Solar Powered Irrigation Pumps in Nepal's Terai

This draft based on the outline that sent few weeks ago. I followed the variables manshened in it and add some

All numbers calculated here consider the entire sample - including zeros.

There us two variables appear in two different datasets:
'Time to irrigate 1 katha' and 'fuel use for a year', the results from both datasets appear here as well

About the tables:

- Each table is divided into two: The first for 'Saptari' and second for the 3 districts of Rautahat ,Bara and Sarlahi - I called it 'RBS' and colored if for convenience
- I added a brief explanation of the variable if needed
- also added the question from the questionnaire and its serial number
- Some variables needed calculation, so I added the calculation method and the variables included

Land

Table 1: Total Own Land Cultivated - Summer

The total own land cultivated for a houshold in **Summer** season (In hectare)
Q [4.4] *total_ownland_cultivated*

SAPTARI	Control		Treatment	
year	N	Mean	N	Mean
2017	91	0.32	22	0.61
2018	91	0.30	22	0.62
2019	84	0.16	23	0.25
RBS				
2018	107	0.23	26	0.72
2019	95	0.31	22	1.14

Table 2: Gross Cropped Area

total cultivated area for a year in hectare:

the total area sown for monsoon,winter, summer and annual crops- all together
Q[4.8] *total_land_cultivated*

SAPTARI	Control		Treatment	
year	N	Mean	N	Mean
2017	91	2.53	22	4.08
2018	91	2.50	22	3.88
2019	84	2.11	23	3.02
RBS				
2018	107	4.04	26	5.33
2019	95	3.66	22	7.07

Table 3: Cropping Intensity

measured by percentage in household level
Gross cropped Area/Net Cropped Area ×100
sum ([4.8] total_land_cultivated) / [4.1e] land_for_cultivation

SAPTARI	Control		Treatment	
year	N	Mean	N	Mean
2017	91	175	22	196
2018	91	168	22	188
2019	84	144	23	152
RBS				
2018	107	171	26	203
2019	95	177	22	186

Irrigation

Irrigation measured by 3 parameters

- Size of the irrigated area
- Time taken to irrigate cultivated area
- Irrigation intensity

Table 4: Size of the irrigated area

Irrigated area for a household in hectare
Q [4.9] Irrigated area out of total land cultivated

SAPTARI	Control		Treatment	
year	N	Mean	N	Mean
2017	91	2.25	22	3.25
2018	91	1.98	22	3.06
2019	84	1.87	23	2.73
RBS				
2018	107	2.55	26	3.88
2019	95	3.21	22	5.13

Irrigation in hours

Time taken to irrigate cultivated area - measured by hours in household level

The data about '1 hectare irrigation time' - is from two dataset:

Water extraction mechanism [6.2] and *Agriculture [5.0]*

Table 5: Time taken to irrigate 1 ha

Q [6.21] How long does it take to irrigate 1 katha of land with this pump

SAPTARI	Control		Treatment	
	N	Mean	N	Mean
2017	94	47	22	61
2018	94	46	22	62
2019	92	51	23	89
RBS				
2018	107	24	30	21
2019	100	16	30	32

Table 6 and table 7 are about 2 parameters:

1. Time to irrigate 1 hectare
   Calculated by: Multiply *hrs_irr_1katha*[5.7] **by** *no_of_irrigation_for_1_katha*[5.8] **by** *cult_area_under_crop*[5.5]
2. Average irrigation hours per household in a year
   based on :*hrs_irr_1katha [5.7]*

Table 6: Time taken to irrigate - YEARLY

SAPTARI	Control			Treatment		
Year	N	mean 1 ha	Mean Total	N	mean 1 ha	Mean Total
2017	94	37	203	22	41	405
2018	94	37	188	22	41	342
2019	92	41	212	23	61	380
RBS						
2018	107	28	348	26	22	244
2019	95	26	396	21	22	456

Table 7: Time taken to irrigate - SEASONAL

Saptari

	Control			Treatment		
MONSOON	N	mean 1 ha	Total	N	mean 1 ha	Total
2017	89	33	73	20	40	137
2018	90	34	53	22	39	109
2019	83	37	92	22	57	189
SUMMER						
2017	70	35	58	18	50	140
2018	62	41	66	16	46	118
2019	48	43	45	17	72	87
WINTER						
2017	88	41	91	22	41	167
2018	87	42	102	22	43	135
2019	81	44	99	22	60	141

Rautahat Bara Sarlah

		Control			Treatment		
Season	Year	N	mean 1 ha	Total	N	mean 1 ha	Total
Monsoon	2018	105	31	208	25	21	117
	2019	94	32	253	21	31	316
Summer	2018	33	35	144	7	22	111
	2019	38	16	51	11	13	85
Winter	2018	105	24	81	25	19	54
	2019	94	25	92	21	20	89

Irrigation Intensity

Measured by percentage in household level
Gross Irrigated Area/Gross Cropped Area $\times 100$

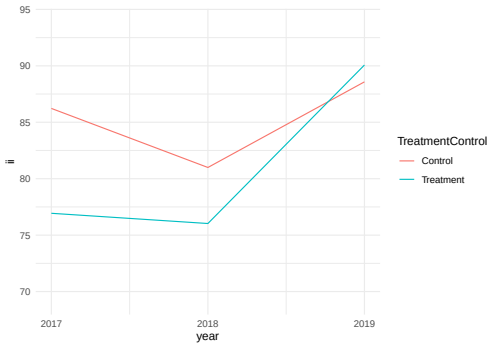
sum *[4.9] irrigated_out_of_tot_land_cult* / sum *[4.8] total_land_cultivated*

Table 8: Irrigation Intensity - YEARLY

SAPTARI	Control		Treatment	
	N	Mean	N	Mean
2017	91	86.23	22	76.94
2018	91	80.99	22	76.03
2019	83	88.58	23	90.07

difference in difference

- **after 1 year**




```
##
## Call:
## lm(formula = ii ~ after_1Y * own_sp, data = irri_intens_S)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -87.349  -6.383  12.651  16.351  23.970
##
## Coefficients:
##                          Estimate Std. Error t value Pr(>|t|)
## (Intercept)                87.349      2.143  40.752   <2e-16 ***
## after_1YTRUE               -6.355      3.658  -1.738   0.0832 .
## own_spTRUE                 -3.700      4.729  -0.783   0.4345
## after_1YTRUE:own_spTRUE    -1.264      8.215  -0.154   0.8778
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 28.27 on 328 degrees of freedom
## Multiple R-squared:  0.01553,    Adjusted R-squared:  0.006522
## F-statistic: 1.724 on 3 and 328 DF,  p-value: 0.1618
```

- **after 2 year**

```
##
## Call:
## lm(formula = ii ~ after_2Y * own_sp, data = irri_intens_S)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -83.611  -5.992  11.420  16.389  23.517
##
## Coefficients:
##                          Estimate Std. Error t value Pr(>|t|)
## (Intercept)                83.611      2.092  39.965   <2e-16 ***
## after_2YTRUE                4.969      3.738   1.329    0.185
## own_spTRUE                 -7.128      4.741  -1.503    0.134
## after_2YTRUE:own_spTRUE     8.620      8.168   1.055    0.292
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 28.22 on 328 degrees of freedom
## Multiple R-squared:  0.019,  Adjusted R-squared:  0.01003
## F-statistic: 2.118 on 3 and 328 DF,  p-value: 0.09782
```

Matching

- after 1 year

```
##                 Stratified by TreatmentControl
##                  Control       Treatment     p      test
##   n                 22            22
##   ii (mean (SD)) 73.49 (39.02) 76.03 (32.06)  0.815
```

- after 2 year

```
##                 Stratified by TreatmentControl
##                  Control       Treatment     p      test
##   n                 19            22
##   ii (mean (SD)) 91.63 (14.79) 89.62 (18.26)  0.704
```

RBS				
2018	104	65.23	26	79.27
2019	94	88.75	22	85.07

Table 9: Irrigation Intensity - SEASONAL

SAPTARI	Monsoon		summer		Winter	
	Control	Treatment	Control	Treatment	Control	Treatment
2017	90.87	81.82	79.29	72.16	85.05	76.21
2018	84.28	77.27	75.46	79.84	83.65	76.48
2019	90.08	93.60	89.73	86.91	88.50	86.20
RBS						
2018	71.10	92.75	66.54	90	59.29	63.42
2019	98.39	95.45	63.09	75	83.31	78.57

Frequency of households who irrigate

The table contains -

- The number of households who irrigate
- Percentage of households from their group - **not** from the entire sample

Table 10: households who irrigate

Q [4.9] Irrigated area out of total land cultivated

SAPTARI	Monsoon				Summer				Winter			
	Control		Treatment		Control		Treatment		Control		Treatment	
	n	Percent	n	Percent	n	Percent	n	Percent	n	Percent	n	Percent
2017	83	88%	18	82%	57	61%	16	73%	81	86%	20	91%
2018	77	89%	17	77%	50	53%	17	77%	79	84%	20	91%
2019	81	88%	22	96%	49	53%	16	70%	78	85%	21	91%

RBS	Monsoon				Summer				Winter			
	Control		Treatment		Control		Treatment		Control		Treatment	
	n	Percent	n	Percent	n	Percent	n	Percent	n	Percent	n	Percent
2018	98	92%	25	83%	26	24%	9	30%	96	90%	23	76%
2019	95	95%	21	70%	27	27%	9	30%	94	94%	21	70%

Fuel use

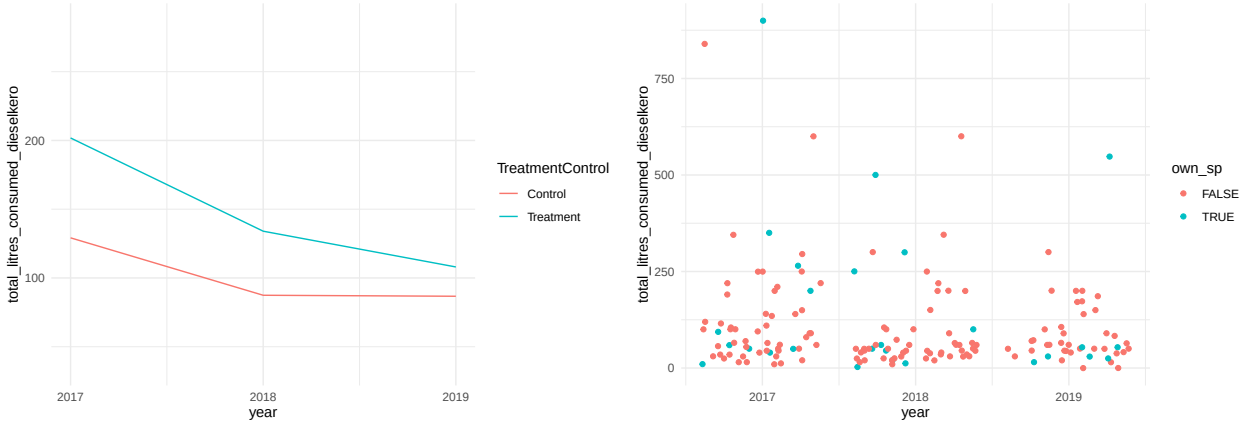
The details about 'Total fuels litres for a year' has two datast

From 'Procurement basline' of RBS file I removed two observations with 15,000 and 10,000 liters of fuel per year becouse it was really high compared to the rest

Table 11: Fuel consumed in a Year (In liters)

Q [7.16] Total litres of diesel/kerosene consumed for agriculture pumps in a YEAR

SAPTARI	Control		Treatment	
	N	Mean	N	Mean
2017	94	129.18	22	201.8
2018	94	87.42	22	134.0
2019	92	86.70	23	108.0



After 1 year

```
##
## Call:
## lm(formula = total_litres_consumed_dieselkero ~ after_1Y * own_sp,
##     data = litres_S)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -153.18  -67.42  -42.42   25.14  736.82
##
## Coefficients:
##                           Estimate Std. Error t value Pr(>|t|)
## (Intercept)                111.115     14.662   7.578 2.66e-12 ***
## after_1YTRUE               -23.695     24.270  -0.976    0.330
## own_spTRUE                  52.062     36.265   1.436    0.153
## after_1YTRUE:own_spTRUE     -5.482     59.661  -0.092    0.927
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 136.8 on 160 degrees of freedom
## Multiple R-squared:  0.02583,    Adjusted R-squared:  0.007568
## F-statistic: 1.414 on 3 and 160 DF,  p-value: 0.2406
```

After 2 year

```
##
## Call:
## lm(formula = total_litres_consumed_dieselkero ~ after_2Y * own_sp,
##     data = litres_S)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -164.90  -73.30  -43.30   27.95  732.10
##
## Coefficients:
##                           Estimate Std. Error t value Pr(>|t|)
## (Intercept)                 108.30      13.66   7.930 3.56e-13 ***
## after_2YTRUE                -21.60      26.28  -0.822   0.4124
## own_spTRUE                   59.60      33.45   1.782   0.0767 .
## after_2YTRUE:own_spTRUE     -38.30      65.48  -0.585   0.5594
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 136.6 on 160 degrees of freedom
## Multiple R-squared:  0.02844,    Adjusted R-squared:  0.01023
## F-statistic: 1.561 on 3 and 160 DF,  p-value: 0.2009
```

Matchig

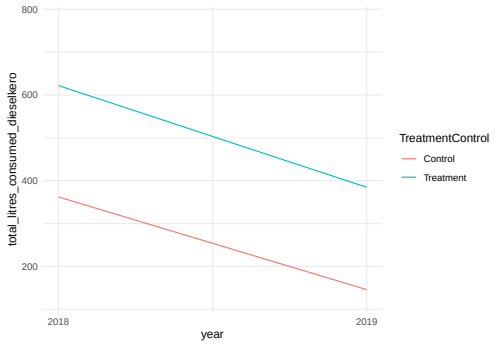
1 year

```
##                            Stratified by TreatmentControl
##                             Control         Treatment       p      test
##   n                             10              10
##   fuel_L_year (mean (SD)) 124.50 (125.77) 134.00 (163.85)  0.886
```

2 year

```
##                            Stratified by TreatmentControl
##                             Control       Treatment       p      test
##   n                             6               5
##   fuel_L_year (mean (SD)) 61.50 (22.92) 139.20 (229.18)  0.426
```

RBS				
2018	71	362.14	25	622.08
2019	46	145.87	16	384.69



After 1 year

```
##
## Call:
## lm(formula = total_litres_consumed_dieselkero ~ after_1Y * own_sp,
##     data = litres_RBS)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -572.08 -260.89 -112.14   33.13 2637.86
##
## Coefficients:
##                          Estimate Std. Error t value Pr(>|t|)
## (Intercept)                362.14      61.02   5.935 1.87e-08 ***
## after_1YTRUE              -216.27      97.31  -2.223   0.0277 *
## own_spTRUE                 259.94     119.56   2.174   0.0312 *
## after_1YTRUE:own_spTRUE    -21.12     191.21  -0.110   0.9122
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 514.1 on 154 degrees of freedom
## Multiple R-squared:  0.08515,    Adjusted R-squared:  0.06732
## F-statistic: 4.778 on 3 and 154 DF,  p-value: 0.003268
```

Table 12: Fuel consumed - Saesons and Year (In liters)

[6.18a] How many liters of fuel per hour **x** *[6.30] How many days in a season was the pump used* **x** *[6.31] How many hours per day*

SAPTARI	Control				Treatment			
	Monsoon	Summer	Winter	Year	Monsoon	Summer	Winter	Year
2017	49	30	26	96	36	42	50	116
2018	42	19	29	75	100	79	11	184
2019	45	29	68	98	82	48	52	182
RBS								
2018	107	149	239	339	171	180	229	507
2019	67	99	50	108	119	292	124	458

Frequency of households who use fuel

The table contains -

- The number of households who irrigate
- Percentage of households from their group - **not** from the entire sample

Table 13: households who consumed fuel

Q [7.12] Did you buy fuel for the pump

RBS	Control		Treatment	
	N	percent	N	percent
2017	50	53%	10	45%
2018	50	53%	10	48%
2019	36	41%	7	30%
RBS				
2018	71	67%	27	90%
2019	46	46%	16	54%

Aquaculture

also here I removed from 'Lands_I_basline' of RBS files - 3 observations with 300 to 400 ponds land size becouse it was really high compared to the rest

Table 14: Total ponds area used for aquaculture (In ha)

Q [4.1c] Land for aquaculture,ponds

SAPTARI	Control		Treatment	
	N	Mean	N	Mean
2017	13	0.43	12	0.39
2018	14	0.47	12	0.39
2019	17	0.51	15	0.40
RBS				
2018	21	0.63	15	1.57
2019	16	0.65	17	1.62