Agricultural Transformation and Farmers' Expectations:

Experimental Evidence from Uganda

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Objectives

- Shed light on the determinants of **agricultural technology adoption** in developing countries – in particular the decision to shift from subistence agriculture to commercial farming

- We focus on a **large-scale extension service program** run by the Government of Uganda to increase the domestic production of new cash crops (i.e. oil seeds) and contribute to sustainable poverty reduction

- We exploit the **randomized roll–out** of the program to assess (i) its direct impact and (ii) the role of farmers **ex-ante beliefs about crop profitability** in explaining adoption choices.

Motivation

- Subsistence farmers still dominate in Africa and agr productivity growth is particularly slow compared to other regions, mainly due to **low adoption rates** of new farming technologies and systems (World Bank, 2007; Sunding and Zilberman, 2001; Meiburg and Brandt, 1962).
- **Commercial farming and value chain development**, especially in cash crops, is one potential mean for fostering rural transformation, increasing productivity and enhancing living standards of smallholder households in developing countries (Ashraf et al., 2009; Barrett et al., 2018; Bellemare and Bloem, 2018).
- Despite the growing attention to technology adoption in developing contexts, knowledge gaps still remain on **why some valuable technologies are rapidly adopted, while others are not** .

What we do

- We use a large extension service program in Uganda to study what drives smallholders to adopt new cash crops (i.e. oil seeds) and switch to commercial farming.
- We exploit detailed data on *ex–ante* farmers' expectations about crop profitability combined with difference across regions induced by the random assigment of the extension program.
- We assess the direct impact of the program on cash crops adoption and intermediate outcomes (input use, market access)
- We futher tests to what extent ex-ante beliefs may be misperceived and the role of the latter in farmers' adoption decisions.

What we find (preview)

- Positive impact of the extension program on oilseed adoption and technical outcomes
- Modest impact on welfare outcomes
- Heterogenous effects along ex–ante price (but not yield) expectations, i.e. farmers who under–estimate oilseeds prices at baseline are more likely to adopt
- Program contributes to revision of farmers' beliefs, in particular by reducing the wedges in expected prices.
- Together, our evidence indicates a potentially important source of agr market frictions, where technology adoption is sub-optimal due to misperception and uncertainty in price expectations.

Background literature– 1

- Long-standing lit on technology adoption in dev countries and several explanations:
  - *Supply–side*: lack of (credit and insurance) market access, lack of infrastructure (along the value chain) and missing linkages (Ambler et al. 2018; Karlan et al. 2014; Stifel and Mintel 2008)
  - *Demand–side*: lack of knowledge, behavioural biases, incomplete learning (Ashraf et al. 2009; Duflo et al. 2011; Hanna et al 2014)
- Role of information is key, hence the focus on the performance of extension service provision (Feder et al. 1985, 1987; Kondylis et al. 2017; Beaman et al. 2017; Deutshmann et al. 2019)

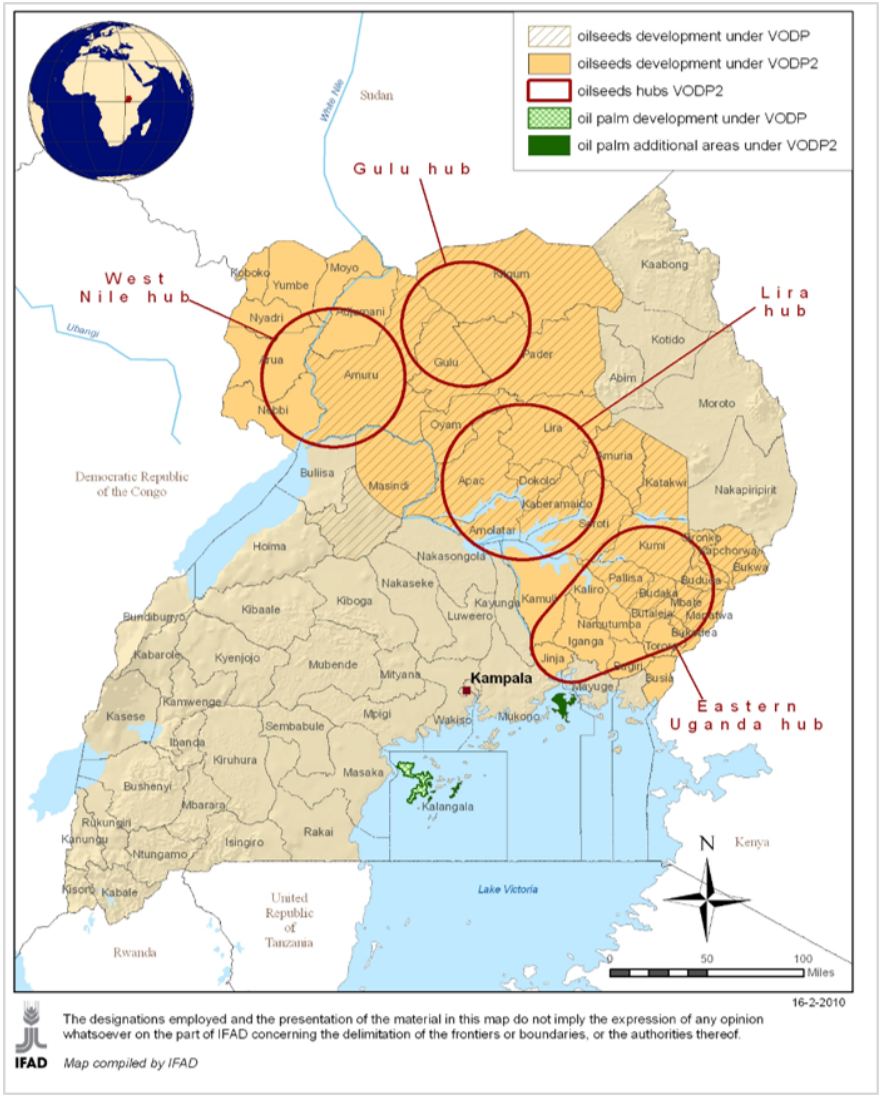
Background literature– 2

- In a standard neoclassical framework, farmers seek to maximize **expected (net) benefits**
- Even with 'familiar' crops, many **production functions are not known in advance** and subjective expectations are formed regarding future events and realizations (depending on both private and public information)
- Adoption rates may be restricted by substantial **heterogeneity in expected returns to technology adoption across farmers** (Suri 2011)
- Direct approach to study the role of expectations in investment decisions in education, migration, health (Jensen 2010, McKenzie et al. 2013, Attanasio and Kauffmann 2014, Wiswall and Zafar 2015, Delavande and Zafar 2019)
- No evidence on farm choices.

The program


THE REPUBLIC OF UGANDA
IFAD
Investing in rural people
MINISTRY OF AGRICULTURE, ANIMAL INDUSTRY AND FISHERIES (MAAIF)
VEGETABLE OIL DEVELOPMENT PROJECT (VODP2)
MAAIF VISION:
"A competitive, profitable and sustainable agricultural sector."
MAAIF MISSION:
"To transform subsistence farming to commercial agriculture."
VODP2 DEVELOPMENT OBJECTIVE
"To increase domestic production of vegetable oil and its by-products."

The program



- **Flagship IFAD project**: Total costs: USD 147.2 million (2 components); IFAD loan: USD 52.0 million; GoU: USD 14.4 million; target beneficiaries: 139,000 households
- **Bundled program**: Extension service + market information & linkages
- **Four hubs**: Lira, Eastern Uganda, Gulu and West Nile, covering 43 districts.

The context

- Since the end of 1990s, **GoU** has been committed to supporting agricultural sector by investing in a nation–wide vegetables oil extension program
  - Target cash crops: Groundnuts, soyabean, sesame, sunflower.
- **Goals**:
  - promote and consolidate the oilseed value chain (exploit crushing capacity)
  - boost production of vegetable oil (and by–products) for both domestic and regional market
  - raise rural households income

The context

- VODP highly relevant for **GoU Plan for Modernization of Agriculture** to promote import substitution, export diversification and poverty reduction
- **Strategy**: heavy GoU leadership, public-private parternships in agribusiness, value chain approach by nurturing commercial links between smallholder farmers and processors (buyers and millers)
- **Two phases**: VODP (1998–2010) and VOPD2 (2010–2019)

The VODP2 intervention

- Extension program supplied by pay-for-service providers to farmer groups
  - **technical services** for increased oilseed production/ productivity; Farmer Learning Platform; training on best agronomic practices; land preparation, planting, inputs use (integrated soil fertility management, pest and deseases handling); post–harvest and storage.
  - **market information**: training about farming as a business, business oriented group development, bulking for produce and inputs; market information gathering and market intelligence; commercial linkages building to value chain actors (seed companies, input dealers, oilseed millers, financial institutions).

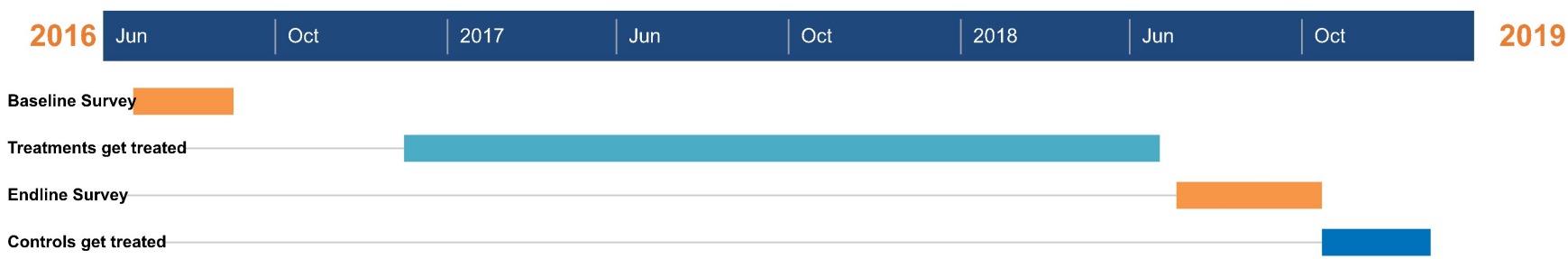
- (Existing) Groups eligibility criteria:
  - being in the area of program development
  - interested in oilseed production
  - available land to implement the learning platform
  - not currently benefiting from other development projects

Our study design

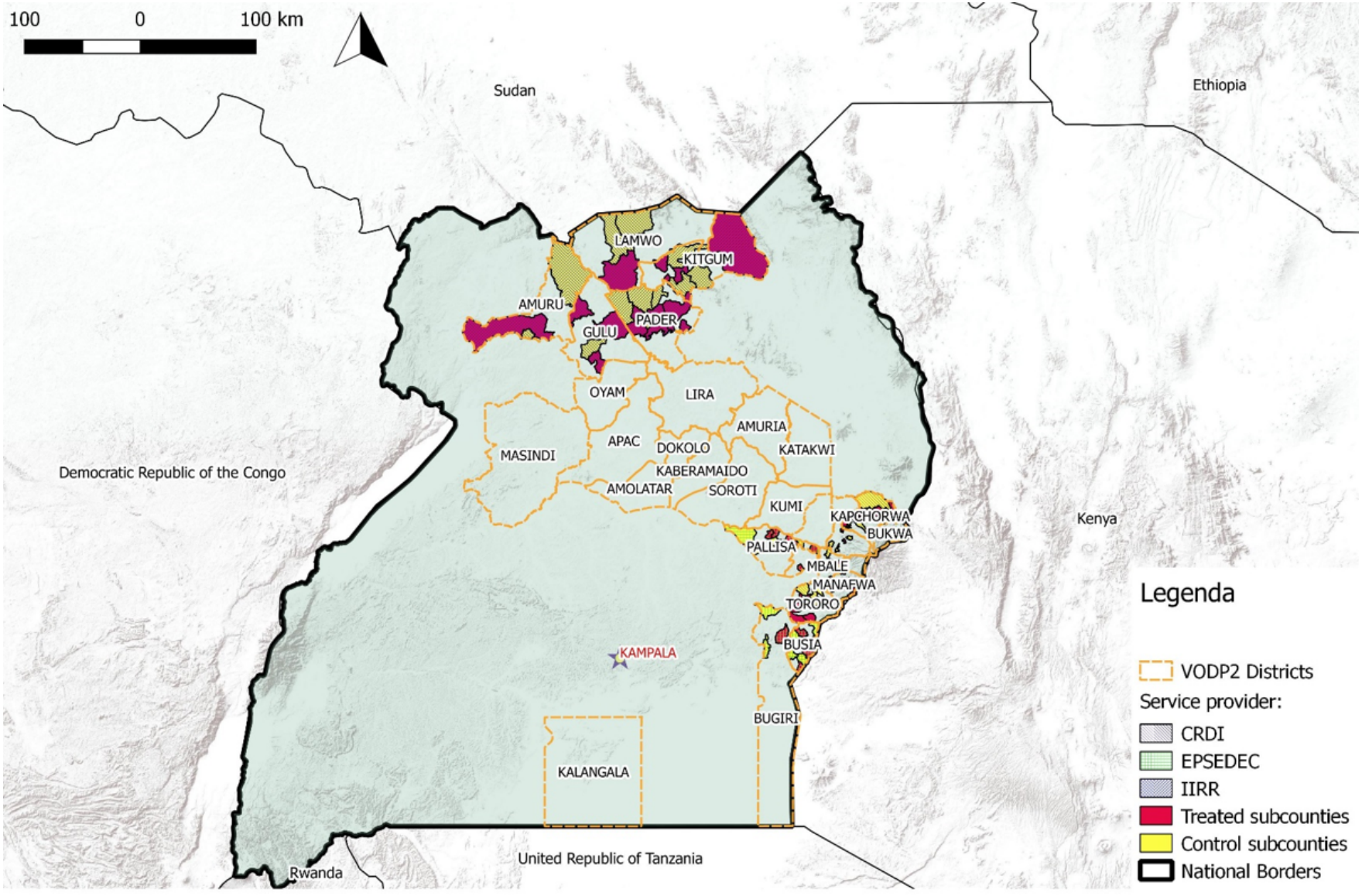
- In parternership with GoU, we designed VODP2 with a phase-in structure, which allowed for a **randomized control trial**

Our study design

- Random assignment of suitable sub-counties to treatment and control group
  - Sub-counties are intermediate administrative level (between districts and villages) with avg 20K population
  - Stratification by district
  - Limit major spillover effects
- Phased roll-out of VODP2 using a cluster–randomized block design, where sub–counties are the block, and groups and farmers are the clusters
- Timeline:



Random program assignment



VODP2: Implementation Districts and Study Areas

Sampling and data

- Focus on two hubs (Mbale-Jinja and Gulu) and 86 eligible sub-counties in 15 districts
- Random selection of 690 farmer groups (8 per sub-county) out of Census of already existing farming groups provided by service providers and local authorities
- Random selection of 4 farmers per farmer group: 2752 farmers
- Baseline survey in Summer 2016; Endline surevey in Fall 2018
  - Farmer questionnaire: socio-demographics, agricultural production (inputs, outputs by crop), technical skills, market linkages, expectations
  - Farmer group questionnaire: size, composition, scope, functioning and activities
- 7.5% attrition but not differential by treatment

Determinants of attrition

	(1) Attriter
Treat	0.0135
	(0.0111)
Oilseed baseline adoption	0.00409
	(0.0109)
Is the HH head	-0.0375
	(0.0511)
Is male	0.0513
	(0.0509)
Can read	0.0213
	(0.0348)
Can write	-0.0106
	(0.0374)
No education	-0.0294
	(0.0320)
Primary education	-0.0349
	(0.0290)
Secondary education	-0.0406
	(0.0270)
Wealth index	-0.00261
	(0.00308)
Total land	-0.000142
	(0.000276)
N. of plots cultivated	0.00128
	(0.00436)
Constant	0.0399
	(0.0350)
Observations	2,733
R-squared	0.033
Strata FE	Yes
Crop FE	No

Descriptive Stats– Balancing check

	(1)	(2)
	Control mean	ITT
PANEL A: Respondent characteristics		
HH head	0.604	0.00452
	(0.489)	(0.0336)
Male	0.623	0.000
	(0.485)	(0.0338)
Can read	0.748	-0.0260
	(0.491)	(0.0253)
Can write	0.741	-0.0184
	(0.495)	(0.0255)
No education	0.0960	0.0166
	(0.295)	(0.0193)
Primary education	0.484	-0.0157
	(0.500)	(0.0255)
Secondary education	0.379	-0.0111
	(0.485)	(0.0269)
Above secondary education	0.0410	0.010
	(0.198)	(0.009)
PANEL B: HH level general outcomes		
N. of plots cultivated	2.293	-0.107
	(1.245)	(0.0777)
Total land	6.648	0.349
	(10.07)	(0.923)
HH days of farm work	233	-6.356
	(132)	(8.581)
Revenues from crop sale	133.6	-19.06
	(323)	(22.46)
HH monthly labour income	23.56	1.640
	(51.74)	(3.380)
Wealth index	-0.0159	0.0318
	(1.945)	(0.102)

Descriptive Stats– Balancing check

Table 2: Oilseed-specific summary statistics and balance

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Soyabean		Sunflower		Sesame		Groundnuts	
	Control mean	ITT	Control mean	ITT	Control mean	ITT	Control mean	ITT
PANEL A: Adoption								
Adoption	0.222	0.0236	0.108	-0.00462	0.210	0.0171	0.437	0.00416
	(0.416)	(0.0429)	(0.310)	(0.0380)	(0.408)	(0.0627)	(0.496)	(0.0525)
Share of land	0.0309	0.00470	0.0256	-0.00271	0.0400	-0.00256	0.0679	0.000173
	(0.0784)	(0.00746)	(0.0935)	(0.0124)	(0.102)	(0.0134)	(0.109)	(0.00995)
PANEL B: Inputs								
Fertilizer use	0.0344	-0.00592	0.00659	-0.00148	0.0110	-0.00149	0.0491	-0.0133
	(0.182)	(0.0101)	(0.0810)	(0.00303)	(0.104)	(0.00449)	(0.216)	(0.0105)
Fertilizer quantity	367.1	-171.7	60.65	-11.14	6.214	-6.212	359.6	300.5
	(4826)	(165.0)	(1739)	(60.26)	(205.3)	(5.537)	(4107)	(415.5)
Fertilizer expense	0.0382	-0.00751	0.0228	-0.0127	0.000621	-0.000621	0.0608	0.0133
	(0.511)	(0.0214)	(0.473)	(0.0141)	(0.0205)	(0.000554)	(0.828)	(0.0471)
Pesticide use	0.0278	-0.00883	0.00879	-0.00148	0.00366	0.000723	0.0542	-0.0220*
	(0.165)	(0.00858)	(0.0934)	(0.00456)	(0.0604)	(0.00228)	(0.227)	(0.0130)
Pesticide quantity	369.7	-159.2	60.73	-11.05	6.171	-6.170	359.9	260.0
	(4821)	(166.1)	(1740)	(60.44)	(204.7)	(5.502)	(4120)	(416.6)
Pesticide expense	0.0272	0.00171	0.0100	-0.0100*	0.000382	-0.000308	0.0522	-0.0449***
	(0.386)	(0.0253)	(0.210)	(0.00555)	(0.0136)	(0.000372)	(0.499)	(0.0140)
Improved seeds use	0.0872	0.0137	0.0520	0.00427	0.0520	0.00354	0.182	0.00179
	(0.282)	(0.0204)	(0.222)	(0.0196)	(0.222)	(0.0160)	(0.386)	(0.0253)
Seeds expense	0.0547	0.0156	0.0485	0.000649	0.0198	0.00180	0.204	0.0641
	(0.345)	(0.0215)	(0.355)	(0.0265)	(0.205)	(0.0106)	(1.047)	(0.0642)
PANEL C: Labour supply (Days of work)								
By all	5.493	1.349	3.492	-0.504	6.937	-0.598	12.44	0.267
	(13.51)	(1.374)	(13.13)	(1.426)	(17.33)	(2.152)	(19.58)	(1.845)
By head	3.116	0.860	1.895	-0.292	4.191	-0.771	7.907	0.178
	(8.281)	(0.855)	(7.866)	(0.781)	(11.48)	(1.273)	(13.38)	(1.330)
By spouse	3.205	0.979	1.902	-0.331	3.952	-0.698	8.123	-0.573
	(9.124)	(0.929)	(8.230)	(0.727)	(11.44)	(1.200)	(13.89)	(1.161)
By other in the HH	1.680	0.353	0.668	-0.0580	1.503	-0.172	4.156	0.430
	(6.307)	(0.460)	(3.375)	(0.313)	(5.967)	(0.465)	(10.58)	(0.782)
By other outside HH	0.543	-0.0563	0.341	-0.0345	0.422	-0.0870	1.617	-0.0288
	(3.317)	(0.156)	(2.213)	(0.195)	(2.830)	(0.134)	(6.404)	(0.325)

Descriptive Stats– Balancing check (2)

Table 2: Oilseed-specific summary statistics and balance (cont.)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Soyabean		Sunflower		Sesame		Groundnuts	
	Control mean	ITT	Control mean	ITT	Control mean	ITT	Control mean	ITT
PANEL D: Market access								
Any sale	0.143	0.0348	0.0842	-0.00676	0.123	0.0122	0.281	-0.0189
	(0.350)	(0.0336)	(0.278)	(0.0326)	(0.329)	(0.0407)	(0.450)	(0.0414)
Seeds bought	0.106	-0.00462	0.0513	0.00647	0.0447	-0.00668	0.114	-0.00171
on the mkt	(0.308)	(0.0180)	(0.221)	(0.0142)	(0.207)	(0.0105)	(0.318)	(0.0174)
Harvest sold	0.00586	0.0102*	0.00806	0	0.00513	-0.00147	0.00879	0
in bulk/group	(0.0764)	(0.00537)	(0.0894)	(0.00645)	(0.0715)	(0.00348)	(0.0934)	(0.00425)
Contacts with	0.0916	-0.00970	0.0821	-0.00310	0.0432	0.0123	0.0315	0.00432
value chain actors	(0.289)	(0.0241)	(0.275)	(0.0204)	(0.203)	(0.0116)	(0.175)	(0.0103)
Sale to mkt actors	0.0300	0.0109	0.0315	-0.00226	0.0293	-0.00737	0.0579	0.00207
	(0.171)	(0.0103)	(0.175)	(0.0160)	(0.169)	(0.0112)	(0.234)	(0.0124)
PANEL E: Production and productivity								
Productivity	0.592	0.262	0.323	0.387	0.367	0.139	1.706	-0.413
	(6.401)	(0.484)	(1.679)	(0.369)	(4.024)	(0.304)	(11.58)	(0.481)
Harvest	0.388	0.371	0.625	0.189	0.500	-0.036	1.408	-0.334
	(5.967)	(0.464)	(4.230)	(0.484)	(7.001)	(0.335)	(20.19)	(0.589)
Harvest value	8.673	9.160	7.884	1.659	21.68	-1.565	111.9	-4.194
	(129.2)	(10.89)	(54.14)	(5.770)	(302.4)	(14.48)	(944.3)	(54.61)
Harvest value/acre	14.17	9.748	4.145	4.644	15.22	11.76	213	-97.32
	(179.2)	(14.35)	(25.56)	(5.050)	(168.2)	(15.70)	(2823)	(134.6)
Sale revenues	2.204	0.677	4.775	-1.847	2.763	-0.598	9.070	-2.939
	(10.79)	(0.766)	(47.41)	(3.132)	(11.75)	(1.149)	(81.27)	(2.888)
PANEL F: Profitability expectations								
Expected yield	5.312	0.389	7.382	0.295	3.939	-0.0271	7.414	0.101
	(3.751)	(0.326)	(9.543)	(1.260)	(2.886)	(0.289)	(7.004)	(0.493)
Expected price	0.207	-0.00452	0.119	0.00538	0.859	-0.548	0.389	-0.0184
	(0.0915)	(0.00858)	(0.0735)	(0.00892)	(13.03)	(0.529)	(0.502)	(0.0282)
Yield wedge	-5.280	0.00617	-2.018	0.00355	-2.772	-0.102	-2.707	-0.0785
	(6.167)	(0.871)	(4.360)	(0.582)	(3.296)	(0.471)	(3.690)	(0.310)
Price wedge	0.399	0.0132	0.316	-0.0308	-0.314	0.839	0.415	0.0146
	(0.265)	(0.0249)	(0.421)	(0.0511)	(19.93)	(0.810)	(0.837)	(0.0641)

Farmers' expectations about oilseed profitability

- We consider both **price** and **yield** expectations in order to distinguish market– *vs* technical–related beliefs.
- We ask respondents their beliefs about their **own** expected price and yield (per unit) at the end of the season if they were to grow each specific oilseed.
- We further collect data on their beliefs about the average price and yield (per unit) faced by the **average farmer** in the rest of the population.
- **Expectations' wedge** as percentage deviation from actual prices and yileds: **(Actual – Expected) / Actual**
  - Oilseed prices by season and district from Info Trade-AGMIS, actual yields Uganda WB–LSMS

Farmers' expectations about oilseed profitability

- *Consider the hypothetical situation where you grow [CROP]. Look ahead after the harvest, how much do you think the end-of-the-season PRICE (USh/Kg) of [CROP] will be for you?*
  - *Consider a typical farmer growing [CROP]. How much do you think the end-of-the-season PRICE (Ush/Kg) of [CROP] can be?*
- *Consider the hypothetical situation where you grow [CROP]. Look ahead after the harvest, how much do you think the average YIELD (Kg/Acre) of [CROP] will for you?*
  - *Consider a typical farmer growing [CROP]. How much do you think the average YIELD (Kg/Acre) of [CROP] can be on average?*

Farmers' expectations validation

- Internal validation:
  - check observed individual–level determinants
  - compare with same questions referring to "typical farmer" (corr=.65)
- External validation:
  - compare expectations with actual realizations

Determinants of farmers' expectations

Table 3: Determinants of oilseed profitability expectations at baseline

	(1)	(2)	(3)	(4)	(5)	(6)
	Expected price			Expected yield		
Is the HH head	0.0308	0.0332	0.0344	1.690***	1.673***	1.901***
	(0.0355)	(0.0351)	(0.0345)	(0.523)	(0.520)	(0.397)
Is male	-0.137	-0.140	-0.135	-1.632***	-1.604***	-1.931***
	(0.108)	(0.111)	(0.103)	(0.568)	(0.568)	(0.446)
Can read	0.0315	0.0280	0.0471	-0.308	-0.368	-0.427
	(0.0423)	(0.0418)	(0.0511)	(0.496)	(0.468)	(0.488)
Can write	-0.0518	-0.0466	-0.0528	0.590	0.620	0.647
	(0.0442)	(0.0415)	(0.0504)	(0.525)	(0.496)	(0.517)
No education	0.431	0.425	0.452	-1.591*	-1.701*	-1.838**
	(0.457)	(0.449)	(0.472)	(0.892)	(0.877)	(0.883)
Primary education	-0.0652	-0.0718	-0.0615	-0.818	-0.914	-0.964
	(0.0732)	(0.0810)	(0.0724)	(0.850)	(0.835)	(0.844)
Secondary education	-0.0462	-0.0523	-0.0482	-0.396	-0.466	-0.509
	(0.0606)	(0.0680)	(0.0657)	(0.846)	(0.833)	(0.837)
Wealth index	-0.0272	-0.0283	-0.0317	0.150***	0.120**	0.128**
	(0.0263)	(0.0278)	(0.0297)	(0.0534)	(0.0538)	(0.0524)
Total land	0.000258	9.54e-05	-0.000235	0.0130**	0.0106*	0.0117**
	(0.000917)	(0.000811)	(0.000613)	(0.00570)	(0.00582)	(0.00571)
N. of plots cultivated	0.110	0.108	0.114	0.151	0.121	0.0480
	(0.118)	(0.115)	(0.121)	(0.115)	(0.113)	(0.0942)
Oilseed baseline adoption		0.105			1.076***	
		(0.126)			(0.201)	
KLK for adoption			-0.0644			0.376***
			(0.0496)			(0.126)
KLK for input use			-0.0150			0.0312
			(0.0176)			(0.0855)
KLK for labour allocation			0.201			0.140
			(0.186)			(0.146)
KLK for productivity			-0.0195			0.491**
			(0.0212)			(0.225)
KLK for mkt linkages			-0.121			0.405*
			(0.116)			(0.211)
Constant	-0.0225	-0.0614	-0.0270	5.958***	5.596***	6.265***
	(0.303)	(0.348)	(0.307)	(1.101)	(1.100)	(1.098)
Observations	5,391	5,391	5,287	5,341	5,341	5,242
R-squared	0.005	0.006	0.007	0.104	0.117	0.132
Strata FE	Yes	Yes	Yes	Yes	Yes	Yes
Crop FE	Yes	Yes	Yes	Yes	Yes	Yes

Expectations' internal and external validation

Table 4: Internal and external cross-validation of profitability expectations

	(1)	(2)	(3)	(4)	(5)
	Expectations about population's		Actual yield		Actual price
	Yield	Price	Survey	LSMS	
Expected yield	1.742*		0.134***	0.00939**	
	(1.030)		(0.0395)	(0.00369)	
Expected price		4.352***			0.000181
		(0.875)			(0.000233)
Constant	436.0***	1,487***	2.103	2.068***	1.379***
	(31.20)	(100.6)	(1.660)	(0.0980)	(0.0386)
Observations	3,585	3,651	5,342	5,341	5,392
R-squared	0.081	0.360	0.020	0.539	0.468
Controls	No	No	No	No	No
Strata FE	Yes	Yes	Yes	Yes	Yes
Crop FE	Yes	Yes	Yes	Yes	Yes

Project take–up

- Partial compliance: 71.5% and 24% of farmers in the treatment and control group reported to have received the extension program

Table 5: Project take-up

	(1) Control mean	(2) ITT
VODP program take-up	0.241	0.475***
	(0.428)	(0.0358)
Specific training/platform on soyabean	0.0298	0.178***
	(0.170)	(0.0313)
Specific training/platform on sunflower	0.0149	0.0750***
	(0.121)	(0.0221)
Specific training/platform on sesame	0.0266	0.0499**
	(0.161)	(0.0190)
Specific training/platform on groundnut	0.0188	0.0167
	(0.136)	(0.0151)
N. of visits to learning platform	0.469	1.154***
	(2.539)	(0.194)
Received advice on new seed varieties	0.380	0.216***
	(0.486)	(0.0335)
Received advice on oilseed production	0.332	0.289***
	(0.471)	(0.0378)
Received advice on farming techniques	0.599	0.167***
	(0.490)	(0.0320)
Received advice on market acivities	0.462	0.139***
	(0.499)	(0.0328)
Received free inputs (any)	0.212	0.00371
	(0.409)	(0.0323)
Received free seeds (any)	0.00235	0.00317
	(0.0485)	(0.00258)

Empirical strategy: ITT effects

Pooled regression with crop fixed–effects as follows:

$$y_{icjd,t=1} = \alpha_0 + \beta_1 \text{Treat}_j + \gamma X_{icjd,t=0} + \delta y_{icjd,t=0} + \omega_c + \mu_d + \varepsilon_{ijd}$$

- where:
  - $y_{icjd,t=1}$ is farmer's i outcome of interest for oilseed c in sub-county j in district d at the endline;
  - **Treat** is the indicator whether the sub-county was assigned to the treatment group (zero otherwise);
  - ω_c are crop fixed–effects and μ_d are district fixed effects (districts are the stratification var).
  - $y_{icjd,t=0}$ is the outcome measured at the baseline, and $X_{ijd,t=0}$ is a set of individual and household level controls, including gender, education, land size, agronomic skills, and household wealth index, all measured at the baseline.
  - S.e. clustered at the sub-county level

Empirical strategy: LATE effects

System of equations as follows:

$$y_{icjd,t=1} = \lambda_0 + \eta_1 \text{VODP2}_{icjd} + \gamma X_{ijd,t=0} + \delta y_{icjd,t=0} + \omega_c + \mu_d + \varepsilon^a_{icjd}$$

$$\text{VODP2}_{icjd} = \pi_0 + \pi_1 \text{Treat}_j + \pi X_{ijd,t=0} + \pi_2 y_{icjd,t=0} + \omega_c + \mu_d + \varepsilon^b_{icjd}$$

- where:
  - VODP2_{icjd} indicates whether farmer i in sub-county j in district d self-report to take up activities specific to oilseed c within the VODP2 project.
  - All the other variables are defined as above.

First–stage results

Table C.1: First stage

	(1)	(2)
	Oilseed specific take-up	Vodp2 take-up
Treat	0.0778***	0.471***
	(0.00825)	(0.0283)
Is the HH head	0.0135	0.241**
	(0.0151)	(0.0932)
Is male	-0.0148	-0.241**
	(0.0154)	(0.0955)
Can read	-0.00273	-0.0251
	(0.0157)	(0.0576)
Can write	-0.00227	0.0224
	(0.0153)	(0.0578)
No education	0.0126	0.0222
	(0.00961)	(0.0550)
Primary education	0.0138**	0.0113
	(0.00656)	(0.0466)
Secondary education	0.0148**	0.0328
	(0.00706)	(0.0484)
Wealth index	-0.00213	-0.00501
	(0.00144)	(0.00582)
Total land	0	0.000659
	(0.000100)	(0.000569)
N. of plots cultivated	0.000878	0.00527
	(0.00225)	(0.00890)
Constant	0.0934***	0.246***
	(0.0257)	(0.0770)
Observations	10,172	2,543
R-squared	0.064	0.280
Controls	Yes	Yes
Crop FE	Yes	No

Results: Oil-seeds adoption

Table 6: Program impact on oilseed adoption

	(1)	(2)	(3)
	Oilseed adoption	Share of land cultivated with oilseed	KLK Index
ITT	0.0370***	0.00626***	0.0811***
	(0.0112)	(0.00218)	(0.0252)
			[0.014]
LATE	0.477***	0.0803***	1.043***
	(0.149)	(0.0284)	(0.332)
Observations	10,172	10,172	10,172
Controls	Yes	Yes	Yes
Strata FE	Yes	Yes	Yes
Crop FE	Yes	Yes	Yes
Control mean	0.245	0.0355	0
F stat excl restr	88.78	89.29	89

Point estimates correspond to an rise in adoption by 15% and in the share of oilseeds–cultivated land by 17.6% relative to the control group.

Heterogeneous effects on oilseed adoption

Table 7: Heterogeneous effects on oilseed adoption

	(1)	(2)	(3)	(4)
	Expected profitability			
	Expected yield	Yield wedge	Expected price	Price wedge
Treat	0.0650***	0.0290*	0.0581***	0.0105
	(0.0189)	(0.0168)	(0.0202)	(0.0166)
Het	0.00419***	0.00152	0.00182***	-0.00115***
	(0.00109)	(0.00232)	(0.000163)	(0.000123)
Treat X Het	-0.00368**	-0.00388	-0.0963***	0.0483***
	(0.00152)	(0.00301)	(0.0334)	(0.0145)
Constant	0.363***	0.390***	0.368***	0.374***
	(0.0610)	(0.0604)	(0.0578)	(0.0575)
Observations	5,341	5,341	5,391	5,391
R-squared	0.104	0.103	0.105	0.105
Controls	Yes	Yes	Yes	Yes
Strata FE	Yes	Yes	Yes	Yes
Crop FE	Yes	Yes	Yes	Yes

Heterogeneous effects on oilseed adoption

Table 7: Heterogeneous effects on oilseed adoption

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Expected profitability				Familiarity		Wealth	
	Expected yield	Yield wedge	Expected price	Price wedge	Ever cultivated	Cultivated at baseline	Total land	Wealth index
Treat	0.0650***	0.0290*	0.0581***	0.0105	0.0335***	0.0379***	0.0398***	0.0370***
	(0.0189)	(0.0168)	(0.0202)	(0.0166)	(0.0126)	(0.0123)	(0.0107)	(0.0112)
Het	0.00419***	0.00152	0.00182***	-0.00115***	0.118***	0.262***	0.000517	0.00301
	(0.00109)	(0.00232)	(0.000163)	(0.000123)	(0.0169)	(0.0262)	(0.000317)	(0.00365)
Treat X Het	-0.00368**	-0.00388	-0.0963***	0.0483***	0.00491	-0.00354	-0.000427	0.000216
	(0.00152)	(0.00301)	(0.0334)	(0.0145)	(0.0225)	(0.0310)	(0.000576)	(0.00538)
Constant	0.363***	0.390***	0.368***	0.374***	0.246***	0.292***	0.291***	0.292***
	(0.0610)	(0.0604)	(0.0578)	(0.0575)	(0.0391)	(0.0382)	(0.0376)	(0.0375)
Observations	5,341	5,341	5,391	5,391	10,145	10,172	10,172	10,172
R-squared	0.104	0.103	0.105	0.105	0.196	0.185	0.185	0.185
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Strata FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Crop FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Heterogeneous effects: robustness check

Table C.9: Heterogeneous effects on oilseed adoption

	Oilseed adoption	
	Levels	Wedge
Treat X Expected price	-0.0871***	0.0405***
	(0.0276)	(0.0115)
Treat X Expected yield	-0.00358**	-0.00425
	(0.00165)	(0.00323)
Treat X Ever cultivated	0.0166	0.00447
	(0.0456)	(0.0460)
Treat X Baseline adoption	0.00461	-0.00324
	(0.0363)	(0.0361)
Treat X Total land	-0.000614	-0.000634
	(0.00105)	(0.00105)
Treat X Wealth index	0.00289	0.00148
	(0.00805)	(0.00809)
Constant	0.298***	0.326***
	(0.0700)	(0.0691)
Observations	5,092	5,092
R-squared	0.106	0.104
Controls	Yes	Yes
Strata FE	Yes	Yes
Crop FE	Yes	Yes

Impact on farmers' expectations

Do farmers change their expectations upon the treatment?

Table 8: Program impact on oilseed expectations

	(1)	(2)	(3)	(4)	(5)
	Oilseed				
	Expected yield	Expected price	Wedge in		KLK Index
			Expected yield	Expected price	
ITT	-0.103	0.0145*	-0.361	-0.0265**	0.0304
	(0.817)	(0.00755)	(1.361)	(0.0123)	(0.0216)
					[0.328]
LATE	-1.066	0.145*	-3.753	-0.264**	0.315
	(8.424)	(0.0758)	(13.93)	(0.124)	(0.219)
Observations	3,600	3,626	3,600	3,626	3,890
Controls	Yes	Yes	Yes	Yes	Yes
Strata FE	Yes	Yes	Yes	Yes	Yes
Crop FE	Yes	Yes	Yes	Yes	Yes
Control mean	5.320	0.303	-3.283	0.481	-0.000531
F stat excl restr	52.45	54.50	52.49	54.51	56.67

Revisions in expectations

Do farmers revise their expectations in a logical way upon the treatment?

Table 9: Revision of expectations

	(1)	(2)	(3)	(4)	(5)	(6)
	Wedge in					
	Expected price			Expected yield		
Treat	-0.0441***	-0.117	-0.107	-5.119	-0.363	-5.597
	(0.0154)	(0.0799)	(0.0837)	(4.939)	(1.442)	(5.538)
Wedge	4.20e-05		-0.000160*	1.951		2.009
	(7.85e-05)		(8.17e-05)	(1.625)		(1.680)
Treat X Wedge	0.0392*		0.0204	-1.389		-1.438
	(0.0224)		(0.0144)	(1.648)		(1.706)
I[Wedge>0]		0.0694**	0.0320		1.485	-3.726
		(0.0281)	(0.0313)		(1.130)	(4.617)
Treat X I[Wedge>0]		0.0936	0.135*		-1.061	2.753
		(0.0837)	(0.0810)		(1.731)	(4.313)
I[Wedge>0] X Wedge			0.0761**			-5.655
			(0.0373)			(4.222)
Treat X I[Wedge>0] X Wedge			-0.124*			6.230
			(0.0711)			(5.324)
Constant	0.450***	0.382***	0.383***	-0.247	-10.21**	0.320
	(0.0406)	(0.0478)	(0.0477)	(4.960)	(3.934)	(5.388)
Observations	3,626	3,626	3,626	3,600	3,600	3,600
R-squared	0.056	0.061	0.063	0.025	0.012	0.026
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Strata FE	Yes	Yes	Yes	Yes	Yes	Yes
Crop FE	Yes	Yes	Yes	Yes	Yes	Yes

Intermediate outcomes: Inputs use

Table 10: Program impact on use of inputs for oilseeds

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Fertilizer			Pesticide			Improved seeds		KLK Index
	Use	Quantity	Expenses	Use	Quantity	Expenses	Use	Expenses	
ITT	0.00600	0.258	0.0353**	0.00732	0.0736	-0.00123	0.0255***	0.0346	0.0420**
	(0.00362)	(0.185)	(0.0135)	(0.00942)	(0.157)	(0.0120)	(0.00953)	(0.0595)	(0.0203)
									[0.205]
LATE	0.0769	3.362	0.460**	0.0939	0.985	-0.0164	0.328***	0.448	0.539**
	(0.0490)	(2.479)	(0.192)	(0.120)	(2.082)	(0.159)	(0.127)	(0.764)	(0.271)
Observations	10,172	9,873	9,898	10,172	9,564	9,569	10,172	9,861	10,172
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Strata FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Crop FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control mean	0.0204	0.427	0.0215	0.0880	0.306	0.0545	0.0956	0.413	0.0174
F stat excl restr	90.10	91.74	88.44	90.44	84.54	84.37	89.20	88.47	89.74

Labor use

Table 11: Program impact on labour allocation

	(1)	(2)	(3)	(4)	(5)	(6)
	Days of work on oilseeds by					KLK Index
	All	Head	Spouse	Other in the HH	Other outside the HH	
ITT	0.666	0.317	0.309	0.101	0.345***	0.0495*
	(0.462)	(0.298)	(0.269)	(0.223)	(0.120)	(0.0254)
						[0.244]
LATE	8.590	4.094	3.977	1.302	4.447***	0.638*
	(6.018)	(3.868)	(3.480)	(2.854)	(1.615)	(0.335)
Observations	9,828	9,828	9,828	9,828	9,828	9,828
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Strata FE	Yes	Yes	Yes	Yes	Yes	Yes
Crop FE	Yes	Yes	Yes	Yes	Yes	Yes
Control mean	6.210	3.593	3.515	2.344	0.617	0
F stat excl restr	87.94	87.79	87.64	87.92	87.77	87.98

Market linkages

Table 12: Program impact on oilseed market linkages

	(1)	(2)	(3)	(4)	(5)	(6)
	Any sale	Seeds bought on the mkt	Harvest sold in bulk/group	Contacts with value chain actors	Sale to mkt actors	KLK Index
ITT	0.0256**	0.00653	0.00575**	0.00582	0.000692	0.0369***
	(0.0101)	(0.00736)	(0.00246)	(0.00656)	(0.00396)	(0.0140)
						[0.036]
LATE	0.329**	0.0840	0.0740**	0.0749	0.00889	0.475***
	(0.128)	(0.0918)	(0.0323)	(0.0835)	(0.0505)	(0.176)
Observations	10,172	10,172	10,172	10,172	10,172	10,172
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Strata FE	Yes	Yes	Yes	Yes	Yes	Yes
Crop FE	Yes	Yes	Yes	Yes	Yes	Yes
Control mean	0.130	0.0521	0.00784	0.0462	0.0263	0.0104
F stat excl restr	88.59	89.77	90.07	89.74	89.33	89.68

Oilseed productivity

Table 13: Program impact on oilseeds productivity

	(1)	(2)	(3)	(4)	(5)	(6)
	Productivity	Harvest	Harvest value	Harvest value/acre	Revenues from sale	KLK Index
ITT	0.0831**	0.038	2.042	4.850**	0.616	0.0364
	(0.0416)	(0.077)	(2.256)	(2.308)	(0.638)	(0.0252)
						[0.249]
LATE	1.070**	0.487	26.25	62.34**	7.908	0.468
	(0.543)	(0.980)	(28.91)	(31.04)	(8.119)	(0.326)
Observations	10,172	10,172	10,172	10,172	10,172	10,172
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Strata FE	Yes	Yes	Yes	Yes	Yes	Yes
Crop FE	Yes	Yes	Yes	Yes	Yes	Yes
Control mean	0.309	0.376	13.96	16.15	3.739	0
F stat excl restr	89.44	89.82	89.78	89.84	89.97	89.82

Wefare outcomes

Table 14: Program impact on welfare

	(1)	(2)	(3)	(4)	(5)	(6)
	Total land	HH days of farm work	Rev from crop sale	HH labour income	Wealth Index	KLK Index
ITT	0.0754	-3.796	15.30	-5.716	0.0566	0.0110
	(0.516)	(7.408)	(11.26)	(20.83)	(0.0626)	(0.0256)
						[0.668]
LATE	0.161	-8.070	32.50	-12.15	0.120	0.0234
	(1.088)	(15.46)	(23.65)	(43.73)	(0.132)	(0.0539)
Observations	2,537	2,457	2,543	2,543	2,543	2,543
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Strata FE	Yes	Yes	Yes	Yes	Yes	Yes
Control mean	7.421	218.7	131.5	139.4	0.0976	0.0197
F stat excl restr	273.1	262	275.1	276.3	276	276

Discussion– 1

- By designing and leveraging a RCT, we show that increased access to (technical+market) information through extension services has a positive impact on cash crop adoption among smallholder farmers in Uganda (both extensive and intensive margins).
- The treatment effect is bigger for those with *ex–ante* low profitability expectations
  - The value of extension service programs seem to be larger for those with low expectations/higher wedge (with low information), as compared to farmers better informed.
- Change in expectations– especially price beliefs– seem to be the main driver of farmers adoption decision (little impact on other intermediate outcomes) (see also Arouna et al. 2019).

Discussion– 2

- Information is key but higher uptake is not coupled with better performance, in terms of short–term hosuehold well-being.
- Modest impact on market access/linkages and hosuehold income cast doubts on expected profitability being actually realized.
- Together, our evidence indicates
  - Change in expectations as a main mechanism underlying farmers adoption choices
  - Low information (access) is mitigated by the provision of extention serices since farmers do revise their beliefs about crop profitability (in a logical way)

Conclusions and policy implications

- Lack of information and uncertainty about future crop profitability – especially in terms of expected price! – may restrict adoption rates.
- Lack of proper farmers' integration into the downstream part of the value–chain may represent a threat to the 'follow–through stages' in oilseed development (disadoption may occur if expected returns to technology adoption are not realized).
- Key role of both price information and market integration for technology upgrade in Sub–Saharan Africa.