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DOES GENDER-SENSITIVE AGRICULTURAL INTERVENTION IMPROVE FOOD SECURITY AND PROFIT EFFICIENCY: *EVIDENCE FROM ORANGE-FLESHED SWEETPOTATO PRODUCERS IN RWANDA*

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Introduction:

Rwanda is a landlocked country in Central Africa, with a high population density of 447 persons/sq km (2013). With 81% still living in rural areas, arable land per capita is only 0.10 hectares. It is therefore, not surprising, that the most important food crop in Rwanda is sweetpotato (*Ipomoea batatas L.*), given its ability to produce high energy output per unit area per unit time. Annual per capita consumption is greater than 80 kg.

Farmers in Rwanda complain of lack of market for their sweetpotato. Hence, the Rwanda Superfoods Product (2010-2014) sought to develop a processed product value chain using vitamin A rich orange-fleshed sweetpotato (OFSP) varieties that specifically linked smallholder producers to the agro-processing company Urwibutso Enterprises. OFSP purée (steamed and mashed sweetpotato) replaced significant amounts of imported wheat flour in biscuits and donuts.

Given that women dominate in sweetpotato production in Rwanda, from the outset an explicit goal was set that at least 75% of the smallholder farmers participating in supplying OFSP to the processor would be women. This target was achieved. Clearly, given the landholding constraint, increasing productivity by applying productivity enhancing technologies (inputs) and increasing efficiency in production (technical, allocative, and economic) would be critical for generating surplus for sale. Baseline data indicate that assuring adequate food within the household was to principal role of sweetpotato.

The gender-aware design of the proof-of-concept study provides a unique opportunity for gender disaggregated analysis of benefits of the intervention and profit efficiency of male and female sweetpotato producers.

Fig. 1 Critical to success was providing quality planting material. Disease-free plantlets from the Rwanda Agriculture Board's tissue culture lab in Rubona (left) were multiplied in screenhouses, then transferred to net tunnels (right) owned by trained farmer multipliers (individuals and groups). Average OFSP yields were 30-50% higher than local varieties, generating surplus for sale.

Methods:

In March 2014, a comprehensive endline survey was conducted among **846** (69% female, and 31% male) sweetpotato producers in rural Rwanda, 39% directly involved in the intervention; **37%** indirect beneficiaries of vines (spillovers); and **24%** control households not accessing any part of the intervention.

The survey instrument contained a module on food security that was a series of 15 questions used to determine whether a household was considered to be food secure or insecure. The food consumption score (maximum score 112) was derived from a seven day recall of 9 food groups (each weighted) consumed (bought or from own stocks). Profit Efficiency (PE) is defined as the ability of farmer to achieve highest profit given the output price and cost of inputs used and profit gained from potential.

Different models were used to assess the impact of the gender-sensitive intervention on food security, food consumption, and profit efficiency. These include 1) a stochastic profit frontier model, which combines technical, allocative and scale efficiency in profit function using ordinary least squares (OLS) regression, 2) Propensity score matching (PSM) model, 3) Endogenous switching regression (ESR) model, and 4) an Inverse probability weighted adjusted regression (IPWAR) model. In addition, the average treatment effect on the treated (ATT) was determined by gender of the sweetpotato producer, combining direct participants and spillover households into the treated group and comparing them to control producers (the untreated).

Fig. 2 *Akarabo* Golden Power Biscuits (43% wheat flour replaced by OFSP Purée) are marketed in 11 shops owned by Urwibutso Enterprises throughout Rwanda in either foil packaging or in a tube.

Results:

i. Key Findings: Sweetpotato Producers: Average Values

	Control		Participant		Spillover	
Variables	Female (N=119)	Male (N=88)	Female (N=247)	Male (N=80)	Female (N=220)	Male (N=92)
Kgs per household	409	333	1118	1099	487	750
Percent sold	32	47	37	36	31	36
Output value ($/ha)	137	69	223	463	205	233
Variable cost ($/ha)+	120	121	142	146	104	139
Profit ($/ha)	104	31	134	365	139	144
Profit margin++	75%	45%	60%	79%	68%	62%

+ Variable cost figure does not include imputed value of family labor
++ Profit margin: profit as a percentage of the revenue (output value).

- Participant women grew 2.7 times the amount of control women
- Participant men grew 3.3 times the amount of control men
- Spillover men grew two times than of control men, but little difference among women
- Profit per hectare highest among participant men; lowest among control men
- All households continue to prioritize sweetpotato retention for home consumption

ii. Impact of intervention on selected outcomes

Outcome variables	OLS+	PSM	IPWAR	ESR
Profit efficiency (0,1)	0.52*** (0.01)	0.48*** (0.01)	0.49*** (0.01)	0.48*** (0.01)
Food insecurity (+Probit used instead of OLS) (0,1)	-0.25** (0.11)	-0.08** (0.05)	-0.05 (0.05)	-0.06 (0.05)
Food consumption score (0,112)	3.54*** (1.31)	5.00*** (1.39)	3.71*** (1.35)	3.76** (1.37)
Number of observations	846	846	846	846

OLS: Ordinary Least Square; PSM: Propensity Score Matching; IPWAR: Inverse probability weighted adjusted regression and ESR: Endogenous Switching Regression

- Gender-sensitive intervention increased profit efficiency by 0.48 points under PSM to 0.52 using OLS.
- Food security improvement ranged from increased 5% under the IPWAR model to by 25% using OLS;
- Similarly, food consumption score increased by intervention between 3.54 to 5 points.

iii. Factual and counterfactual effects:

Outcome	Model: Profit efficiency			Model: Food Security			Model: Food consumption		
	Decision stages			Decision stages			Decision stages		
Category of Farmer	Treated (A)	Not treated (B)	ATT (A-B)	Treated (D)	Not treated (E)	ATT (D-E)	Treated (G)	Not treated (E)	ATT (G-E)
Female intervention (n=467)	0.64	0.29	0.35***	0.45	0.93	-0.48***	52.53	27.66	24.87***
Female control (n=119)	0.48	0.19	0.28***	0.42	0.58	-0.16***	56.43	49.81	6.62***
Male intervention (n=172)	0.76	0.23	0.53***	0.34	0.75	-0.41***	54.32	31.70	22.62***
Male control (n=88)	0.62	0.17	0.46***	0.34	0.46	-0.12***	59.04	49.79	9.25***

- Average intervention effect on profit efficiency, food security, and food consumption, is 35%, 48%, and 25%, respectively, for female growers.
- If control female growers had been treated their profit efficiency could have been 28% more; and they could have been 16% less food insecure.
- Treated female and male OFSP growers would lose profit efficiency by 35 and 53 percent points had they not be treated.

Summary of key findings:

- On average, women OFSP participants in the sweetpotato value chain effort grew *and* sold as much sweetpotato as male participants.
- For all categories of households, use of sweetpotato for home consumption was the highest priority.
- Just receiving vines of improved OFSP varieties from their neighbors enabled "spillover" male sweetpotato growers to double their production and both female and male spillovers growers to improve their profits per hectare.
- The profit efficiency of participant households was 64% compared to 18% of the control households.
- Profit efficiency of female beneficiary, and female spillover growers was found to be 3.5%, and 5% higher, respectively, than that of control male growers.
- Profit efficiency appeared to be negatively associated with area under sweetpotato ($p<0.000$), age of household head ($p<0.000$), and positively with participation in intervention ($p<0.000$).
- The intervention increased food consumption scores by 25 and 23 points ($p<0.000$), in households with female and male sweetpotato growers, respectively. It reduced the likelihood of being food insecure in households with female and male sweetpotato growers by 35% and 53%, respectively.
- Food security and food consumption scores were positively and significantly associated with the education level of the household head, number of sweetpotato varieties planted, participation in informal business, and livestock ownership.

Fig 3. A project agronomist interacting with producers. Some of the groups dominated by women from poorer households required significantly more training than better off groups to achieve minimum quality requirements of the processor. Groups were assisted In developing production calendars to stagger output so as to be able to provide a consistent supply to the processor.

Fig 4. Demand creation campaigns were conducted at the village and district level to build awareness of the nutritive value of orange-fleshed sweetpotato. Two cooperatives (one of them pictured here), began making and marketing OFSP doughnuts themselves in addition to selling to Urwibutso Enterprises.

Fig 5. Appealing to youth was one of the core marketing objectives of the marketing strategy. Urban youth were reached principally through radio jingles and a television advertisement placed by the processor for one year.

Conclusions:

- Food security, food consumption, and profit efficiency can be improved by explicitly targeting women in sweetpotato value chain initiatives. This was in spite of households with female sweetpotato growers being less educated, owning fewer livestock and being more likely to be food insecure than households with male sweetpotato growers.
- A critical component in this land-constrained environment was raising yields through the introduction of improved varieties of orange-fleshed sweetpotatoes combined with an improved seed system that provided farmers with greater access to quality planting material.
- The OFSP donuts and biscuits sales have continued since the ending of the project in 2014. From July 2015 to April 2017, Urwibutso Enterprises sold OFSP-based bakery products worth US $522,989.

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