iDEal Nicaragua - SDC

EVALUATION REPORT
February 2017

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Introduction

Purpose

iDEal is currently receiving funding for the Scaling Up Productive Water Phase 2 funded by the Swiss Agency for Development and Cooperation (SDC). Under this project, iDEal is responsible for reporting on the following metrics:

- Change in smallholder income of our clients
- Change in post-harvest loss
- Change in production costs associated with agri-food production
- Women's empowerment related to irrigation and agricultural production

The most important evaluation outcome at this point is to obtain credible evidence around the effectiveness of the approach iDEal has taken in Nicaragua and to provide iDEal with a set of meaningful learnings that can be used to improve their programs, be used by field technicians to market improved irrigation technologies/practices to potential clients and be used to fulfill accountability requirements to SDC.

One of the primary questions that the iDEal team has had since the launch of iDEal is whether or not the distribution method of drip irrigation technologies to the end user has an effect on the household-level social impact of the technologies. With this in mind, the present evaluation seeks to estimate household level treatment effects for clients that purchased technology directly from iDEal, as well as for clients that receive the technology through a third party organization or agency.

Study Design

EXPERIMENTAL DESIGN

The overall design follows a 'difference-in-differences' quasi-experimental approach – comparing changes in the client and non-client group, as well as the differences between the two client groups. The differences-in-differences model estimates causal inference by controlling for group-level and temporal fixed-effects. This modeling approach requires panel data, that is, repeated observations on the same individuals. The evaluation has baseline and endline data collection from the same households to create our panel sample.

At the baseline stage, the analysis is primarily concerned with characterizing the client and non-client groups according to key demographic and production variables. The hypothesis is that both groups are substantively equivalent at baseline, increasing the probability that observed differences at follow up are related to the adoption of iDE products and/or services. However, if there are systematic differences between the control and treatment groups that occur at the aggregate they will be captured by group-level fixed effects in the differences-in-differences model.

The difference-in-differences model depends on several assumptions, primarily that all groups experience the same trends over the course of the evaluation. If one group experiences a systematic change other than the treatment exposure this will violate the parallel trend assumption. Further, this model assumes no autocorrelation, that is, errors in the two different time periods are uncorrelated.

LIMITATIONS

As we are comparing non-randomized intervention and control groups (i.e. the project interventions were not randomly assigned to farmers) observed differences between the two may be due to other factors that predict their likelihood of participating in the first place. These factors could include geography (fundamental differences between farmers that invest in drip irrigation through iDEal vs. farmers that do not invest in drip irrigation through iDEal such as proximity to market, soil type, the presence of other interventions, etc.) and personal characteristics (farmers who purchase an iDEal technology or suite of services may be by nature more entrepreneurial, have better pre-existing crop management practices, etc.). These types of self-selecting criteria would threaten the internal validity of our study through selection bias.

The data collection also relies on farmer recall for figures around input costs, harvest yields, and sales earnings. The evaluation attempted to reduce recall bias by limiting the time period of farmer recall to the

most recent harvest cycle. However, as many farmers do not have written record of their agriculture activities their estimations are prone to recall bias.

In addition, given that only five months passed between baseline and endline data collection, farmers producing long-time crop cycles (those greater than six-month harvest cycles) had no results to show by endline.

Field enumerators also faced some difficulty in collecting the second round of data from households and just over 8% of the sample was lost due to attrition. The distribution of attrition was unequal between treatment and control groups, 13 clients dropped out of the control group while only 2 left the direct treatment group and 2 left the indirect treatment group. The attrition further threatens the internal validity of the study if there are systematic reasons for their departure from the evaluation. In some instances, farmers simply refused to answer the second survey, perhaps suffering from survey fatigue. In one case in particular a farmer had to move after a parent fell ill. However, overall the reasons for their departure vary and are primarily unknown.

The evaluation also faces a historical threat to its internal validity as Nicaragua is in the midst of a three-year drought. Jaime Incer, a former minister of the environment and natural resources and the president of the Nicaraguan Foundation for Sustainable Development (Fundenic-SOS), recently reported that by late March the country had lost 60 percent of its surface water sources and up to 50 percent of its underground sources, which either dried up or have been polluted.[1] The lack of access to sufficient water resources affected numerous households as some were unable to cultivate their land.

EXPERIMENTAL GROUPS

The evaluation will follow three cohorts:

- Treatment Group #1 – a random sample of new clients, defined as farmers who have directly purchased a drip irrigation technology in 2015 and used iDEal's installation and technical services in the past three months.
- Treatment Group #2 – a random sample of new clients, defined as farmers that have received a drip irrigation technology in 2015 that was purchased through iDEal but distributed through a third party (i.e., any drip irrigation sale occurring that was not a direct sale to the end-user).
- Control Group - a sample of non-clients (those who did not purchase an iDEal-facilitated technology and/or service in 2015) with comparable socio-demographic, agricultural and water access characteristics. This group acts as the control.

SAMPLE DESIGN

Specific sampling protocols for each experimental group are given below:

Treatment Group #1: iDEal collected a survey from every one of the 26 client that has purchased and installed the system directly from iDEal since February 2015. In addition to collecting surveys from each of the existing customers, iDEal collected a survey from every client that purchased a drip irrigation kit and had it installed through May 2016, until the total sample size equal to 50 farming households has been achieved.

Treatment Group #2: iDEal contacted the organizations that they frequently sell their products to identify the households that have installed drip irrigation systems since February 2015. iDEal collected a survey from the 19 clients that have purchased and installed the system through an indirect source since February 2015. In addition to collecting surveys from each of the existing indirect customers, iDEal collected surveys from every client that purchased a drip irrigation kit and had it installed through these indirect sources through May until a total sample size equal to 50 farming households has been achieved.

[1] Silva. J.A. "Climate Change Dries Up Nicaragua." Inter Press Service. 5 Apr. 2016 http://www.ipsnews.net/2016/04/climate-change-dries-up-nicaragua/

Control Group: Control Group households were identified by the iDEal staff and were collected from a similar geographical area as the treatment households. The enumerator randomly selected a neighboring household after completing a Treatment Group #1 or Treatment Group #2 survey. The enumerator spun a bottle and walked 1 -3 km in the resulting direction to find the next closest household that is not an iDEal client.

The following sample is used for the current evaluation as presented in Table 1. The total sample size and distribution of group sizes differs from the original plan due to some control farmers purchasing iDEal drip irrigation during the evaluation cycle and correcting of sales records once in the field interviewing farmers.

Table 1: Sample Sizes for iDEal Nicaragua Evaluation

Experimental Group	Proposed	Actual
Treatment Group 1 - Direct Clients	50	57
Treatment Group 2 - Indirect Clients	50	44
Control Group	100	98
Total	200	199

IMPLEMENTATION

We collected one-crop season production and income data by recall at baseline and again five months later after the next crop cycle. Given the staffing resources, the sample was collected on a rolling basis. The first cohort of treated households (and randomly selected control households) was collected in December 2015.

An iDEal staff member collected additional baseline data as more technologies were installed between December and May 2016. An iDEal staff member followed-up with each household to collect an endline survey roughly five months after the baseline data was collected for the household.

Two of the modules from the household survey were collected only at baseline and were not repeated at endline, the Progress out of Poverty Index (PPI) and Women's Empowerment in Agriculture Index (WEAI). The WEAI and PPI were omitted from the second round of study given the short duration between survey rounds. The PPI measures a household's relative poverty level and the WEAI measures women's empowerment within a household, neither of which are expected to significantly differ between baseline and endline.

Given the sensitivity of gender and empowerment questions, the WEAI analysis measures the setting in which the respondent was interviewed. That is, the survey documents whether the respondent could be interviewed alone or in the presence of other members of the household, notably an adult of the opposite sex. As the objective is to measure gender empowerment, it is important to separate males and females when possible to ensure that respondent bias is minimized. Table 2 shows that only 36% of our respondents were able to be interviewed alone while the majority had some presence of another adult or children. The influence of other adults being present, particularly of opposite gender, could influence bias the results of our empowerment measure.

Table 2: Ability to be Interviewed Alone

With Adult Mixed Sex and Children Present	46%
Alone	36%
With Adults Mixed Sex Present	6%
With Adult Female Present	5%
With Children Present	4%
With Adult Male Present	3%

The survey instrument closely aligns with survey instruments that have been used in other evaluations carried out by iDE and the Global iQ team that have measured significant impacts in agriculture productivity, income, and water efficiency for small holder farmers. The baseline survey with the WEAI module took, on average, one and a half hours to complete. The endline survey without the WEAI module took, on average, 45 minutes to complete. The data was collected either via our mobile data collection platform called TaroWorks, or was collected in paper format and then entered electronically at office headquarters through the same platform. Given the rolling nature of the data collection, baseline data collection began in December 2015 and ended in the beginning of May 2016. Endline began in May 2016 and was completed by October 2016.

Sandra Cruz conducting field survey using mobile platform TaroWorks. Photo Credit: Rachel Rose, iDE

Sample Demographics

This section describes the demographic and socio-economic composition of the target population. We define "household" as a group of persons who lived together and shared common feeding arrangements or were economically supported by one agricultural enterprise during the survey period. For the purpose of our evaluation, our unit of analysis and reporting is at the household level.

Household Characteristics

Overall, we see some statistically significant differences between treatment and control groups on household characteristics as presented in Tables 3 – 6 below. However, as mentioned in the experimental design section, so long as the differences are consistent at an aggregate group level we will account for the discrepancies between treatment groups with the differences-in-differences evaluation method.

HEAD OF HOUSEHOLD

We see that, on average, female-headed households comprise just over one-third of our sample (37%). We find a statistically significant difference between percentage of female-headed households for direct treatment group (51%) and the control group (31)%[2] as well as between the direct and indirect treatment groups (34%)[3]. One potential reason for this significant difference is that direct irrigation sales are selling equitably between both genders. Female-headed households may be more likely to purchase irrigation systems if they are the primary income earners or food suppliers for their families and are looking for ways to increase incomes or yields harvested. On average 45% of the household respondents were female, a margin larger than the representation of female-headed households. Enumerators reported this is likely due to the fact that women were the primary respondents available during the time of interview as the male heads of household were off-site working.

[2] T-test is significant at the 5% level of significance.
[3] T-test is significant at the 10% level of significance.

Table 3: Percent of Female Respondents and Female Heads of Household

	Female Respondents	Female HOH
Control	46% (5)	31% (5)
Direct Treatment	46% (7)	51% (7)
Indirect Treatment	41% (7)	34% (7)
TOTAL	**45% (4)**	**37% (3)**

Standard errors in parentheses

Summary statistics on the average age and the level of education obtained for the head of household are presented in Tables 4 and 5, respectively. We find that, on average, the household head is 46 years old in our sample. In addition, the majority of our sample (77%) have obtained elementary or secondary levels of education, with 42% obtaining elementary education, and 35% obtaining secondary education. There are no significant differences between treatment and control groups for either age or education statistics.

Table 4: Average Age of Head of Household

Control	48 (1.3)
Direct Treatment	46 (1.8)
Indirect Treatment	45 (1.9)
TOTAL	**47 (0.9)**

Standard errors in parentheses

Table 5: Level of Education Obtained by Head of Household

	Control	Direct Treatment	Indirect Treatment	TOTAL
None	13% (4)	4% (3)	15% (6)	**11% (2)**
Elementary (1-6)	65% (5)	59% (7)	50% (8)	**60% (4)**
Lower Secondary (7-9)	6% (2)	4% (3)	13% (5)	**6% (2)**
Upper Secondary (10-11)	9% (3)	16% (5)	8% (4)	**11% (2)**
College	7% (3)	18% (5)	15% (6)	**12% (2)**

Standard errors in parentheses

POVERTY INCIDENCE - PROGRESS OUT OF POVERTY INDEX

The Progress Out of Poverty Index (PPI) was developed by the Grameen Foundation and is a valuable tool that iDE uses in as many of its country programs as possible to measure the incidence of poverty among iDE customers. The PPI score is obtained by adding together the scores from ten simple and verifiable questions pertaining to household size, building materials, education, energy use, etc.[4] Each set of questions has been specifically chosen and weighted for the country in which it is to be implemented. The resulting PPI score is

[4] The ten questions are extracted from the respective country's income/expenditure survey and must match the translation and content exactly. The 2010 Nicaraguan PPI version was used in our survey.

then used to estimate the probability that the household is in poverty using a PPI Scorecard. The PPI scorecard provides probabilities for each possible PPI score, and may be used to estimate the household's likelihood of falling below a number of poverty thresholds, including for the purposes of this analysis the $2.50 PPP per day threshold.

Using the various PPI thresholds, we find overall that poverty rates are moderate for our sample. 18% of the sample are poor according to the $2.50 PPP threshold. That is, 18% of our total sample are living on less than $2.50 a day, adjusted for 2005 Purchasing Power Parity. The average poverty level for the indirect treatment groups (27%) is significantly higher than the poverty rates for the control (17%) and direct treatment groups (14%).[5] This poverty distribution makes sense considering the distinction between direct and indirect clients. Our indirect treatment group is composed of farmers who received an iDEal drip irrigation system through a third-party, most likely an NGO or other community organization. These organizations are targeting the poor in their programmatic efforts. Thus through partnership with external organizations through third party sales, iDEal is reaching a poorer segment of the population. Full results are presented in Table 6, below.

Table 6: PPI Poverty Rates

	Control	Direct Treatment	Indirect Treatment	TOTAL
$2.50 / Day	17% (2)	14% (2.4)	27% (3.2)	**18% (1.4)**

Standard errors in parentheses

LAND HOLDINGS

We see wide disparities between average land holding size as presented in Table 7. It is worth noting that there are several outliers in the direct treatment group that are skewing the averages upward. A couple of the clients have inherited or own large amounts of land. A more accurate representation is the distribution of land holding type for an average household within each treatment group as presented in Figure 1.

Table 7: Average Land Holdings in Manzanas, by Land Type

	Control	Direct Treatment	Indirect Treatment	TOTAL
Rain-fed	1.6 (.2)	2.5 (.4)	1.7 (.3)	**1.8 (.2)**
Irrigated	0.7 (.2)	2.3 (1.6)	1.0 (.3)	**1.3 (.5)**
Other	1.9 (.4)	5.6 (1.8)	6.0 (1.8)	**4.4 (.9)**
TOTAL	**4.2 (.5)**	**10.4 (2.4)**	**8.7 (2.1)**	**7.5 (1.0)**

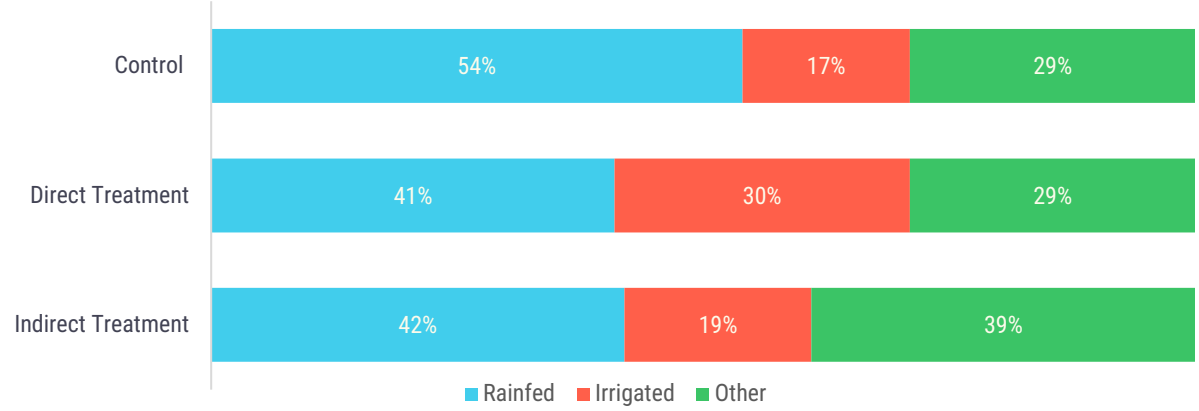
Standard errors in parentheses

In Figure 1 we see that control households, on average, dedicate 54% of their land to rainfed watering which is significantly different from direct (41%) and indirect (42%) households' allocation.[6] Further, we see that direct treatment households have allocated a significantly greater percentage of their land (30%) to irrigation prior to treatment in comparison to control households (17%).[7] This indicates they may already be engaging in irrigation activities at a greater rate than control households prior to their purchase of iDEal drip irrigation kits. As previously noted, the differences-in-differences model takes these pre-existing baseline discrepancies into account.

[5] T-tests are significance at the 5% level of significance.
[6] T-tests are significant at the 10% level of significance.
[7] T-test is significant at the 5% level of significance. (Differences between direct and indirect households are insignificant.)

In addition, it is worth noting the high percentage of land allocated to "other" across all treatment groups. This is due to an interpretation of the survey question in which respondents included in their "other" land holding calculations *all* land they owned including non-arable land such as forests, etc.

Figure 1: Average Land Distribution for Control and Treatment Households



WATER SOURCE

We can see in Table 8 the households' primary water source for irrigation. It is notable that for the direct treatment group a well or borehole served as the primary water source for 84% of households, while only 50% for indirect households and 34% for control households. Further, rain was the primary water source for control households at 47%.[8] This demonstrates that from the outset our treatment and control groups have preexisting differences in access to water, which will affect their crop outcomes. Further, it could signal that access to a reliable water source such as a well or borehole is a necessary, but not sufficient, pre-requisite for drip irrigation. If control farmers primarily rely on rainwater for irrigation because they do not have access to a well or borehole, it could mean that they are less likely to benefit from or purchase drip irrigation even if funds were sufficient. Future sales efforts could target farmers with well and borehole water access as low hanging fruit.

Example of household well with self-designed rope pump. Photo Credit: Rachel Rose iDE

[8] Differences between well and rain water sources are significant at the 5% level of significance for all groups.

Table 8: Primary Water Source for Irrigation by Treatment Group

	Control	Direct Treatment	Indirect Treatment	TOTAL
Well/Borehole	34% (5)	84% (5)	50% (8)	**52% (3)**
Rain	47% (5)	11% (4)	18% (6)	**30% (3)**
River/Stream	8% (3)	2% (2)	23% (6)	**9% (2)**
Other	5% (2)	2% (2)	2% (2)	**4% (1)**
Bottled/Trucked	5% (2)	0% (0)	2% (2)	**3% (1)**
Reservoir/Water Tank	1% (1)	0% (0)	5% (3)	**2% (1)**
Didn't Plant	0% (0)	2% (2)	0% (0)	**1% (1)**

Standard errors in parentheses

Women's Empowerment in Agriculture Index (WEAI)

Background

WEAI was pioneered and advanced by researchers of the International Food Policy Research Institute (IFPRI), USAID, and the Oxford Poverty and Human Development Initiative (OPHI) to monitor and evaluate direct and indirect outcomes of interventions on women's empowerment under the USAID's 'Feed the Future' program.

WEAI is an aggregate index often reported at the country or regional level. It is based on individual level data on men and women within the same household. In addition, it is the only survey-based index with identical questionnaires for both male and female primary decision makers of the household. The WEAI is comprised of two sub-indices: (1) the five domains of empowerment (5DE); and (2) the gender parity index (GPI).

Each of the five domains are made up of sub-indicators that relate to a specific dimension of empowerment. The composition of sub-indicators and dimensions of empowerment allow us to better understand which women are either empowered or disempowered across a range of areas related to empowerment within the household. The 5DE asks a set of questions to the female and male members of a household separately. The details of each of the domains are further summarized below.

1. *Production*: This dimension is concerned with the respondent's decisions about agricultural production and refers to sole or joint decision-making related to food and cash crop farming, livestock, and fisheries.
2. *Resources*: This dimension is concerned with the respondent's ownership of and access to productive resources such as land, livestock, agricultural equipment, consumer durables, and credit.
3. *Income*: This dimension is concerned with the respondent's sole or joint control over the use of income and expenditures.
4. *Leadership*: This dimension is concerned with the respondent's leadership in the community - measured by membership and participation in formal or informal economic or social groups.
5. *Time*: This dimension is concerned with the respondent's allocation of time to productive and domestic tasks.

Each of the five domains carries equal weight. Based on 5DE, a woman is counted as empowered if she achieves adequacy in four out of five domains of empowerment or is empowered in some combination of weighted indicators that reflect 80% total adequacy. One of the features of the WEAI is that it highlights the areas in which women are empowered while also highlighting the areas in which they are not. It allows policy makers and/or program decision-makers easier to adjust their policies and practices to better achieve the desired results related to empowerment. The 5DE is computed for men as well, allowing the analyst to statistically compare empowerment levels of men and a women belonging to the same households.

The Gender Parity Index (GPI) is a measure of inequality. It is an assessment of inequality across the five domains of empowerment between a man and a woman from the same household. The GPI sub-indicator sheds light on women who are as empowered as their male counterparts.

Five Domains of Empowerment (5DE)

Measuring the 5DE results in a number ranging from zero to one, where higher values indicate greater empowerment. The score has two components. First, it reflects the percentage of women who are empowered *(H_e)*. Second, it reflects the percentage of domains in which those women who are not yet empowered *(H_n)* already have adequate achievements

$$5\text{DE} = H_e + H_n(A_a)$$

Where:

$$H_e = \%\ \text{of women (men) who are empowered}$$

$$H_n = \%\ \text{of women (men) who are disempowered}$$

$$A_a = \%\ \text{of domains in which disempowered women (men) have adequate achievements}$$

Table 9 presents the percentage of women and men within our experimental groups who are empowered *(H_e)* at the time of baseline measurement. We see statistically significant differences in empowerments rates between genders for our control and indirect treatment groups where men have higher levels of empowerment to the level of 24 to 35 percentage points, respectively.[9] Notably within our direct treatment groups we see no statistically significant difference between women and men at baseline, indicating a potential selection bias. Women who already felt empowered within their household for agriculture matters may be more likely to purchase iDEal drip irrigation systems. This could be attributable to the higher rates of female-headed households in direct treatment households (51%) than in control or indirect treatment households (31% and 34%, respectively) as reported previously in Table 2. If female-headed households result in women within those households have higher levels of empowerment that would explain the significant differences observed.

Table 9: Empowerment Rates at Baseline

	Women	Men
Control	60% (5)	84% (6)
Direct Treatment	86% (5)	81% (9)
Indirect Treatment	54% (14)	89% (8)

Standard errors in parentheses.

Table 10 presents the 5DE score for both men and women in our baseline sample as well as the construction variables that were used to calculate the score. Overall we see that men have greater empowerment than women and a higher average adequacy score.

[9] T-tests are significant at the 5% level of significance.

Table 10: Average 5DE Construction Variable Scores, by Gender

	Women	Men
5DE SCORE	0.87	0.94
Respondents achieving empowerment (H_e)	64%	81%
Respondents disempowered (H_n)	36%	19%
Average Adequacy score (A_a)	63%	70%

Table 11 presents the average sub-indicator scores for each of the 5DE domains. We see that both men and women score low on the resources domain which includes access to credit, and ownership and transactions of assets indicators signifying greater disempowerment in these areas. While men scored relatively well on all other domains of empowerment, we see that women have their lowest empowerment on decision making around agriculture production. These findings suggest that the programmatic efforts to increase women's voice in agriculture decision making will most effectively improve their empowerment scores.

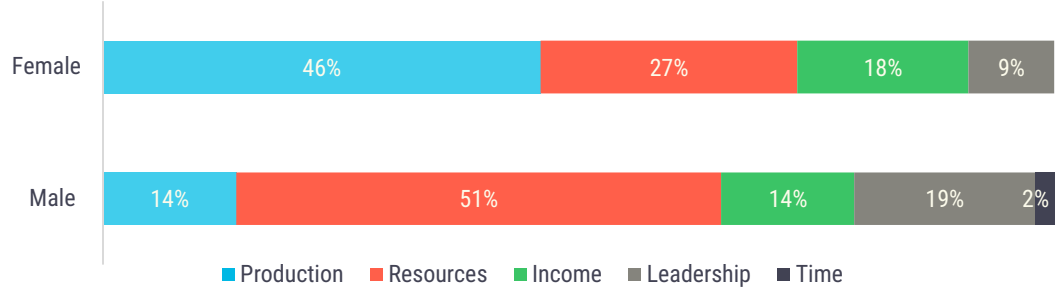
Table 11: Average Sub-Indicator Score for 5DE Domains, by Gender

Domain	Sub-Indicator	Women	Men
Production	Decision Making	.70	.96
Resources	Access to Credit	.76	.85
	Ownership of Assets	.87	.84
	Purchase/Sale of Assets	.83	.85
Income	Control over Income	.89	.96
Leadership	Speaking in Public	.99	.99
	Group Membership	.89	.90
Time	Workload	1	1
	Leisure Time	1	.99

Figure 2 presents the overall contribution of each 5DE domain to disempowerment by gender. That is to say, which of the 5 domains seems to be contributing the most to women's or men's respective disempowerment (lower empowerment scores). For men, the largest contributing domain is 'resources' (51%). Referring to Table 12, we can see that that relatively low scores are evenly distributed across the three sub-indicators for this domain. Improving access to credit and agency in the purchase and sale of assets will most effectively improve men's empowerment scores.

The greatest contributor to disempowerment for women is the 'production decision-making' domain (46%). We see that lack of voice in decision-making processes is driving a low empowerment score for women. The 'resources' domain is the second greatest contributor to disempowerment (27%), where women scored relatively low on the access to credit sub-indicator and would benefit from increased opportunities to access credit, particularly for agriculture investment.

Figure 2: Contribution of Domains to Disempowerment, by Gender



Gender Parity Index (GPI)

GPI also ranges from zero to one, with higher values indicating greater gender parity. It is a relative measure that reflects the inequality in 5DE profiles between the primary adult male and female within each household. GPI measures the percent of women who experience gender parity. A woman experiences gender parity if (1) she is empowered (that is she meets adequacy in 80% of the 5DE sub-indicators) or (2) if her empowerment score is equal to or greater than the empowerment score of the primary male in her household. A woman could be disempowered according to the 80% adequacy threshold, but if she is equally empowered or more empowered than the primary male in her household she has gender parity. GPI is constructed using the following formula:

$$\text{GPI} = 1 - H_w(R_p)$$

Where:

$$H_p = \%\ \text{of women with gender parity}$$

$$H_w = \%\ \text{of women without gender parity}\ \ (1 - H_p)$$

$$R_p = \text{average empowerment gap between women compared to men in their household}$$

Table 12 presents the GPI score for our sample data. We find that the GPI score is 0.77 indicating modestly high levels of gender parity in our baseline. We see that roughly two-thirds of the women in our sample do not have gender parity, meaning that the woman in the household is disempowered and has a lower empowerment score relative to the male respondent in her household.

Table 12: Gender Parity Index Score and Construction Variables[10]

GPI		0.77
	Women achieving gender parity (H_p)	34%
	Women not achieving gender parity (H_w)	66%
	Average Empowerment Gap (R_p)	35%

WEAI Score

Finally, the total overall WEAI score is computed as a weighted sum of the 5DE and the GPI. Thus, improvements in either the 5DE or GPI will increase the WEAI where:

$$\text{WEAI} = 0.9(\text{5DE}) + 0.1(\text{GPI})$$

We present the weighted WEAI scores in Table 13 where it is denoted as "WEAI-lite Score" to reflect modifications in the WEAI survey instrument. It is worth noting the modification as our WEAI figures will not be directly comparable to other WEAI scores calculated following the IFPRI standard.

Table 13: WEAI-lite Score

WEAI-lite Score	0.86
5DE	0.87
GPI	0.77

Qualitative interviews with female farmers in treatment households revealed improved empowerment for women using iDEal drip irrigation systems. One female farmer stated that with her own drip system she spends less time working in the field and is able to bake bread to sell as an additional source of income for her household, diversifying her income sources and giving her more autonomy over the use of income. Another female stated that due to her initiative to purchase and learn the drip irrigation system she has

[10] N=155 for GPI as both male and females WEAI interviews were not able to be conducted in every household. Given the length of the WEAI survey instrument some households refused to complete another survey after the household modules. Also in several instances the males in a household were off working the field and unable or refused to complete the WEAI survey.

greater presence in family-making decisions. Even more, she feels such confidence in her knowledge gain that she would be willing to teach other women how to use the system.

Female iDEal client reporting an increased sense of decision-making empowerment since purchasing drip irrigation. Photo Credit: Rachel Rose, iDE

Crop Productivity

Methodology

There are important methodological approaches to note when studying the results of difference-in-differences estimates for crop productivity. First, the self-reported input costs, harvest yields, loss yields, and sold quantities had some outliers which were likely a result of recall bias as mentioned in the limitations section. The data was thoroughly reviewed a second time to check of erroneous data entry. Any remaining errors are a result of farmer recall. Given the potential of outliers to influence the data, in this particular case to bias the results higher than expected, a uniform approach to cleaning the data was undertaken.

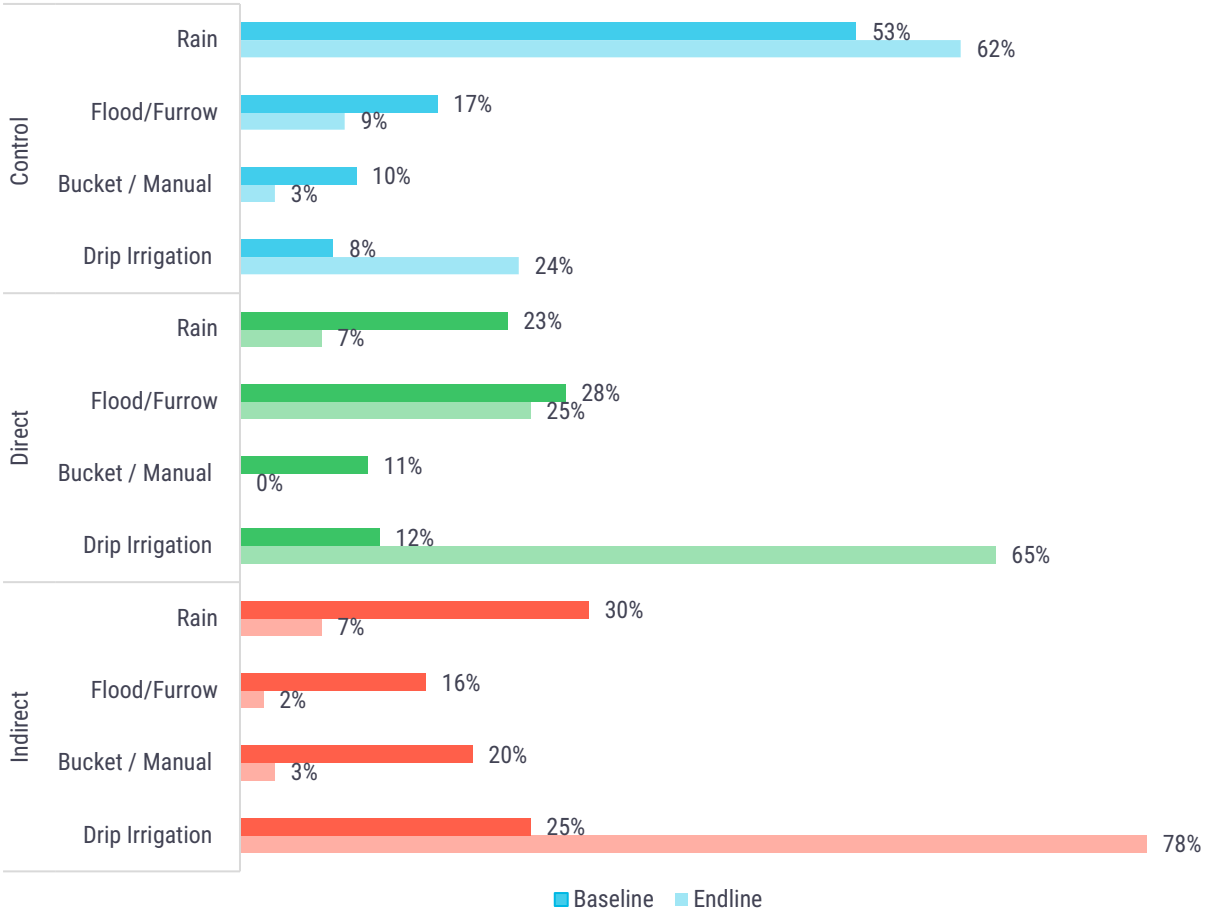
For the key variables of seed costs, harvest quantity, harvest lost quantity, sold quantity, and water use, the cleaning approach was as follows. Observations that fell above the 95th percentile or below the 5th percentile were replaced with the average value of the respective variable from the trimmed sub-sample, conditional upon the crop type. For example, if a household grew plantains and had a very high seed cost that fell above the 95% percentile for plantains, then the value was replaced with the average seed cost for plantains calculated from the trimmed subset. Multiple thresholds of the trimming analysis were calculated to find a balance between eliminating extreme outliers while still ensuring high variance of the remaining data to manage standard errors. Overall, using the 5th and 95th percentile thresholds resulted in the replacement of roughly 7% of observations for the key variables listed. To note any statistical significance found in the difference-in-differences estimations is sensitive to the trimming threshold selected.

In addition, measurements were standardized across the unit of square meter.[11] Comparing aggregate totals of costs, yield, and income would be irrelevant given the high variance of land size under cultivation. Finally, monetary responses were given in the local currency and were converted to $USD adjusted for Purchasing Power Parity (PPP).[12]

Water Application

Households were asked about their primary method of applying water during crop production at both baseline and endline. In Figure 3 we can see the reported differences between the primary methods of application among the various experimental groups.[13] We report on the four primary methods of water application; rain, flood and furrow, bucket hauling, and drip irrigation.

Figure 3: Primary Method of Applying Water, at Baseline and Endline by Treatment Group



We see that rates of applying rainwater decrease substantively for our treatment groups; dropping from 23% to 7% among the direct treatment group and from 30% to 7% among the indirect treatment group. The same holds true for the method of bucket hauling where application rates in the direct treatment group drop by 11 percentage points to a rate of zero and decrease by 17 percentage points for the indirect treatment group. We also see decreases in rates among the control group for the bucket hauling method, while we see the rate of rainwater application rising by 9 percentage points to a total of 62%.

[11] The manzana is taken as 7,000 square meters (approximately 1.7 acres). https://sizes.com/units/manzana.htm
[12] Local Córdobas were converted to $USD PPP using the 2015 World Bank PPP Nicaragua conversion factor for private consumption (PPP factor = 11.1) http://data.worldbank.org/indicator/PA.NUS.PRVT.PP
[13] Percentage totals among the four primary methods of application do not equal 100 as methods with small percentages (hosepipes, no water, sprinkler, and other) were omitted for ease of display.

The declining rates in manual or rainwater applications among treatment groups are supported with a drastic increase of application via drip irrigation. Drip irrigation usage rates increase from 12% to 65% for the direct treatment group and from 25% to 78% for the indirect treatment group. Both groups increased their usage by 53 percentage points. This is important to note the gains in drip irrigation usage for our treatment groups while still acknowledging that we do not have 100% usage. Qualitative interviews with farmers indicated that they often used mixed methods of water application for their crops depending on field size, crop variety, and water scarcity. As such, even for farmers utilizing the drip irrigation system, their primary method of water application may still be a traditional method or rainwater.

Further, it is worth noting the increase in drip irrigation rates among the control group. We see an increase of 16 percentage points to a total of 24% of control farmers using drip irrigation as their primary method of water application at endline. This indicates contamination among control group as farmers adopted the technology outside of iDEal sales. As acknowledged in the limitations section, treatment assignment is non-random as the iDEal model is market-based and farmers are self-selecting the treatment through their purchase of drip irrigation systems. We know there are competitors in the market selling similar drip irrigation technologies.

Contamination can also be explained in part from the method of identifying control households. To ensure we were comparing like households, a control household was identified by its close proximity (neighboring or within the same village) to a treatment household. During qualitative interviews with control farmers, several expressed their interest in drip technology after seeing the success of their neighbors and by endline control farmers had purchased drip technology of their own accord.

Crop Mix

It is helpful to consider the variety of crops produced by experimental group. Figures 4, 5, and 6 demonstrate the overall distribution of households growing each type of crop. The left side of the figure shows the percentage of households growing each type of crop at baseline. The right side show the percentages grown at endline. For example, 31% of control households grew maize at baseline and only 21% of control households grew maize at endline. Maize and beans are the most produced crops for all experimental groups.

In comparing the figures, we see that control households have less diverse crop mixes than treatment households using drip irrigation. Further, when comparing endline to baseline we see that both treatment and control households are diversifying their crop mixes by introducing new varieties such as green peas, hibiscus, pineapple, watermelon, zucchini, and coffee. No treatment households were growing these crops at baseline and a small percentage of households began growing them at endline. Some differences in crop selection may be explained by the change in agriculture season between baseline and endline and risk spreading through crop diversification.

Figure 4: Percentage of Control Households Growing Various Crop Types

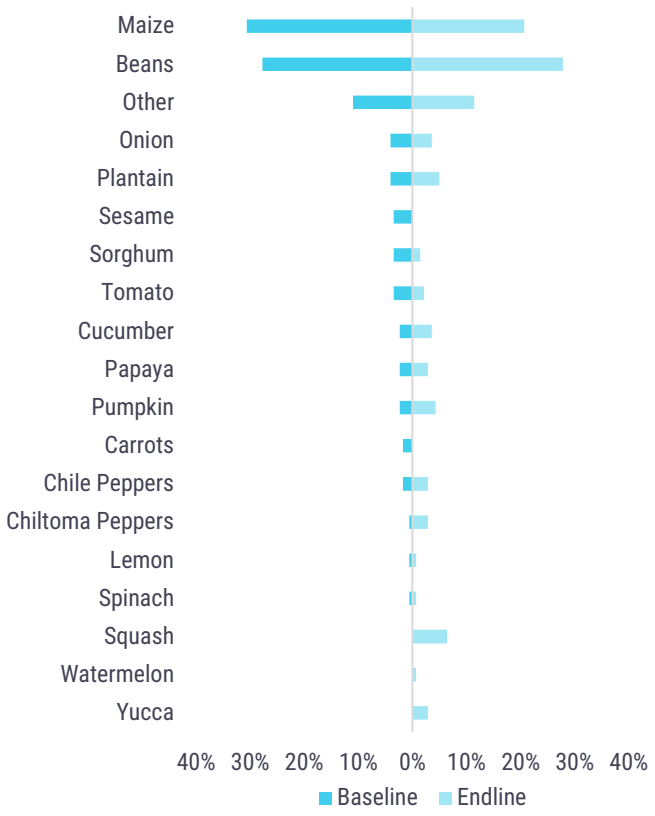


Figure 5: Percentage of Direct Households Growing Various Crop Types

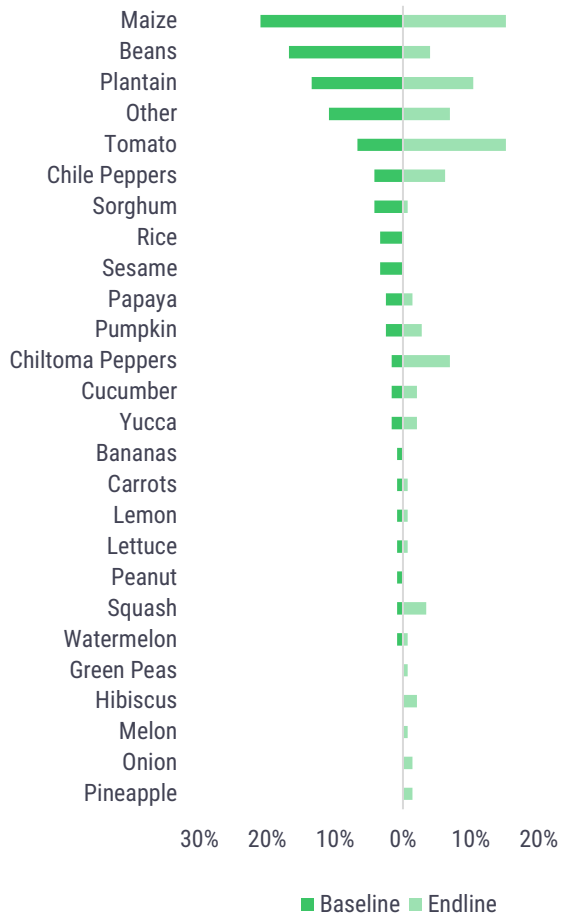
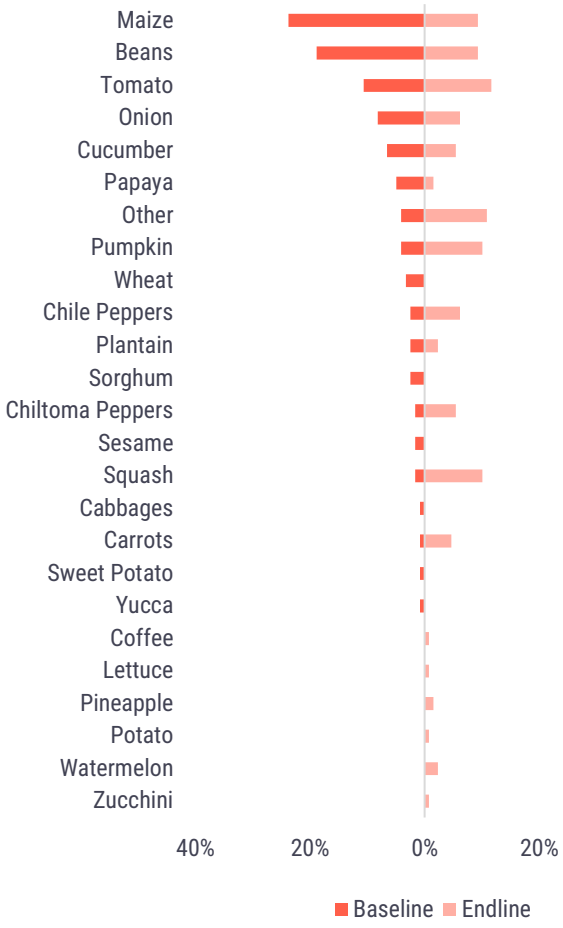


Figure 6: Percentage of Indirect Households Growing Various Crop Types



Production Costs

One key metric of interest is the change in production costs between experimental groups. Table 14 reports the results of our difference-in-differences estimation on several production cost factors. Overall, the majority of the results are statistically insignificant, particularly total input costs. As mentioned in the methodology section, outliers (and the subsequent cleaning approach) heavily impacted the standard errors of our data which yielded insignificant results. This means that while we are able to generate the precise point estimates of certain variables, such as input costs, the margin of error for those estimates is high enough that it makes them indistinguishable from one other. That is to say, when results are noted as statistically insignificant, comparisons between variables are statistically no different from one another, or they are not statistically different from zero, given the high margin of error. Thus is due to "noisy data" that is not normally distributed. Outliers skew the distribution of our data and thus create a lot of variance resulting in high standard errors.

However, it is worth noting the sign on the difference-in-differences coefficients, particularly those with statistical significance. Seed costs for irrigated crops in the direct treatment group are negative and statistically significant at the 10% level, meaning that the resulting value is statistically different from the control group. To interpret this result, the significant difference-in-difference coefficient of -0.01 for irrigated seed crops means that in comparison to the control group, direct treatment farmers spend, on average $.01 less for irrigated seeds per square meter of land, holding all else constant.

Further, while the other results are statistically insignificant, meaning there is no difference between the treatment and control groups, the negative sign on direct treatment input costs suggests they are spending

less on input costs after adopting drip irrigation. We do not see any indication of a decrease in input costs for the indirect treatment group in comparison to the control group. One possible explanation is that the accompanying technical advice provided to direct treatment farmers, and not necessarily to indirect recipients depending on the third party supplier, allows direct households to have lower input costs after adopting the iDEal system. Indirect households are supported by NGOs and third-party providers and are likely to receive inputs at low cost or for free. Interestingly, the estimate comparing the indirect to the control group shows the indirect group spending more on average for inputs; however, those results are statistically not different from zero.

Table 14: Difference-in-differences Results of Production Costs by Treatment (per m^2 and PPP-adjusted)

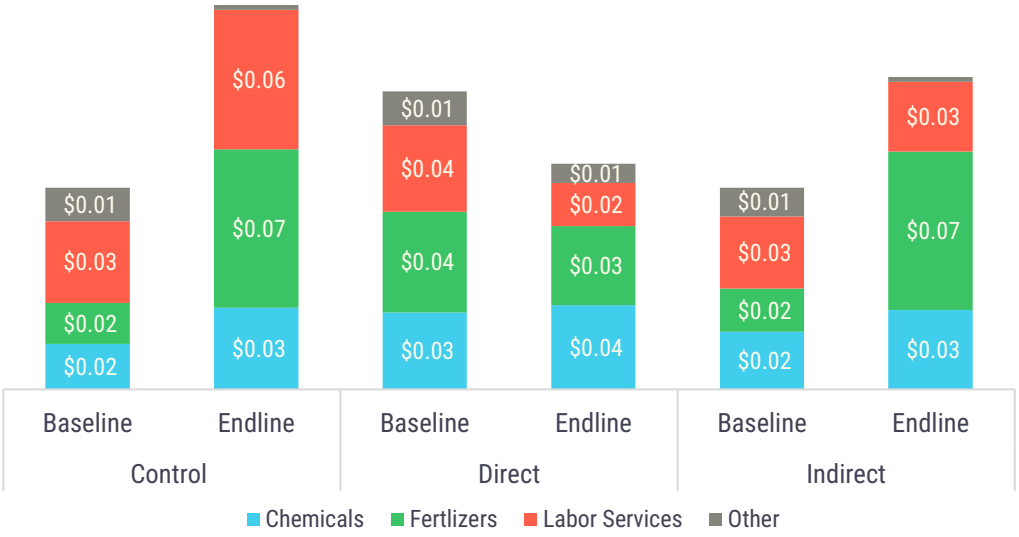
		DID Estimator
Direct Treatment	Rainfed crop seed costs	0.0 (.004)
	Irrigated crop seed costs	- .01* (.01)
	Rainfed crop input costs	- 0.12 (.11)
	Irrigated crop input costs	- 0.27 (.32)
	Total input costs	**- 0.41 (.35)**
Indirect Treatment	Rainfed crop seed costs	0.002 (.002)
	Irrigated crop seed costs	0.01 (.01)
	Rainfed crop input costs	0.02 (.03)
	Irrigated crop input costs	1.69 (1.3)
	Total input costs	**1.72 (1.3)**

Standard errors in parentheses.
** 10% Significance ** 5% Significance *** 1% Significance*

Figure 7 presents the distribution of input costs per square meter of land at both baseline and endline for all experimental groups. We see that that total control input costs (gain of $0.08 per m^2) and indirect input costs (gain of $0.05 per m^2) have risen at endline in comparison to baseline, while direct input costs have declined (loss of $0.01 per m^2). Further both treatment groups are spending less overall than control households on input costs. The change from rainy and dry season is one reason the inputs may have increased at endline for the control and indirect treatment groups. Farmers tend to use more chemicals and fertilizer inputs during the rainy season to help ensure a productive yield. In addition, this year was the first sign of a decent rainy season which encouraged famers to invest further in inputs and ensure their harvests. Notably, even with these trends demonstrating greater invest in agriculture inputs at baseline for control and indirect households, direct treatment households spent less on agriculture inputs. This suggests that increased productivity from drip irrigation may reduce the need for surplus fertilizers and chemicals for direct treatment households.

It is also important to recall the average land holdings, as presented in Table 7, and that we are standardizing by square meter. Given that treatment households have, on average, larger land holdings than control households, any input cost savings calculated at the square meter rate will have a relatively greater impact for larger plot sizes.

Figure 7: Average Input Costs per Square Meter, by Treatment and Time



Small-Holder Income

HOUSEHOLD LEVEL ANALYSIS

One of the primary metrics of interest is the impact of drip irrigation on small-holder famers' incomes. Using self-report harvest yields, input costs, and sale prices we constructed profit variables for each experimental group. The results of the difference-in-differences estimation are presented in Tables 15 and 16. While positive in direction, indicating improved income for drip irrigation users, the results across all treatment groups are statistically insignificant given the high standard errors.

It is important to note that for this set of analysis we are working with a restricted sub-sample. Only half of our sample sold any produce to market meaning the rest of the households are producing solely for self-consumption. Notably we find a statistically significant greater proportion of our treatment farmers had market sales in comparison to control farmers.[14] Table 15 shows that roughly three-fourths of our treatment households are selling crops at market while roughly half of control households are selling at market. These differences existed prior to receiving treatment and may be indicative of a selection bias, that entrepreneurial farmers already selling at market are more likely to know about or purchase iDEal drip systems.

Table 15: Percent of Households Selling at Market, by Time and Treatment

	Baseline	Endline
Control	55% (5)	42% (5)
Direct Treatment	78% (6)	80% (5)
Indirect Treatment	85% (5)	78% (7)

Standard errors in parentheses.

[14] T-tests between both direct and indirect treatment groups and the control group are significant at the 1% level of significance for both time periods.

The analysis presented in Table 16 is on the sub-sample farmers that sold any crops at market thus contributing to higher standard errors. Further, the five-month timeframe between baseline and endline data collection was not sufficient for some crops to complete a full cycle, notably crops such as plantains produced by many of our famers. Thus we restricted the income analysis to crops with short cycles (six months or less) to accurately capture any potential income impacts.

Table 16: Direct Households DID Results of Income for Short Crops (per m^2 and PPP-adjusted)

	Baseline	Endline	Difference	% Change
Direct Treatment	$0.33 (.20)	$0.55 (.37)	$0.22 (.25)	67%
Control	$0.43 (.14)	$0.18 (.22)	- $0.25 (.25)	-58%
		Difference-in-difference estimator	$0.47 (.50)	

Standard errors in parentheses.
** 10% Significance ** 5% Significance *** 1% Significance*

The results in Table 16 are illustrative, even if not statistically significant. We see that between baseline and endline direct treatment farmers saw a positive gain in income per square meter while control farmers saw a decline in income per square meter. Unfortunately, given the high margin of error for these values the results are not statistically significant; however, the positive gain for direct farmers and the loss for control farmers suggests that iDEal clients were better off than control farmers. Table 17 presents a different story for indirect farmers.

Table 17: Indirect Households DID Results of Income for Short Crops (per m^2 and PPP-adjusted)

	Baseline	Endline	Difference	% Change
Indirect Treatment	$1.52 (.60)	$1.41 (.49)	-$0.11 (.61)	-7%
Control	$0.43 (.14)	$0.18 (.22)	- $0.25 (.25)	-58%
		Difference-in-difference estimator	$0.15 (.81)	

Standard errors in parentheses.
** 10% Significance ** 5% Significance *** 1% Significance*

Here it is important to recall the severe drought that the country has been facing for the past three years. Some farmers reported an inability to plant anything this season due to lack of rains and access to a water source. We see that in the case of indirect farmers there is a negative trend for both treatment and control. That is each group had lower incomes at endline than at baseline indicating a concurrent stressor of the heightened drought and lack of water. The difference-in-difference estimator presented in Table 17 is positive, which means that while both the indirect and control groups suffered from a loss in income, the indirect treatment group had a relatively smaller loss in income compared to the control group. Again, these results are statistically insignificant, but they suggest that the use of drip irrigation helped to mitigate the impact of the drought for indirect treatment farmers. Further, we cannot control for the level of support provided by the NGO third-party distributors to the indirect households. At the time of endline data collection, indirect households may or may not have received support depending on the state of the NGO project and this could affect their output.

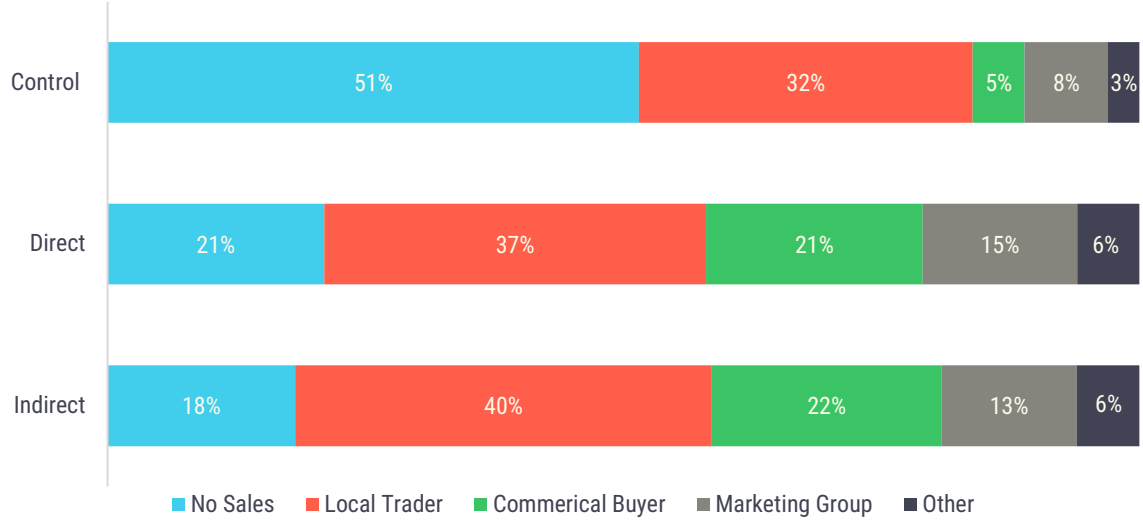
Finally, for households that did not sell any produce at market and thus had no agriculture income to report, we still heard qualitatively from farmers about the benefits of drip irrigation to help feed their families. For example, one client reported that while she didn't sell any crops at market she was able to produce enough to feed her 32 family members. This outcome is not measurable in terms of income generated from crop sales, but should be considered as disposable income saved due to increased production for self-consumption that reduces marketplace expenditures.

Interview with direct iDEal client who reported harvest yields large enough to feed her 32 family members.
Photo Credit: Rachel Rose, iDE

SALES DATA

When we look at the distribution of agriculture buyers across the experimental groups we see an interesting story as illustrated in Figure 8. We see that, on average, direct and indirect treatment households sell more of their produce than not, and their primary buyers are local traders and commercial buyers. Over half of control households did not sell produce to any buyer. This also supports the non-monetary positive impact of drip irrigation, that while differences of income gains are insignificant, farmers who use iDEal drip irrigation systems are more successful at producing beyond self-consumption to sell at market.

Figure 8: Primary Buyer of Agriculture Produce, by Treatment



Productivity

Given that only half of our sample sold crops at market, we reviewed differences in harvest productivity for all households. Table 18 presents the differences of total harvest yields in pounds per square meter at baseline and endline for each experimental group. The results are standardized by square meter to account for different sized plots. Overall, we see that each experimental group has increased their productivity between baseline and endline. While the positive gains in productivity for direct and treatment groups are encouraging, we see that the control group had positive gains in productivity as well during this time period. This suggests that influences external to the drip irrigation system, such as the change from the dry to rainy season, may have increased crop yields for all households.

Table 18: Average Harvest Yield (lb/m^2), by Treatment and Time

	Baseline	Endline
Control	3.1 (1)	4.1 (2)
Direct Treatment	5.1 (2)	5.4 (2)
Indirect Treatment	8.7 (3)	9.0 (3)

Standard errors in parentheses.

Further, aggregating household productivity across all crop types into a standard unit of measure, such as pounds per square meter, can be misleading given the different crop mixes produced by each household. A farmer growing spinach may have a very high yield harvest, yet the pound per square meter metric will be quite low if he or she grew a denser crop at baseline. To account for this, we conducted crop level analysis of productivity. Figures 9 and 10 present crop level changes in productivity for four of the main crops grown by all experimental groups (other groups were either grown in quantities for comparison or were not grown by all experimental groups). Though the differences are not statistically significant, we do see trends of productivity gains varying between experimental groups and crop variety. For example, indirect households had greater yields in maize at endline while control and direct households saw gains in cucumber and bean productivity. This could indicate iDEal households are shifting their productivity to groups that benefit most from drip irrigation such as cucumbers or maize.

Figure 9: Average Harvest Yield (lb/m^2) for Beans and Maize

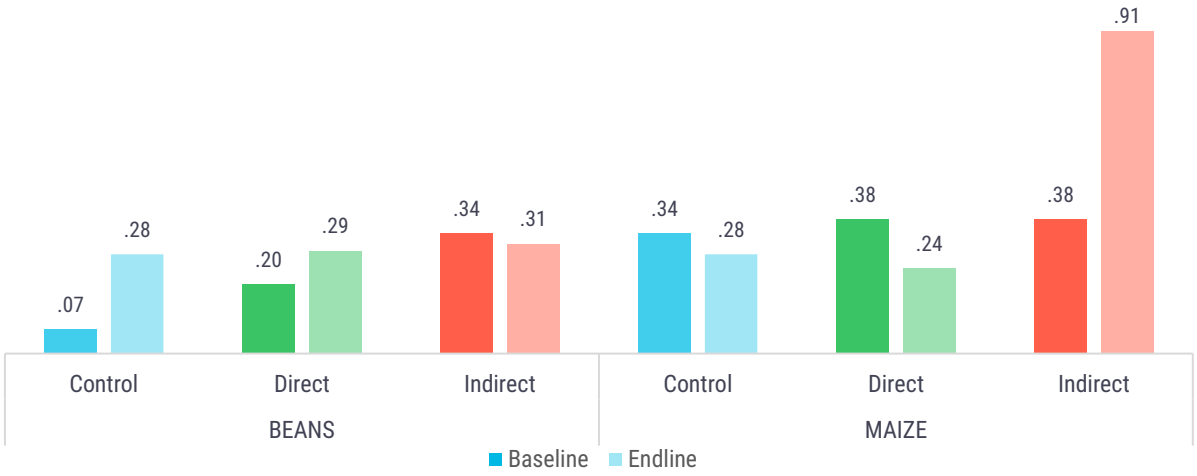
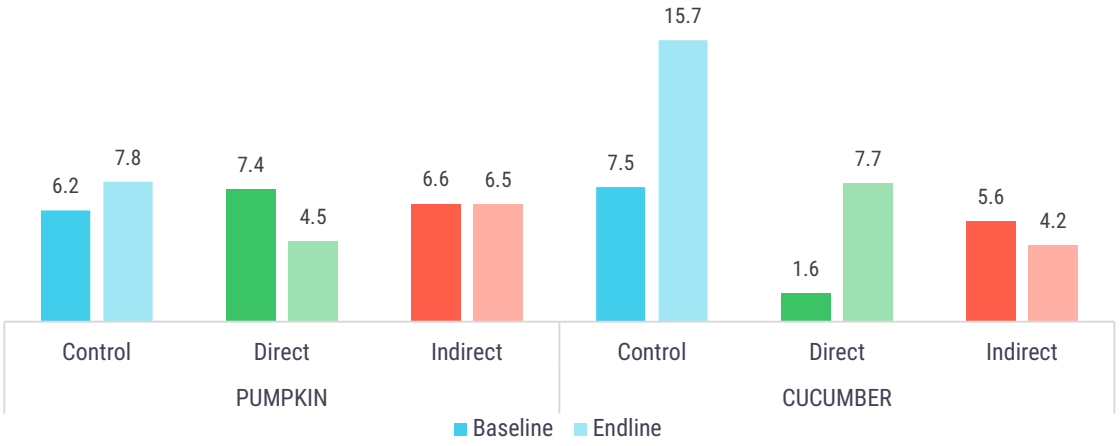


Figure 10: Average Harvest Yield (lb/m^2) for Pumpkin and Cucumber



Post-Harvest Loss

We are also interested in estimating the differences in post-harvest loss between our experimental groups. Tables 19 and 20 report positive difference-in-differences estimates that would be interpreted as treatment groups having higher rates of post-harvest loss in comparison to control groups. However, these results are not statistically significant. Further, when looking at the changes between baseline and endline within each treatment group we have a better understanding of change over time. We see that the direct treatment group reduced their post-harvest loss by two percentage points between baseline and endline. The reason this finding is not significant is because control farmers also reduced their post-harvest loss by 16 percentage points between baseline and endline, meaning there could be some other factor driving down post-harvest loss in addition to the efforts of the iDEal program. In particular, it is helpful to recall from our crop mix data that control households produce a smaller variety of crops in comparison to treatment households which indicates they are more risk adverse. Thus if a particular crop in which control households have invested does well one season they benefit more and if the crop fails they lose more as well.

Table 19: Direct DID Results of Post-Harvest Loss in Percentage and Percentage Points (pp)

	Baseline	Endline	Difference
Direct Treatment	10% (3)	8% (3)	- 2 pp
Control	27% (3)	11% (3)	- 16 pp
	Difference-in-difference estimator		14 pp*** (5)

Standard errors in parentheses.
** 10% Significance ** 5% Significance *** 1% Significance*

The lack of significance in this metric may be attributable to self-report error. The harvest yield and loss counts underwent the data cleaning approach mentioned in the methodology section to control for outliers. However, the post-harvest baseline value of 27% for the control group is quite high in comparison to the all other time periods and treatment groups and may be biased upwards.

Table 20 for the indirect treatment group shows the same story as for the direct treatment group. Overall we do see that post-harvest loss between baseline and endline has declined by 9 percentage points for the indirect treatment group. This reduction is concurrently happening while control households see a decline of 16 percentage points, which results in the positive, though insignificant, difference-in-differences estimator.

Table 20: Indirect DID Results of Post-Harvest Loss in Percentage and Percentage Points (pp)

	Baseline	Endline	Difference
Indirect Treatment	17% (4)	8% (3)	- 9 pp
Control	27% (3)	11% (3)	- 16 pp
	Difference-in-difference estimator		7 pp (6)

Standard errors in parentheses.
** 10% Significance ** 5% Significance *** 1% Significance*

Water Productivity

Included in the survey instrument was a module that collected self-reported farm-level water use across three distinct crop stages (seedling, growth, and fruiting). A series of questions were asked about four methods of water extraction – bucket hauling, manual pump, diesel or petrol pump, electric pump – to estimate water usage over each crop stage.[15] Water use was calculated using a method described in Appendix 3 with the goal of estimating water efficiency and economic productivity among experimental groups.

While iDE has successfully implemented a water estimation module in other evaluations[16], the self-report and time estimation of this evaluation proved to be highly problematic. In particular, one of the greatest areas prone to high outliers is the self-reported duration of a single irrigation event. Second, total water usage is highly correlated to crop type given the crop stage lengths used in part four of the construction method.

As such, the most telling indicator we have is average weekly water use presented in Table 21 below. The difference-in-difference results are statistically insignificant and most sub-population estimates are not significantly different from zero give the quite high standard errors. However, there are certain observable trends. Though insignificant, the sign on the difference-in-difference estimators for between each treatment group and the control group suggest that drip irrigation users are able to use less water than non-irrigation users (a finding which is substantiated by the SDC Vietnam evaluation). Further, we see that across all experimental groups there is an increase in water usage between baseline and endline, which is likely due to the shift from a wet to dry season during time of data collection.

Table 21: Difference-in-Difference Results of Water Use per Week by Treatment (liters/m^2)

	Baseline	Endline	Difference
Direct Treatment	117 (47)	239 (60)	123
Control	93 (30)	504 (275)	412
Direct and Control Difference-in-difference estimator			**-289** **(290)**
Indirect Treatment	42 (14)	403 (201)	362
Control	93 (30)	504 (275)	412
Indirect and Control Difference-in-difference estimator			**-51** **(346)**

Standard errors in parentheses.
** 10% Significance ** 5% Significance *** 1% Significance*

Finally, research by the School of Agriculture, Forest and Food Sciences (HAFL) at Bern University of Applied Sciences found that farmers consistently underestimate the duration of their irrigation doses. Even when supported with a good emitter flow measurement their self-report estimates have a large margin of error that yield the values insignificant. Given these findings, improved methods at estimating water use will be important for future water productivity estimates.

[15] Gravity was also included as an extraction method; however, no reliable estimates of water usage could be calculated using the data provided and thus those responses were omitted from water use estimates.
[16] iDE's SDC Evaluation in Vietnam found that micro-irrigation farmers used, on average, 32% less water than non-users. A result that was statistically significant at the 1% level of significance.

Customer Survey

Both treatment and control households were asked a series of questions regarding their access to and satisfaction with input suppliers, extension agents, market information, finance providers, and produce buyers.

Input Suppliers

In comparison to baseline, we see a growth in the percentage of direct and indirect treatment households that use an NGO as their primary source for agriculture inputs, (growth of 22 and 10 percentage points, respectively). This could be a result of concurrent NGO activity occurring in the regions in which iDEal works or it could be due to a misunderstanding of iDEal activities. One of the survey options provided was "iDEal Technician" however, if a farmer considers iDEal an NGO and not a social enterprise, then he or she may have selected that option in light of his or her drip irrigation purchase. All results are presented in Table 22 below. Overall we see the majority of farmers from all treatment groups purchase their inputs from an Agro Store.

Table 22: Main Source of Agricultural Inputs

	Control		Direct Treatment		Indirect Treatment	
	Baseline	Endline	Baseline	Endline	Baseline	Endline
Agro Store	71% (5)	68% (5)	77% (6)	51% (7)	75% (7)	75% (7)
Kiosk	12% (3)	8% (3)	4% (2)	4% (3)	14% (5)	3% (3)
Local Farmer markets	10% (3)	8% (3)	11% (4)	11% (4)	7% (4)	13% (3)
Informal	5% (2)	5% (2)	7% (3)	2% (2)	2% (2)	0% (-)
Non-Government Organization	1% (1)	7% (1)	2% (2)	24% (3)	0% (-)	10% (5)
Government	0% (-)	1% (2)	0% (-)	4% (2)	2% (2)	0% (-)
iDEal Technician	0% (-)	1% (1)	0% (-)	4% (3)	0% (-)	0% (-)

Standard errors in parentheses. No observations are noted with (-)

Extension Agent Service

We see greater impact of the iDEal program when comparing primary source of agriculture advice before and after the evaluation. Notably, among the direct treatment group those receiving no agriculture advice dropped from 54% to 9% while simultaneously those receiving agriculture advice from an iDEal technician dramatically rose from 0% to 50%. We also saw that agriculture advice from an NGO rose by 10 percentage points in this group as well. If the same conflation of iDEal and NGO occurred, then it is likely that some of the advice attributed to NGO sources is also iDEal as well.

Similarly, the indirect treatment group drops to only 8% of households having no source of agriculture advice, a decline of 19 percentage points since baseline. iDEal technicians serving as the primary source rose from 2% to 23% as NGO also rose from 14% to 40%. Notably, the indirect treatment group had high rates of advice from farmer cooperatives which is to be expected with the definition of our indirect sample. Recalling that indirect households are iDEal clients in which a third party purchased the drip irrigation system and distributed the systems, it is very likely that farmer cooperatives were one of the main third party purchasers.

Finally, control households still suffer from low access to agriculture advice. At endline, 60% of control households had no source of advice. We do see a modest gain in farmer cooperative source of advice, which is indicative of additional activity within control households or potential spillover from neighboring treatment households. Full results are presented in Table 23.

Table 23: Main Source of Agricultural Advice

	Control		Direct Treatment		Indirect Treatment	
	Baseline	Endline	Baseline	Endline	Baseline	Endline
None	71% (5)	60% (5)	54% (7)	9% (4)	27% (7)	8% (4)
Ministry of Agriculture	3% (2)	6% (3)	9% (4)	2% (2)	5% (3)	3% (3)
Other[17]	7% (4)	6% (3)	12% (5)	4% (3)	18% (9)	5% (3)
NGO	12% (3)	9% (2)	21% (5)	31% (6)	14% (5)	40% (8)
Friends or family	1% (1)	5% (2)	2% (2)	2% (2)	9% (4)	0% (-)
iDEal Technician	0% (-)	2% (2)	0% (-)	50% (7)	2% (2)	23% (7)
Farmer Cooperative	6% (2)	12% (4)	2% (2)	4% (3)	25% (7)	23% (7)

Standard errors in parentheses. No observations are noted with (-)

Market Information

When questioned about the primary source of market information, roughly 85% of all households selected informal word-of-mouth. This held consistent across all experimental groups for both baseline and endline. In addition, approximately 75% of household received market price information the day before heading to the market and 15% received information day of market visits at the time of baseline (there were no significant differences between experimental groups). At endline, an average of 88% of households received market information the day before and 11% received information the day of a visit indicating a slight improvement in access to market information. Interestingly, though the method is informal and timing is short for access to market information, approximately 83% of the sample is very or somewhat satisfied with their access to market price information.

Table 24 presents the average distance and time needed to reach the closest market for both purchasing goods and selling produce (location of markets remain unchanged between baseline and endline). While we do see significant differences in distance to market between experimental groups, we do not see that any significant differences between goods purchasing markets and produce selling markets. This suggest that for most households they have the ability to sell produce at the same market in which they purchase most goods. On average, direct treatment households have further to travel (24 km) in comparison to control households (19 km) and indirect treatment households (16 km).[18]

Table 24: Access to Markets in Distance and Time, over Treatment

		Control	Direct Treatment	Indirect Treatment
Goods Purchasing Market	Distance (km)	19 (1)	24 (2)	16 (1)
	Time (min)	46 (2)	52 (3)	49 (4)
Produce Selling Market	Distance (km)	20 (2)	24 (3)	20 (3)
	Time (min)	43 (3)	45 (4)	51 (4)

Standard errors in parentheses

[17] Includes categories of media, private company agent, and local business.
[18] T-tests are significant at the 10% and 1% level of significance, respectively.

Finance Providers

Figure 11 illustrates the decline in financing rates across all experimental groups between baseline and endline. Declines for the control and direct treatment groups are statistically significant[19] while differences for the indirect group are not. Notably, while rates of borrowing declined over time, average amounts borrowed did not. On average, households borrowed approximately $1,711 PPP (there were no significant differences between treatment groups or time periods). The change in finance rates is due to the timing of the crop cycles between baseline and endline. During their first cycle famers have to invest greater upfront costs. Upon subsequent cycles their large investments are covered by an already established credit line and the need for financing is reduced.

Figure 11: Borrowing Rates, over Treatment and Time

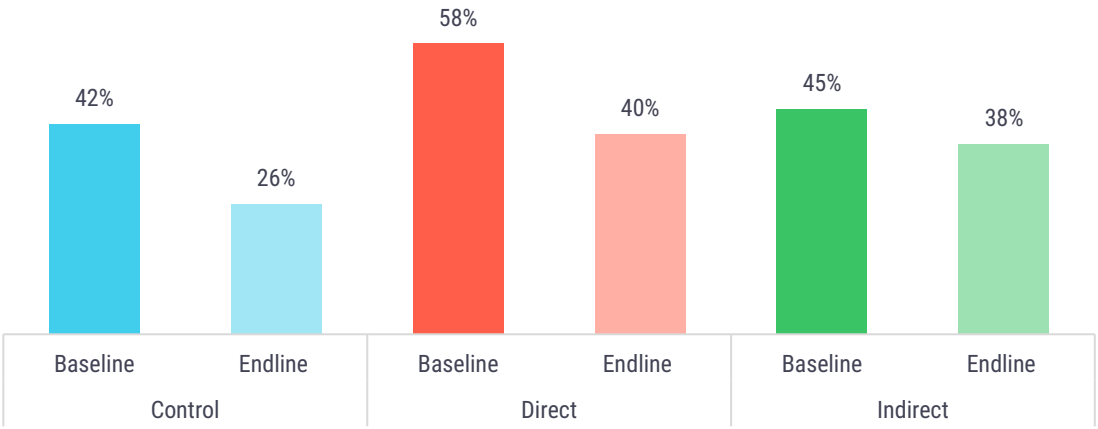


Table 25 presents the primary source of borrowing for all experimental groups. We see that overall micro-finance institutions and cooperatives are the top two lenders comprising over three fourths of the market (39% and 37%, respectively). While control households primarily rely on micro-finance institutions, both treatment groups utilize cooperatives as their primary source for financing which suggests they may be better connected to farmers' groups and other cooperative memberships than our control households.

Table 25: Primary Source of Financing

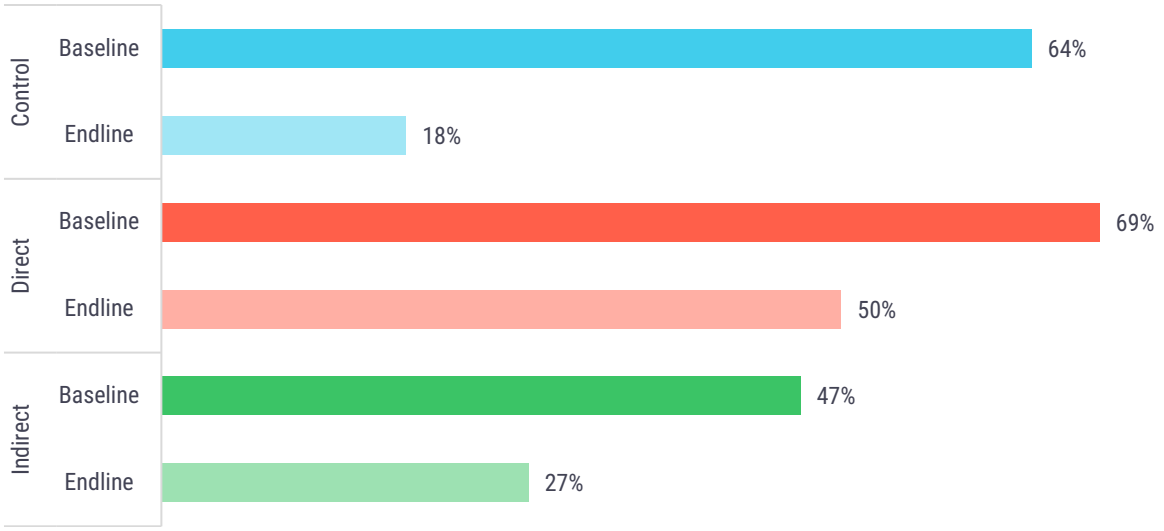
	Control	Direct Treatment	Indirect Treatment	TOTAL
Micro-Finance Institution	45% (8)	36% (9)	30% (11)	**39% (5)**
Cooperative	28% (7)	44% (9)	45% (11)	**37% (5)**
Other	10% (5)	13% (6)	15% (8)	**12% (3)**
Savings and Loan Group	10% (5)	0% (0)	10% (7)	**7% (3)**
Local Money-Lender	8% (4)	0% (0)	0% (0)	**3% (2)**
Family/Friends	0% (0)	6% (4)	0% (0)	**2% (2)**

Standard errors in parentheses

[19] T-tests are significant at the 1% level of significance.

Quite interestingly, we see rates of female borrowing decline sharply for all experimental groups between baseline and endline as illustrated in Figure 12. In the control group borrowing dropped by 46 percentage points to a rate of 18% at endline.[20] Direct and indirect treatment groups decline by 19[21] and 20[22] percentage points, respectively. This sharp decline in female borrowing is likely due the difference in cyclical investments as previously described.

Figure 12: Rates of Female Borrowing, over Treatment and Time



Conclusion

While quantifiable gains in key indicators are insignificant, there is much evidence to suggest that farmers using iDEal drip irrigation have better outcomes, either in terms of direct gains or in mitigation of other external impacts. This is particularly notable given the duration of the evaluation period in which impacts of drip irrigation use were expected after one short crop cycle as well as the concurrent drought plaguing the country of Nicaragua.

In regards to overall input costs, findings suggest farmers who directly purchased drip irrigation from iDEal see a reduction in their costs. In addition, while both indirect and control farmers saw a loss in income between baseline and endline, we found that direct iDEal farmers had a positive increase in overall income, though the quantifiable differences are insignificant. Further, indirect farmers had less income loss than control famers indicating that drip irrigation may help mitigate impacts of the drought.

We also have qualitative data that suggests many of the positive impacts are non-quantifiable. For example, only half of the sample sold produce to market and the other half produced solely for self-consumption. The "income earnings" for these households are a result of money saved by producing more for own consumption and relying less on outside purchase. Through the WEAI analysis and qualitative interviews we found that for our female clients some of the strongest impacts are also non-monetary. By purchasing drip irrigation, female clients not only contribute more to their households but also become the knowledge holder of drip technology in the family. This gives them greater respect and autonomy in decision-making processes within their household.

It is clear that gains from the use of iDEal drip irrigation systems will only increase as farmers become more familiar with the technology and have opportunities for multiple and longer crop cycles. In times of external stress such as the current drought, drip irrigation can also improve farmers' resilience by increasing their capacity to mitigate water shortages as well as diversifying their crop harvest.

[20] T-test is significant at the 1% level of significance.
[21] T-test is significant at the 10% level of significance.
[22] T-test is insignificant.

Appendix 1: Household Crop Production Survey Instrument

INTERVIEW DATA

1.1	INTERVIEWER NAME	1.5	IDENTIFICATION # OF RESPONDENT
1.2	INTERVIEW DATE		Y Y Y Y / M M / D D
1.3	SUPERVISOR NAME		
1.4	SUPERVISOR SIGNATURE		

LOCATION

1.6	DEPARTAMENTO		1.10	LATITUDE	
1.7	MUNICIPIO		1.11	LONGITUDE	
1.8	COMUNIDAD		1.12	ADDRESS	
1.9	FARMER GROUP				

BASIC HOUSEHOLD DATA

RESPONDENT DETAILS

2.1	RESPONDENT'S FULL NAME	2.6 SEX OF RESPONDENT	Male	
			Female	
2.2	IS RESPONDENT THE HEAD OF HOUSEHOLD? YES |___| NO |___|	2.7 RESPONDENT PHONE NUMBER	|_|_|_|_|_|_|_|_|_|	
2.3	HEAD OF HOUSEHOLD'S FULL NAME	2.8 SEX OF HOUSEHOLD HEAD	Male	
2.4	AGE OF HOUSEHOLD HEAD (in years)		Female	
2.5	EDUCATION OF HOUSEHOLD HEAD |_____| Education Code			

EDUCATION CODES

00: No Education
01: Pre-Escolar
02: 1. Grado
03: 2.Grado
04: 3. Grado
05: 4. Grado
06: 5. Grado
07. 6. Grado
08: 7. Grado
09: 8. Grado
10: 9. Grado
11: 10. Grado
12: 11. Grado
13: Técnico Medio
14: Técnico Superior
15: Universidad
16: Licenciatura
17: Ingeniería
18: Profesor (Primaria)
19: Profesor (Secundaria)
20: Profesor (Universidad)
21: Otro (especifique)
22: University
23: Other Tertiary
88 Don't know
99 Refused

LAND AND WATER USE

	Questions	Response Options		2014/2015 SEASON*
3.1	Land holding in Manzanas?	RAINFED		
		IRRIGATED		
		Other (grazing, fallow, etc)		
		TOTAL		
3.2	What was your primary source of water for irrigation in **the most recent 2015 CROP SEASON**?	RIVER / STREAM	1	|__|
		WELL / BOREHOLE	2	
		RESERVOIR / TANK	3	
		OTHER (SPECIFY)	4	
		RAIN	5	
		BOTTLED / TRUCKED	6	
		DIDN'T PLANT	7	
3.3	How did you move water from the source to your field for irrigation in **the most recent 2015 CROP SEASON?**	BUCKET / WATERING CAN	1	|__|
		TREADLE PUMP	2	
		DIESEL / PETROL PUMP	3	
		SOLAR PUMP	4	
		TRADITION RIVER DIVERSION	5	
		MODERN CANAL	6	
		OTHER (SPECIFY)	7	
		RAIN	8	
		ELECTRIC PUMP	9	
		ROPE PUMP	10	
		DIDN'T PLANT	11	
		GRAVITY	12	
3.4	How did you apply water to your crops in **the most recent 2015 CROP SEASON?**	BUCKET / WATERING CAN	1	|__|
		FLOOD / FURROW	2	
		SPRINKLER	3	
		HOSEPIPE	4	
		DRIP IRRIGATION	5	
		OTHER (SPECIFY)	6	
		RAIN	7	
		DIDN'T PLANT	8	

WATER USE

Now we are going to ask you about the water extraction methods you used in the most ***recent 2015 CROP SEASON***, and how much water is applied during each of the three primary stages of the growth cycle. The three primary stages of the growth cycle are Seedling, Growth and Fruiting.

Extraction Method	SEEDLING STAGE		Specific Questions for each technology to determine volume. [ENUMERATOR SHOULD SPECIFY THAT AN IRRIGATION CYCLE IS ONE APPLICATION OF WATER TO HIS PLOT ON A SINGLE DAY. IN SOME INSTANCES THE FARMER WILL HAVE MULTIPLE IRRIGATION CYCLES TO IRRIGATE THE ENTIRE PLOT. SMALLER FARMERS MAY BE ABLE TO IRRIGATE THE ENTIRE PLOT IN ONE DAY DURING ONE IRRIGATION CYCLE.]			
	A] During the SEEDLING stage of the crop cycle, did you extract water for your crops in the most recent dry season using [EXTRACTION METHOD]?	B] How many times per week do you irrigate during the SEEDLING stage of the crop cycle using [EXTRACTION METHOD]?	C] How many buckets/watering cans are used for each irrigation cycle during the SEEDLING stage of the crop cycle?	D] How large is each bucket watering can/bucket used for irrigation during the SEEDLING stage of the crop cycle?	E] Do different family members carry different size containers of water?	
4.1 Bucket/Hauling	Yes |____| No |____|	|___| times	|___| buckets/cans	|___| liters	Yes |____| No |____|	
4.2 Manual pump	Yes |____| No |____|	|___| times	C] What type of manual pump do you use during the SEEDLING stage of the crop cycle? 1. Treadle Pump 2. Rope and Washer Pump 3. Hip pump 4. Other |___|	D] How deep is the well that you are pumping from during the SEEDLING stage of the crop cycle? |__| meters	E] How many hours do you spend manually pumping water for each irrigation cycle during the SEEDLING stage of the crop cycle? |__| hours	
4.3 Diesel/Petrol Pump	Yes |____| No |____|	|___| times	C] What size is the petrol pump you use during the SEEDLING stage of the crop cycle? 1. 1 inch 2. 2 inch 3. 3 inch 4. Larger than 3 inch 5. Other_____ |___|	D] How deep is the well/river /stream that you are pumping from during the SEEDLING stage of the crop cycle? |__| meters	E] How many hours do you run your petrol/diesel pump for each irrigation cycle during the SEEDLING stage of the crop cycle? |___| hours	F] How many liters does the petrol/diesel pump use per hour during the SEEDLING stage of the crop cycle? |__| liters

4.4 Electric Pump	Yes |____| No |____|	|___| times	C] What size is the electric pump you use during the SEEDLING stage of the crop cycle? 1. 1 inch 2. 2 inch 3. 3 inch 4. Larger than 3 inch 5. Other_____ |___|	D] How deep is the well/river /stream that you are pumping from during the SEEDLING stage of the crop cycle? |__| meters	E] How many hours do you run your electric pump for each irrigation cycle during the SEEDLING stage of the crop cycle? |___| hours	
4.5 Gravity	Yes |____| No |____|	|___| times	C] What is the size of the hose you use to carry the water during the SEEDLING stage of the crop cycle? 1. 1 inch 2. 1 ¼ inch 3. 2 inch 4. 3 inch |___|	D] What is the distance from your field to the water source during the SEEDLING stage of the crop cycle? |__| meters	E] How many hours do you water for each irrigation cycle during the SEEDLING stage of the crop cycle? |___| hours	
Instructions	*1=Yes; 0=No* *IF NO, SKIP TO NEXT ROW.*					

Extraction Method	GROWTH STAGE		Specific Questions for each technology to determine volume. [ENUMERATOR SHOULD SPECIFY THAT AN IRRIGATION CYCLE IS ONE APPLICATION OF WATER TO HIS PLOT ON A SINGLE DAY. IN SOME INSTANCES THE FARMER WILL HAVE MULTIPLE IRRIGATION CYCLES TO IRRIGATE THE ENTIRE PLOT. SMALLER FARMERS MAY BE ABLE TO IRRIGATE THE ENTIRE PLOT IN ONE DAY DURING ONE IRRIGATION CYCLE.]			
	A] During the GROWTH stage of the crop cycle, did you extract water for your crops in the most recent dry season using [EXTRACTION METHOD]?	B] How many times per week do you irrigate during the GROWTH stage of the crop cycle using [EXTRACTION METHOD]?	C] How many buckets/watering cans are used for each irrigation cycle during the GROWTH stage of the crop cycle? |___| buckets/cans	D] How large is each bucket watering can/bucket used for irrigation during the GROWTH stage of the crop cycle? |___| liters	E] Do different family members carry different size containers of water? Yes |____| No |____|	
4.6 Bucket/Hauling	Yes |____| No |____|	|___| times				
4.7 Manual pump	Yes |____| No |____|	|___| times	C] What type of manual pump do you use during the GROWTH stage of the crop cycle? 1. Treadle Pump 2. Rope and Washer Pump 3. Hip pump 4. Other |___|	D] How deep is the well that you are pumping from during the GROWTH stage of the crop cycle? |__| meters	E] How many hours do you spend manually pumping water for each irrigation cycle during the GROWTH stage of the crop cycle? |__| hours	
4.8 Diesel/Petrol Pump	Yes |____| No |____|	|___| times	C] What size is the petrol pump you use during the GROWTH stage of the crop cycle? 1. 1 inch 2. 2 inch 3. 3 inch 4. Larger than 3 inch 5. Other_____ |___|	D] How deep is the well/river /stream that you are pumping from during the GROWTH stage of the crop cycle? |__| meters	E] How many hours do you run your petrol/diesel pump for each irrigation cycle during the GROWTH stage of the crop cycle? |___| hours	F] How many liters does the petrol/diesel pump use per hour during the GROWTH stage of the crop cycle? |__| liters

4.9 Electric Pump	Yes |____| No |____|	|___| times	C] What size is the electric pump you use during the GROWTH stage of the crop cycle? 1. 1 inch 2. 2 inch 3. 3 inch 4. Larger than 3 inch 5. Other_____ |___|	D] How deep is the well/river /stream that you are pumping from during the GROWTH stage of the crop cycle? |__| meters	E] How many hours do you run your electric pump for each irrigation cycle during the GROWTH stage of the crop cycle? |___| hours	
4.10 Gravity	Yes |____| No |____|	|___| times	C] What is the size of the hose you use to carry the water during the GROWTH stage of the crop cycle? 1. 1 inch 2. 1 ¼ inch 3. 2 inch 4. 3 inch |___|	D] What is the distance from your field to the water source during the GROWTH stage of the crop cycle? |__| meters	E] How many hours do you irrigate during the GROWTH stage of the crop cycle? |___| hours	
Instructions	*1=Yes; 0=No* *IF NO, SKIP TO NEXT ROW.*					

Extraction Method	FRUITING STAGE		Specific Questions for each technology to determine volume. [ENUMERATOR SHOULD SPECIFY THAT AN IRRIGATION CYCLE IS ONE APPLICATION OF WATER TO HIS PLOT ON A SINGLE DAY. IN SOME INSTANCES THE FARMER WILL HAVE MULTIPLE IRRIGATION CYCLES TO IRRIGATE THE ENTIRE PLOT. SMALLER FARMERS MAY BE ABLE TO IRRIGATE THE ENTIRE PLOT IN ONE DAY DURING ONE IRRIGATION CYCLE.]			
	A] During the FRUITING stage of the crop cycle, did you extract water for your crops in the most recent dry season using [EXTRACTION METHOD]?	B] How many times per week do you irrigate during the FRUITING stage of the crop cycle using [EXTRACTION METHOD]?				
4.11 Bucket/Hauling	Yes |____| No |____|	|___| times	C] How many buckets/watering cans are used for each irrigation cycle during the FRUITING stage of the crop cycle? |___| buckets/cans	D] How large is each bucket watering can/bucket used for irrigation during the FRUITING stage of the crop cycle? |___| liters	E] Do different family members carry different size containers of water? Yes |____| No |____|	
4.12 Manual pump	Yes |____| No |____|	|___| times	C] What type of manual pump do you use during the FRUITING stage of the crop cycle? 1. Treadle Pump 2. Rope and Washer Pump 3. Hip pump 4. Other |___|	D] How deep is the well that you are pumping from during the FRUITING stage of the crop cycle? |__| meters	E] How many hours do you spend manually pumping water for each irrigation cycle during the FRUITING stage of the crop cycle? |__| hours	
4.13 Diesel/Petrol Pump	Yes |____| No |____|	|___| times	C] What size is the petrol pump you use during the FRUITING stage of the crop cycle? 1. 1 inch 2. 2 inch 3. 3 inch 4. Larger than 3 inch 5. Other_____ |___|	D] How deep is the well/river /stream that you are pumping from during the FRUITING stage of the crop cycle? |__| meters	E] How many hours do you run your petrol/diesel pump for each irrigation cycle during the FRUITING stage of the crop cycle? |___| hours	F] How many liters does the petrol/diesel pump use per hour during the FRUITING stage of the crop cycle? |__| liters

4.14 Electric Pump	Yes |____| No |____|	|___| times	C] What size is the electric pump you use during the FRUITING stage of the crop cycle? 1. 1 inch 2. 2 inch 3. 3 inch 4. Larger than 3 inch 5. Other_____ |___|	D] How deep is the well/river /stream that you are pumping from during the FRUITING stage of the crop cycle? |__| meters	E] How many hours do you run your electric pump for each irrigation cycle during the FRUITING stage of the crop cycle? |___| hours	
4.15 Gravity	Yes |____| No |____|	|___| times	C] What is the length of the hose you use to carry the water during the FRUITING stage of the crop cycle? 1. 1 inch 2. 1 ¼ inch 3. 2 inch 4. 3 inch |___|	D] What is the distance from your field to the water source during the FRUITING stage of the crop cycle? |__| meters	E] How many hours do you irrigate during the FRUITING stage of the crop cycle? |___| hours	
Instructions	*1=Yes; 0=No* *IF NO, SKIP TO NEXT ROW.*					

KEY CROP PRODUCTION

Please provide details for the crops you harvested in **2014/2015 SEASON***.

#	5.1 Crop Cod	5.2 Month planted [USE 1-12 for months	5.3 Area planted (In Manzana)	5.4 Seed/seedlings Cost *(if farmer uses their own seeds, unit price paid equals 0)*			5.5 Harvest quantity		5.6 Amount of Harvest Loss		5.7 Sold quantity		
				QUANTITY	UNIT	UNIT PRICE PAID	QUANTITY	UNIT	QUANTITY	UNIT	QUANTITY	UNIT	UNIT PRICE RECEIVED
RAINFED CROPS ***(2015 SEASON)***													
1													
2													
3													
4													
5													
6													
7													
8													
9													
10													
IRRIGATED CROPS ***(2014/2015 SEASON)***													
11													
12													
13													
14													
15													
16													
17													
18													
19													
20													

SEED UNIT CODES: 1: Grams 2: Pound

UNIT CODES: 1: Bag (Malla): 50 Pounds 2: Bag (Normal): 100 Units 3: Boxes (Cajillas): 60 Pounds 4: Bag (Quintal): 100 Pounds 5: Bag (arroba): 25 Pound 6: Pound 7: Box (bidón): 25 pound 8: Units 9: Dozen: 12 Units

CROP CODES

10. Avocado
11. Sesame
12. Cotton
13. Rice
14. Pumpkin
15. Bananas
16. Cocoa
17. Coffee
18. Sweet Potato
19. Cow Pea
20. Onion
21. Chile Peppers
22. Coconut
23. Cabbage
24. Spinach
25. Beans
26. Chickpea
27. Sunflowers
28. Green Peas
29. Hibiscus
30. Lettuce
31. Lentils
32. Lemon
33. Maize
34. Mango
35. Peanut
36. Cashews
37. Melon
38. Millet
39. Mustard Seed
40. Yam
41. Orange
42. Okra
43. Potatoes
44. Papaya
45. Cucumber
46. Pineapple
47. Squash
48. Plantain
49. Watermelon
50. Sorghum
51. Soy Bean
52. Tobacco
53. Tomato
54. Wheat
55. Yucca
56. Carrots
57. Zucchini
58. Other
59. Chiltoma

		60. Broccoli

OTHER INPUT AND PRODUCTION COSTS

	INPUT TYPE	TOTAL COST FOR RAINFED PRODUCTION IN **2014/2015 SEASON***	TOTAL COST FOR IRRIGATED PRODUCTION IN **2014/2015 SEASON***
6.1	CHEMICALS (pesticides- herbicides, acaricides, fungicides, etc)		
6.2	FERTILIZERS (inorganic and purchased organic fertilizers)		
6.3	Labor/services (hired labor, machinery/tool rent, land rent)		
6.4	Fuel		
6.5	Other inputs (plastics, transport, etc.)		

CUSTOMER SATISFACTION

FOR THE 2014/2015 SEASON PLEASE ANSWER THE FOLLOWING QUESTIONS:

INPUT SUPPLIERS

7.1	What was your main source of agricultural inputs in the past year?	PULPERIA (KIOSK)		1
		AGROSERVICIO (AGRO STORE)		2
		ONG		3
		GOVERNMENT		4
		INFORMAL		5
		LOCAL FARMER MARKETS		6
		IDEAL TECHNICIANS		7

7.2	How satisfied are you with the service you received from this supplier? *[Read options; select one]*	VERY SATISFIED		1
		SOMEWHAT SATISFIED		2
		NEITHER SATISFIED NOR DISSATISFIED		3
		SOMEWHAT DISSATISFIED		4
		VERY DISSATISFIED		5
		DON'T KNOW		9

7.3	Have you recommended this supplier to anyone else?	NO		0
		YES		1

EXTENSION AGENT SERVICE

7.4	Who was your main provider of agricultural advice in the past year? *[Read options; select one]* *[IF 'NO SERVICE', skip to 8.7]*	NONE		0
		MINISTRY OF AGRICULTURE (NICARAGUAN GOVERNMENT)		1
		LOCAL BUSINESS (SHOP / TRADER)		2
		PRIVATE COMPANY AGENT		3
		MEDIA (RADIO, TV, NEWSPAPER)		4
		NGO		5
		FRIENDS OR FAMILY		6
		IDEAL TECHNICIANS		7
		OTHER _____		8
7.5	How satisfied are you with your access to agricultural advice? *[Read options; select one]*	VERY SATISFIED		1
		SOMEWHAT SATISFIED		2
		NEITHER SATISFIED NOR DISSATISFIED		3
		SOMEWHAT DISSATISFIED		4
		VERY DISSATISFIED		5
		DON'T KNOW		9
7.6	How many visits did you receive from an extension agent in the past year?			

MARKET INFORMATION

7.7	What is your main source of market information? *[Read options; select one]*	MEDIA (TELEVISION, RADIO, NEWSPAPER)		1
		GOVERNMENT SERVICE		2
		NGO		3
		INFORMAL (WORD-OF-MOUTH)		4
		OTHER (SPECIFY)		5
7.8	Where is your closest market?	|____| kilometers		
7.9	On average, how long does it take for you to get to the closest market during the time of year that you sell goods at it?	|_____| Minutes		
7.10	Where is the market where you sell the majority of your goods?	|____| kilometers		
7.11	On average, how long does it take for you to get to the market where you do the majority of your selling?	|_____| Minutes		

7.12	When do you typically get price information from this market? *[Read options; select one]*	BEFORE GOING TO THE MARKET		1
		SAME DAY		2
		NEXT DAY		3

		AFTER TWO DAYS OR MORE		4
		NEVER		5
		NOT APPLICABLE (NO MARKET IDENTIFIED)		9

7.13	How satisfied are you with your access to market information? *[Read options; select one]*	VERY SATISFIED		1
		SOMEWHAT SATISFIED		2
		NEITHER SATISFIED NOR DISSATISFIED		3
		SOMEWHAT DISSATISFIED		4
		VERY DISSATISFIED		5
		DON'T KNOW		9

FINANCE PROVIDERS

7.14	Did you borrow money to pay for agricultural equipment or inputs in 2014/2015? *[If NO, skip to 8.21]*	YES		1
		NO		0
7.15	If yes, How much was borrowed in 2014/2015?	|_____| Cordobas		
7.16	Which was the main source for your borrowing in 2014/2015? *[Select one]*	FAMILY / FRIENDS		1
		SAVINGS AND LOAN GROUP		2
		MICRO-FINANCE INSTITUTION		3
		BANK		4
		LOCAL MONEY-LENDER		5
		COOPERATIVES		6
		OTHER (SPECIFY)		7

7.17	Was the person primarily responsible for borrowing the money a male or female, even if the loan came from friends or family?	MALE		1
		FEMALE		2

7.18	How satisfied are you with this lender? *[Read options; select one]*	VERY SATISFIED		1
		SOMEWHAT SATISFIED		2
		NEITHER SATISFIED NOR DISSATISFIED		3
		SOMEWHAT DISSATISFIED		4
		VERY DISSATISFIED		5
		DON'T KNOW		9

7.19	Have you recommended this lender to anyone else?	YES		1
		NO		0

PRODUCE BUYERS

7.20	To whom did you sell the most agricultural produce in the past year? *[Read options; select one]* *[IF 'NO SALES', skip to 7.1]*	NO SALES		0
		LOCAL TRADER		1
		LOCAL ESTABLISHMENT (LODGE, SCHOOL, ETC.)		2
		COMMERCIAL BUYER (SUPERMARKET, COMPANY, ETC.)		3
		MARKETING GROUP OR COLLECTION CENTRE		4
		OTHER (SPECIFY)		5
7.21	How satisfied are you with this buyer? *[Read options; select one]*	VERY SATISFIED		1
		SOMEWHAT SATISFIED		2
		NEITHER SATISFIED NOR DISSATISFIED		3
		SOMEWHAT DISSATISFIED		4
		VERY DISSATISFIED		5
		DON'T KNOW		9

PROGRESS OUT OF POVERTY INDEX

#	Question	Response Options		Code
8.1	¿Cuántos miembros tiene el hogar?	Ocho o más		1
		Siete		2
		Seis		3
		Cinco		4
		Cuatro		5
		Tres		6
		Uno o dos		7
8.2	En el presente año escolar, ¿se matricularon en el sistema de educación formal todos miembros del hogar de las edades 7 a 18?	No hay miembros 7 a 18		0
		No		1
		Sí		2
8.3	En su ocupación principal en los últimos siete días, ¿cuantos miembros del hogar trabajaron como empleados/obreros?	Ninguno		1
		Uno		2
		Dos o más		3
8.4	¿De cuántos cuartos dispone el hogar (no incluya cocina, baños, pasillos ni garaje)?	Uno		1
		Dos		2
		Tres o más		3
8.5	¿Qué material predomina en el piso de la vivienda?	Tierra, u otro		1
		Madera (tambo), ladrillo de barro, o embaldosado o concreto		2
		Ladrillo de cemento, mosaíco, terrazo o cerámica		3
8.6	. ¿Qué combustible utilizan usualmente para cocinar?	Leña no comprada		1
		Leña comprada, carbón, o no cocinan		2
		Gas butano o propano, gas kerosén, electricidad, u otro		3
8.7	¿Tiene este hogar una plancha?	No		1
		Sí		2
8.8	¿Tiene este hogar una licuadora?	No		0
		Sí		1
8.9	¿Con cuántos teléfonos celulares cuenta el hogar?	Ninguno		0
		Uno		1
		Dos o más		2
8.10	¿Tiene este hogar una bicicleta, bote, caballo, burro, mulo, motocicleta, o vehículo?	No		1
		Sí		2

Appendix 2: Women's Empowerment in Agriculture Index (WEAI): iDE Survey Instrument

EACH HOUSEHOLD COMPLETES TWO OF THESE FORMS, ONE FOR PRIMARY MALE AND ONE FOR PRIMARY FEMALE

NOTE: The information in Module A can be captured in different ways; however, there must be a way to a) identify the proper individual within the household to be asked the survey, b) link this individual from the module to the household roster, c) code the outcome of the interview, especially if the individual is not available, to distinguish this from missing data, d) record who else in the household was present during the interview. This instrument must be adapted for country context including translations into local languages when appropriate.

Please double check to ensure:

- *You have completed the roster section of the household questionnaire to identify the correct primary and/or secondary respondent(s);*
- *You have noted the household ID and individual ID correctly for the person you are about to interview;*
- *You have gained informed consent for the individual in the household questionnaire;*
- *You have sought to interview the individual in private or where other members of the household cannot overhear or contribute answers.*
- *Do not attempt to make responses between male and female respondents the same—it is ok for them to be different.*

MODULE A: INDIVIDUAL IDENTIFICATION

	Code		Response	Response codes
A.01. Name of iDEal technician that serves the household	_____ _____	**A.05 Marital status**	☐	**A.05** Single/never married.....1 Divorced.....2 Separated.....3 Widowed.....4 Customary marriage, monogamous.....5 Customary marriage, polygamous.....6 Religious marriage, monogamous.....7 Religious marriage, polygamous.....8 Civil marriage, monogamous.....9 Civil marriage, polygamous.....10 Cohabiting, single partner.....11 Cohabiting, multiple partners.....12
A.02. Name of respondent currently being interviewed **First name:** ..... **Last name:**		**A.06. Outcome of interview**	☐	**A.06** Completed .....1 Incomplete .....2 Absent .....3 Refused .....4 Could not locate 5
A.03. Sex of respondent: Male.....1 Female.....2	☐	**A.07. Ability to be interviewed alone:**	☐	**A.07** Alone .....1 With adult females present.....2 With adult males present.....3 With adults mixed sex present.....4 With children present.....5 With adults mixed sex and children present....6
A.04. Type of household Male and female adult .....1 Female adult only.....2 Male adult only 3	☐			

MODULE B: ROLE IN HOUSEHOLD DECISION-MAKING AROUND PRODUCTION AND INCOME GENERATION

Activity		Did you (singular) participate in [ACTIVITY] in the past 12 months (that is during the last [one/two] cropping seasons)? Yes.....1 No .....2 >> next activity	How much input did you have in making decisions about [ACTIVITY]?	How much input did you have in decisions on the use of income generated from [ACTIVITY]	To what extent do you feel you can make your own personal decisions regarding [ACTIVITY] if you want(ed) to?
Activity Code	Activity Description	**B.01**	**B.02**	**B.03**	**B.04**
A	Food crop farming: crops that are grown primarily for household consumption			[ONLY IF THERE IS EXCESS THAT IS SOLD]	
B	Cash crop farming: crops that are grown primary for sale in the market				
C	Taking crops to market/selling produce				
D	Livestock raising				
E	Fishing or fishpond culture (where relevant to ask)				
F	Wage and salary employment: in-kind or monetary work both agriculture and other wage work for other people				
G	Choosing crops for agricultural production				
H	Getting inputs for agricultural production				
I	Purchasing major HH expenditures (e.g. large appliance such as TV or fridge)				
J	Purchasing minor HH expenditures (such as food, pots, plates)				
			B.02/B.03: Input into decision making No input.....1 Input into some decisions .....2 Input into all decisions.....3 No decision made 4		**B.04: Extent of participation in decision making** Not at all……..…..1 Small extent……..……2 Medium extent……3 High extent……..4

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Productive Capital		Does anyone in your household currently have any [ITEM]? Yes .....1 No.....2 >> next item	How many of [ITEM] does your household currently have?	Who would you say owns most of the [ITEM]?	Who would you say can decide whether to sell, give away, rent out or purchase[ITEM] most of the time?
Productive Capital		C.01a	C.01b	C.02	C.03
A	Agricultural land (pieces/plots)				
B	Large livestock (oxen, cattle)				
C	Small livestock (goats, pigs, sheep)				
D	Chickens, Ducks, Turkeys, Pigeons				
E	Fish pond or fishing equipment				
F	Farm equipment (non-mechanized)				
G	Farm equipment (mechanized)				
H	Non-farm business equipment (mill, grocery stand, computer, batteries for cell phone charging, etc.)				
				C.02-C.03: Decision-making and control over productive capital Self .....1 Partner/Spouse .....2 Self and partner/spouse jointly.....3 Other HH or non-HH member .....4 Self and other HH member(s).....5 Partner/Spouse and other household member(s).....6 Self and other non-HH individuals.....7 Someone (or group of people) outside the HH.....8 Partner/Spouse and other outside people.....9 Self, Partner/Spouse and other outside people.....10 Other.....11	

Lending sources		Has anyone in your household taken any loans or borrowed cash/in-kind from [SOURCE] in the past 12 months? (If No skip to next lending source) If **NONE**, go to **D.05**	Who made the decision to borrow from [SOURCE]?	Who makes the decision about what to do with the money/ item borrowed from [SOURCE]?	Whose name is the loan in?
Lending source names		**D.01**	**D.02**	**D.03**	**D.04**
A	Non-governmental organization (NGO)				
B	Informal lender				
C	Formal lender (bank/financial institution)				
D	Friends or relatives				
E	Group based micro-finance or lending including VSLAs / SACCOs/ merry-go-rounds				
F	Government (FISP)				
		D.01Taken loans Yes, cash .....1 Yes, in-kind .....2 Yes, cash and in-kind.....3 No.....4 Don't know……5	**D.02- D.04: Decision-making and control over credit** Self.....1 Partner/Spouse .....2 Self and partner/spouse jointly.....3 Other HH or non-HH member ……..4 Self and other HH member(s)……..5 Self and other non-HH individuals…….6 Other……7		

QNo.	Question	Response	Response codes
D.05	Could you please tell us why you/your HH did not take any loans or borrow any cash/in-kind?	[ADD DETAILS HERE, ABOUT WHY THE HOUSEHOLD DID NOT TAKE LOAN]	Didn't want one.....1 Didn't know where to get one .....2 Lack of collateral .....3 No guarantor.....4 Interest rates too high.....5 Culturally unacceptable .....6 Illiteracy .....7 Lack of financial management skills.....8 Not available in my area.....9 Didn't need it.....10 Other (specify)

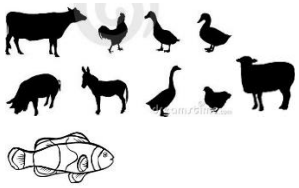
MODULE E: INDIVIDUAL LEADERSHIP AND INFLUENCE IN THE COMMUNITY

QNo	Question	Response	Response codes
E.01	Do you feel comfortable speaking up in public about issues relating to your local community? (E.g. infrastructure such as small wells, roads, water supplies; public works; misbehaviour of elected officials)		No, not at all comfortable..... 1 Yes, but with a great deal of difficulty..... 2 Yes, but with a little difficulty..... 3 Yes, fairly comfortable..... 4 Yes, very comfortable..... 5
E.02	Do you feel comfortable speaking up in public about issues relating to your individual or family's circumstances such as land, assets, inheritance or wages?		

MODULE E CONTINUED: GROUP MEMBERSHIP AND INFLUENCE IN THE GROUP

Group membership		Is there a [GROUP] in your community? Yes ..... 1 No ..... 2 >> next group	Are you a member of this [GROUP]? Yes... (Read codes below) No .....4>> next group
	Group Categories	E.03	E.04
A	Agricultural / livestock/ fisheries producer's group (including marketing groups); Trade and business association		
B	Credit or microfinance group (including SACCOs/merry-go-rounds/ VSLAs); Mutual help or insurance group (including burial societies)		
C	Civic group (improving community) or charitable group (helping others); forest users' group; water users group; local government; religious group		
D	Other women's group (only if it does not fit into one of the other categories)		
E	Other (specify)		
			E.04: Group membership and influence in the group Attend meetings……1 Speak at/participate in meetings……2 Hold an administrative or management position (e.g. Chair, secretary, treasurer).....3

MODULE F: TIME ALLOCATION

ACTIVITY **(Ask respondents to divide 24 beads/pebbles/beans etc. into the following category to represent how they think they spend their time.) (Each bead/pebble/bean counts as one hour in the day)**						
 (A) Collecting firewood and water	 (B) Domestic work (including cooking, cleaning, sewing, caring for children, sick family members and elderly)	 (C) On-farm agricultural production/activities (e.g. weeding, planting, livestock, harvesting, processing)	 (D) Marketing produce (including travelling to/from markets)	 (E) Irrigating crops	 (F) Other income generating activities	 (G) Leisure (e.g. visiting friends and neighbours; spending time with family; sports; listening to the radio etc.)
[Put beads here]	[Write the number of beads in each cell once complete]					
 (H) Eating/drinking	 (I) Social activities (e.g. group attendance, religious activities, community/family obligations e.g. funerals)	 (J) Sleep/rest	 (K) Animal husbandry/ livestock/ fishing (including beekeeping, foraging)	 (L) Shopping/getting services (including health services, paid-for personal care such as haircutting or getting vetinary services). Include travel time.	(M) Other – please specify	(N) Other – please specify

SATISFACTION WITH TIME ALLOCATION

QNo.	Question	Response	Response options/Instructions
F.02	How satisfied are you with your available time for leisure activities like visiting friends/neighbors, watching TV, listening to the radio or doing sports?		READ: Please give your opinion on a scale of 1 to 10. 1 means you are not satisfied and 10 means you are very satisfied. If you are neither satisfied or dissatisfied this would be in the middle or 5 on the scale.

Appendix 3: Methods of Estimating Water Use

1) Flow rates (liters/hours) were determined for the manual, diesel and electric pump methods by taking into account pump size or type and well or river depth used for extraction. Flow rate models were provided by iDE's irrigation engineer.

2) For households using the bucket hauling method, the capacity of the container used for watering was multiplied by the number of containers needed for water to proxy a "flow rate" during a single irrigation cycle.

3) In order to calculate the total amount of water used for an average week, within a given crop cycle per household and crop, we multiplied the flow rate by the duration of a single irrigation event (in hours) by the frequency of irrigation events per week.

$$Weekly\ Water\ Use_{ijk} =$$

$$duration\ of\ single\ irrigation\ event_{ijk} * flow\ rate_{ij} * frequency\ of\ events\ per\ week_{ijk}$$

Where:

$i =$ crop cycle (i. e. seedling, growth, and fruiting)

$j =$ household

$k =$ crop

4) Once we estimated the household's average weekly water use per crop stage, we estimated the number of crop stage weeks as a function of the household's specific crop portfolio. To do this we obtained the average crop stage lengths from Food and Agriculture Organization and country staff provided appropriate corrections relevant to the program area.[23] We multiplied the weekly water estimates per crop and household by the average length of crop stage to obtain total water use estimates per crop stage.

$$Total\ Water\ Use_{ijk} =$$

$$Weekly\ Water\ Use_{ijk} * \#\ of\ Crop\ Stages\ Weeks\ Per\ Crop_{ijk}$$

5) Finally, to calculate total water used by the household, per crop, during the season we sum the total water used across the three crop stages. This provides us with a detailed analysis of water usage per crop per household. For the purposes of our analysis at the household level, the data was then reshaped and summed to provide water usage estimates at the household level.

$$Total\ Water\ Use\ for\ Season_j = \sum_{i=seedling}^{fruiting} Total\ Water\ Use_{ij}$$

[23] Crop cycle lengths taken from http://www.fao.org/docrep/x0490e/x0490e0b.htm