 1.34 ns |
| Economically-active population in the family (ages 16-65 years) | 3.88  (0.10) | 3.81  (0.09) | 3.90  (0.09) | 0.57 ns | -0.80 ns |
| Percentage of *bari* land (upland) of the total agricultural land | 0.69  (0.015) | 0.66  (0.014) | 0.70  (0.017) | 1.51 ns | -1.76 \* |
| Number of relatives who are available when support needed | 6.37  (0.44) | 6.11  (0.36) | 6.97  (0.42) | 0.47 ns | -1.52 ns |
| Time to agricultural extension office (minutes for one-way travel) | 53.49  (2.52) | 56.12  (1.94) | 63.22  (3,31) | -0.84 ns | -1.97 \*\* |
| Percent increase in maize area in the past five years | 0.19  (0.021) | 0.13  (0.016) | 0.19  (0.02) | 2.26 \*\* | -2.08 \*\* |
| Binary Variables (dummy, 1: yes; 0: no) | | | | | |
| Male household head | 0.78  (0.02) | 0.80  (0.02) | 0.86  (0.02) | -0.52 ns | -2.23 \*\* |
| Rice-growing household | 0.67  (0.025) | 0.69  (0.22) | 0.52  (0.02) | -0.38 ns | 5.14 \*\*\* |
| Household had television in base year | 0.54  (0.02) | 0.50  (0.02) | 0.62  (0.02) | 1.13 ns | -3.38 \*\*\* |
| Household uses fertilizer | 0.67  (0.025) | 0.59  (0.02) | 0.50  (0.02) | 2.39 \*\* | 2.54 \*\* |
| Household head literate | 0.72  (0.024) | 0.68  (0.022) | 0.70  (0.02) | 1.20 ns | -66 ns |
| Household had *kacchi*b house in the base year | 0.76  (0.02) | 0.76  (0.02) | 0.72  (0.02) | -0.07 ns | 1.52 ns |
| Household grew more than two varieties of maize in base year | 0.19  (0.025) | 0.05  (0.01) | 0.03  (0.01) | 6.37 \*\*\* | 1.50 ns |

Note: \*, \*\*, \*\*\* denote significance of mean difference at the 10%, 5%, and 1% level, respectively; ns=not significant at 10%, standard error in brackets

aTime to nearest CBSP is not included for comparing spillover impact (control-in vs. control-out) as CBSPs are only formed in project districts, and control-out group households are from outside project districts

b*Kacchi* house means non-concrete/non-brick house

Table S2: Test of matching quality by comparing the mean of the treatment and control group after matching with percentage bias reduction

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Variable | Treatment group | Control-in group | % Bias | % Reduction in bias | p-value for equality of mean after matching |  |
| Time to nearest market (minutes for one-way travel) | 62.47 | 62.59 | -0.2 | 90.2 | 0.97 |  |
| Time to nearest CBSP (minutes for one-way travel) | 10.73 | 11.49 | -6.5 | -16.2 | 0.40 |  |
| Total cultivable area (ha) | 0.51 | 0.53 | -4.4 | 73.6 | 0.61 |  |
| Years growing maize | 35.93 | 35.71 | 1.6 | 79.4 | 0.83 |  |
| Percentage of females in the household | 0.49 | 0.49 | 1.5 | 44.5 | 0.84 |  |
| Economically-active population in the family (ages 16 – 65 years) | 3.91 | 4.08 | -9.6 | -85.3 | 0.22 |  |
| Percentage of *bari* (upland) land of the total agricultural land | 0.69 | 0.67 | 6.7 | 39.5 | 0.36 |  |
| Number of relatives who are available when support needed | 6.44 | 6.66 | -2.8 | 36.4 | 0.72 |  |
| Time to agricultural extension office (minutes for one-way travel) | 53.84 | 53.64 | 0.5 | 90.5 | 0.95 |  |
| Percent increase in maize area in the past five years | 0.19 | 0.21 | -4.9 | 70.2 | 0.55 |  |
| Male household head | 0.78 | 0.79 | -3.3 | 8.7 | 0.67 |  |
| Rice-growing household | 0.67 | 0.71 | -7.4 | -143.0 | 0.33 |  |
| Household had television in base year | 0.54 | 0.58 | -7.8 | 2.0 | 0.29 |  |
| Household uses fertilizer | 0.67 | 0.67 | -0.8 | 95.3 | 0.91 |  |
| Household head literate | 0.72 | 0.74 | -4.8 | 48.0 | 0.52 |  |
| Household had *kacchi* house in the base year | 0.76 | 0.77 | -4.0 | -147.5 | 0.59 |  |
| Household grew more than two varieties of maize in base year | 0.20 | 0.19 | 2.9 | 93.4 | 0.75 |  |
|  | unmatched | matched |  |  |  |  |
| PS R2 | 0.06 | 0.01 |  |  |  |  |
| Mean bias | 10 | 4 |  |  |  |  |

Table S3: Summary statistics of the impact outcome indicators comparing the treatment and control-in group

|  |  |  |  |
| --- | --- | --- | --- |
| Outcome | Treatment mean | Control-in mean | t-test |
| Maize income | 442\*\*\* (20) | 308 (15) | 5.5 |
| Maize sufficiency | 9.4\* (0.17) | 9.0 (0.16) | 1.68 |
| Food expenditure | 26.6 ns (1.40) | 27.4 (1.17) | 0.44 |
| Female workload | 0.69ns (0.87) | 0.67 (0.79) | 1.47 |
| Female leadership | 40.3\*\*\* (2.47) | 23.6 (1.95) | 5.39 |

Note: \*, \*\*, \*\*\* denote significance of difference in mean at the 10%, 5%, and 1% level, respectively; ns=not significant at 10%.The figures in the parentheses are std error.

Table S4: Sensitivity of average treatment effect of five outcome indicators based on three different matching methods

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Matching  methods | Average treatment effect on outcomes | | | | |
| Maize income | Maize sufficiency | Food expenditure | Female workload | Female leadership |
| Nearest neighbor | 122.33 \*\*\* (24.75) | -0.02 ns  (0.23) | -0.59 ns  (1.69) | 1.50 ns  (1.42) | 16.25 \*\*\*  (3.22) |
| Kernel matching (bandwidth (0.05)) | 135.19 \*\*\*  (27.62) | 0.06 ns  (0.27) | 1.57 ns  (2.05) | 1.36 ns  (1.33) | 15.92 ns  (3.52) |
| Radium matching caliper (0.05) | 134.06\*\*\*  (27.56) | 0.09 ns  (0.27) | 1.43 ns  (2.04) | 1.43 ns  (1.34) | 15.72 \*\*\*  (3.51) |

Note: \*, \*\*, \*\*\* denote significance of difference in mean at the 10%, 5%, and 1% level. Treatment effect for nearest neighbor matching using teffects psmatch while that for Kernel matching and radium matching were done using psmatch2 command in Stata

Table S5: Results of placebo regression to re-affirm no hidden bias due to omitted variable

|  |  |  |
| --- | --- | --- |
| Dependent variable:  years spouse involved in farming | Coefficients | Standard error |
| HH is member of CBSP group (1=yes, 0=no) | 0.97 ns | 1.02 |
| Time to nearest market (minutes for one-way travel) | -0.01 ns | 0.01 |
| Time to nearest CBSP (minutes for one-way travel) | 0.56 ns | 0.04 |
| Total cultivable area (ha) | 0.99 ns | 1.18 |
| Years growing maize | 0.54\*\*\* | 0.04 |
| Percentage of females in the household | -6.25\* | 3.22 |
| Economically-active population in the family (ages 16 – 65 years) | 0.28 ns | 0.27 |
| Percentage of *bari* (upland) land of the total agricultural land | -0.29 ns | 2.45 |
| Number of relatives who are available when support needed | 0.07 ns | 0.06 |
| Time to agricultural extension office (minutes for one-way travel) | 0.03\*\* | 0.01 |
| Percent increase in maize area in the past five years | 0.93 ns | 1.35 |
| Male household head (1=yes, 0=No) | 18.22\*\*\* | 1.31 |
| Rice-growing household (1=yes, 0=No) | 0.90 ns | 1.51 |
| Household had television in base year (1=yes, 0=No) | -0.53 ns | 1.05 |
| Household uses fertilizer (1=yes, 0=No) | -1.36 ns | 1.04 |
| Household head literate (1=yes, 0=No) | 2.59\*\* | 1.19 |
| Household had non-concrete house (1=yes, 0=No) | 0.19 ns | 1.19 |
| Household grew more than two varieties of maize in base year (1=yes, 0=No) | -0.44 ns | 1.62 |
| Constant | -13.37\*\* | 3.95 |
| R-sq | 0.43 |  |
| Num obs | 796 |  |

Table S6: Summary statistics of variety adoption, yield, food expenditure, and maize sufficiency for control-in and control-out households

|  |  |  |  |
| --- | --- | --- | --- |
| Outcome | Control-in mean | Control-out mean | t-test |
| Improved seed adoption | 0.27\*\*\* (0.02) | 0.10 (0.02) | 6.29 |
| Maize yield | 2.21\* (0.0.06) | 1.90 (0.06) | 3.58 |
| Food expenditure | 27.39 (1.17) | 35.49\*\*\* (1.58) | -4.17 |
| Maize sufficiency | 9.0\* (0.16) | 8.58 (0.18) | 1.72 |

Note: \*, \*\*, \*\*\* denote significance of difference in mean at the 10%, 5%, and 1% level, respectively; ns=not significant at 10%.The figures in the parentheses are std error.

Table S7: Sensitivity of the treatment effect of spillover impact based on different methods for outcome indicators

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Outcome variable | ATE for impact outcome variables | | | |
|  | HMRP variety adoption | Yield | PC cereal expenditure | Maize sufficiency |
| Nearest neighbor | 0.18 \*\*\* (0.03) | 0.37\*\*\* (0.09) | -5.74\*\* (2.23) | 0.68\*\*\* (0.26) |
| Radium matching caliper (0.05) | 0.17\*\*\* (0.03) | 0.38\*\*\* (0.10) | -5.28\*\*\* (2.60) | 0.89\*\*\* (0.32) |
| Kernel matching (bandwidth (0.05) | 0.17 \*\*\* (0.32) | 0.38\*\*\* (0.10) | -5.38\*\* (2.60) | 0.90\*\*\* (0.32) |

Note: \*, \*\*, \*\*\* denote significance of difference in mean at the 10%, 5%, and 1% level. ATE for nearest neighbor matching using teffects psmatch while that for Kernel matching, and radium matching were done using psmatch2 command in Stata

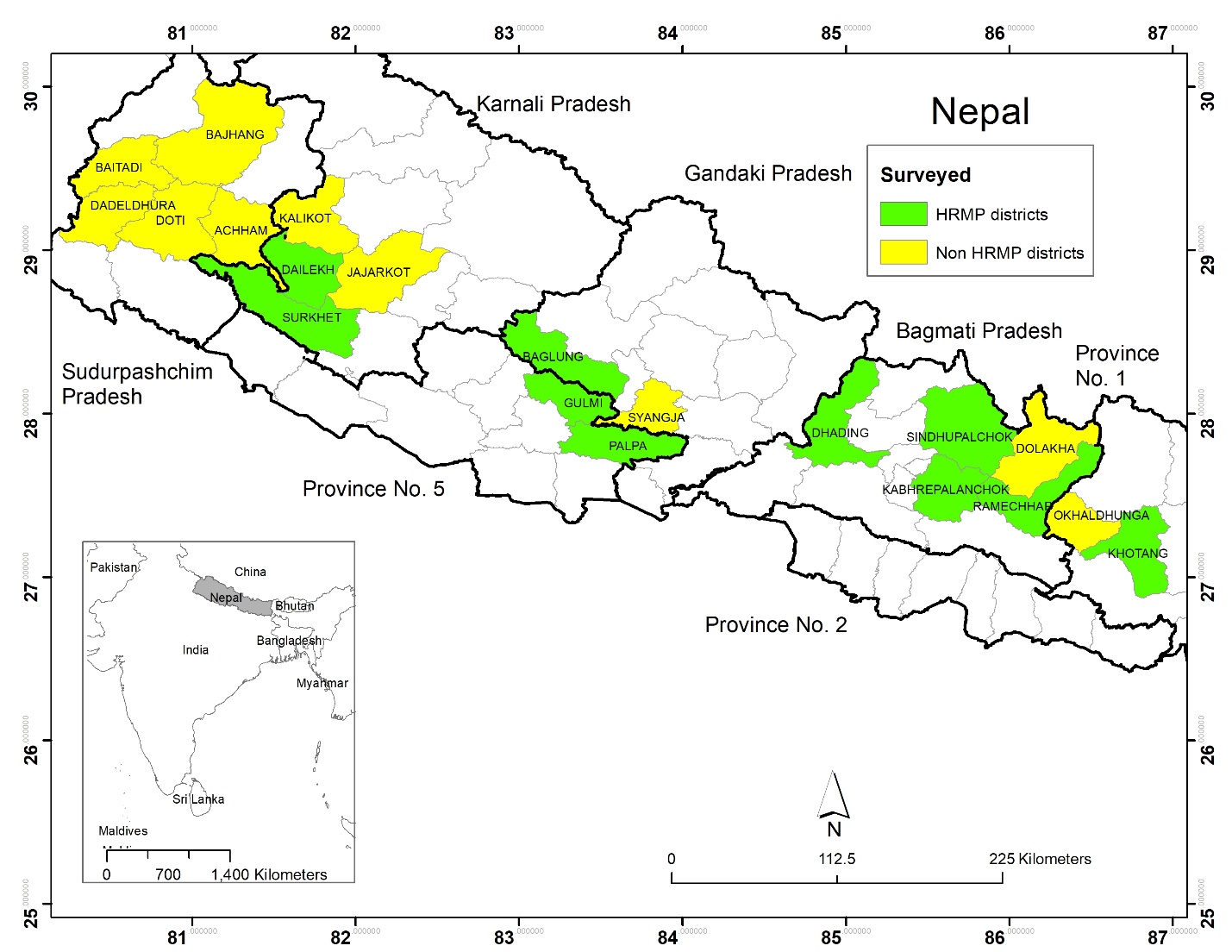


Figure S1: Map of Nepal (75 districts) with surveyed districts (10 from project districts; 10 from non-project districts)