ETH Yield Gap Analysis

Michiel van Dijk & Tom Morley

30 August 2016

What has been done

- Data cleaned
- Some econometric issues solved
- New estimation of sfa model and yield gaps

Yield gap framework

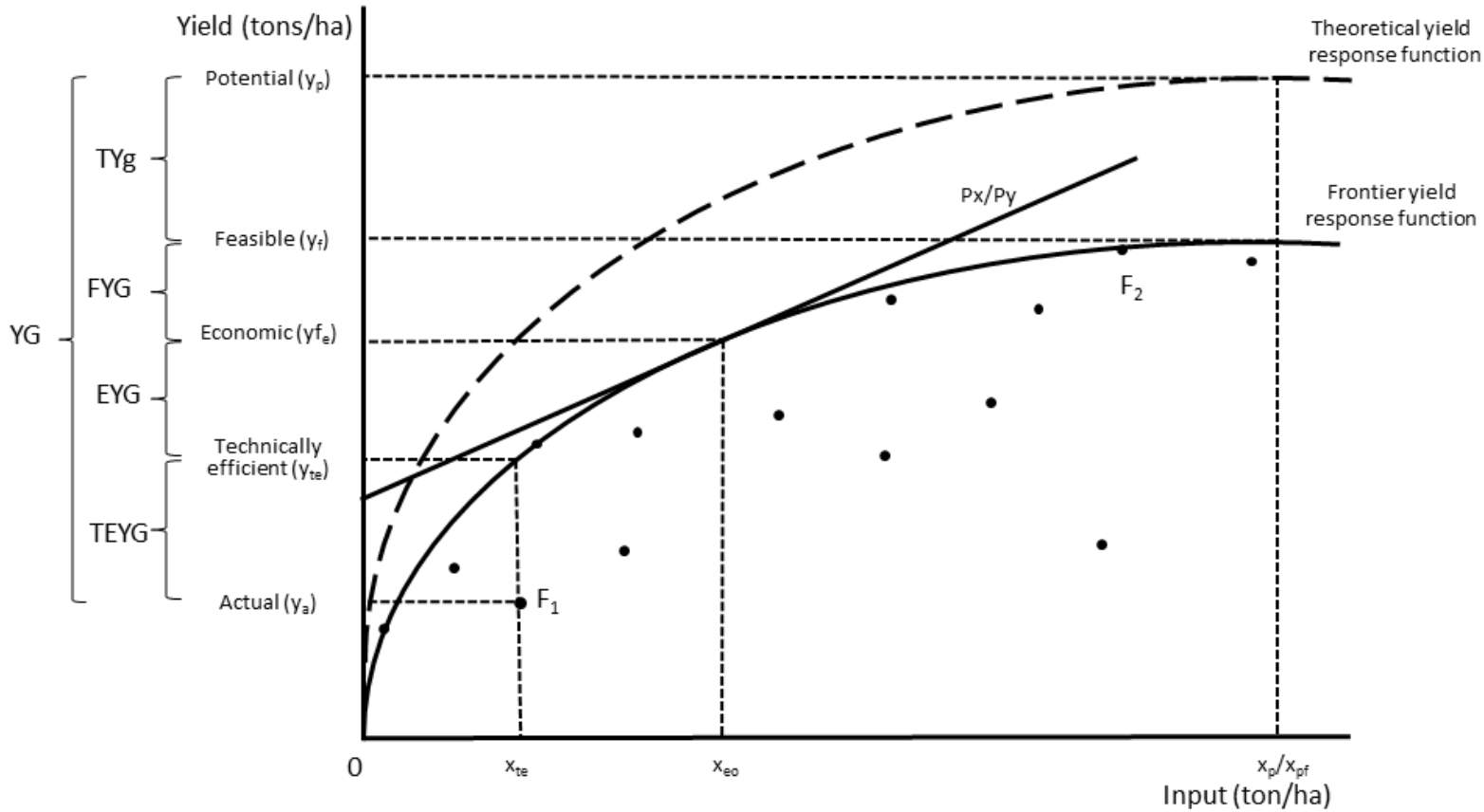


Figure 1

Methodology

- Stochastic frontier analysis
  - Controlling for time-constant unobserved heterogeneity (e.g. management skills on yield) by means of correlated random effects framework
  - Controlling for time-varying unobserved heterogeneity (e.g. income on use of fertilizer) by means of instrumental variable control function

Data

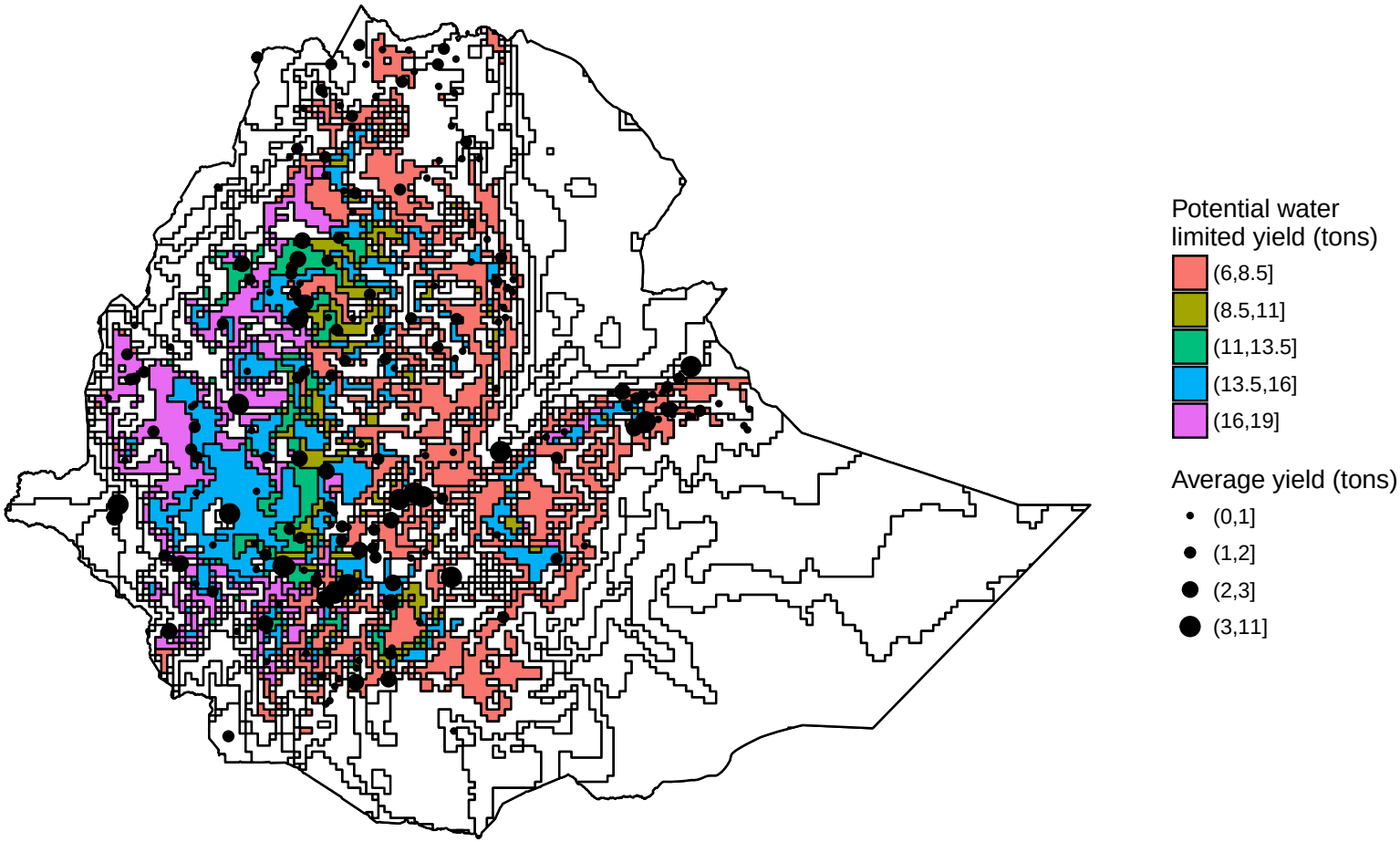
- LSMS-ISA surveys 2011 and 2013
  - Biased (unbalanced) sample for 2011 due to mistake in the survey
  - Yield defined as production/plot size $=>$ different from FAOSTAT/GYGA

Summary statistics

Table 1: Summary statistics

Statistic	N	Mean	St. Dev.	Min	Max
Yield	2,331	1,720.91	2,168.02	2.68	18,181.82
ImprovedSeeds	2,331	0.22	0.41	0	1
Slope	2,331	11.88	10.31	0.00	83.70
yesN	2,331	0.36	0.48	0	1
Nitrogen	2,331	24.44	51.72	0.00	691.29
Rain	2,331	730.25	139.41	210	1,135
Irrigation	2,331	0.05	0.22	0	1
SOC	2,331	16.97	4.66	3.91	37.21
Labour	2,331	317.52	4,373.32	0.60	205,882.40
Area	2,331	0.17	0.29	0.0002	6.70
crop_count2	2,331	0.57	0.50	0	1
surveyyear2	2,331	0.10	0.30	0	1

LSMS-ISA and GYGA



Data issues

- How to solve missing yield potential data?
  - Average values are too low, maximum is too high.
- To calculate feasible yield gap information is needed on the use of inputs when costs are zero:
  - Level of nitrogen when yield diminishes (per region)
  - Use of labour and capital at this point
- Information on nitrogen/fertilizer use can be taken from experimental plot data => literature survey.
- Use of labour and capital demands assumptions (e.g. 10% increase)

Stochastic frontier analysis

Table 2: Frontier yield response model

	Coef.	std. Error	
(Intercept)	6.260	0.310	***
noN	0.550	0.210	**
logN	0.150	0.060	**
loglab	0.310	0.040	***
dumoxen	-0.020	0.260	
logarea	-0.210	0.040	***
irrig	0.070	0.190	
impr	0.230	0.110	*
slope	-0.010	0.010	
elevation	-0.000	0.000	***
SOC2	0.020	0.010	***
phdum22	-0.080	0.080	
phdum23	-0.030	0.100	
rain_wq	-0.000	0.000	***
AEZTropic - warm / subhumid	0.270	0.170	
AEZTropic - cool / semiarid	0.190	0.130	
AEZTropic - cool / subhumid	0.610	0.140	***
AEZTropic - cool / humid	0.380	0.150	*
crop_count2	0.400	0.070	***
surveyyear2	-0.220	0.100	*

Yield gap estimations

Table 3: Relative yield gap

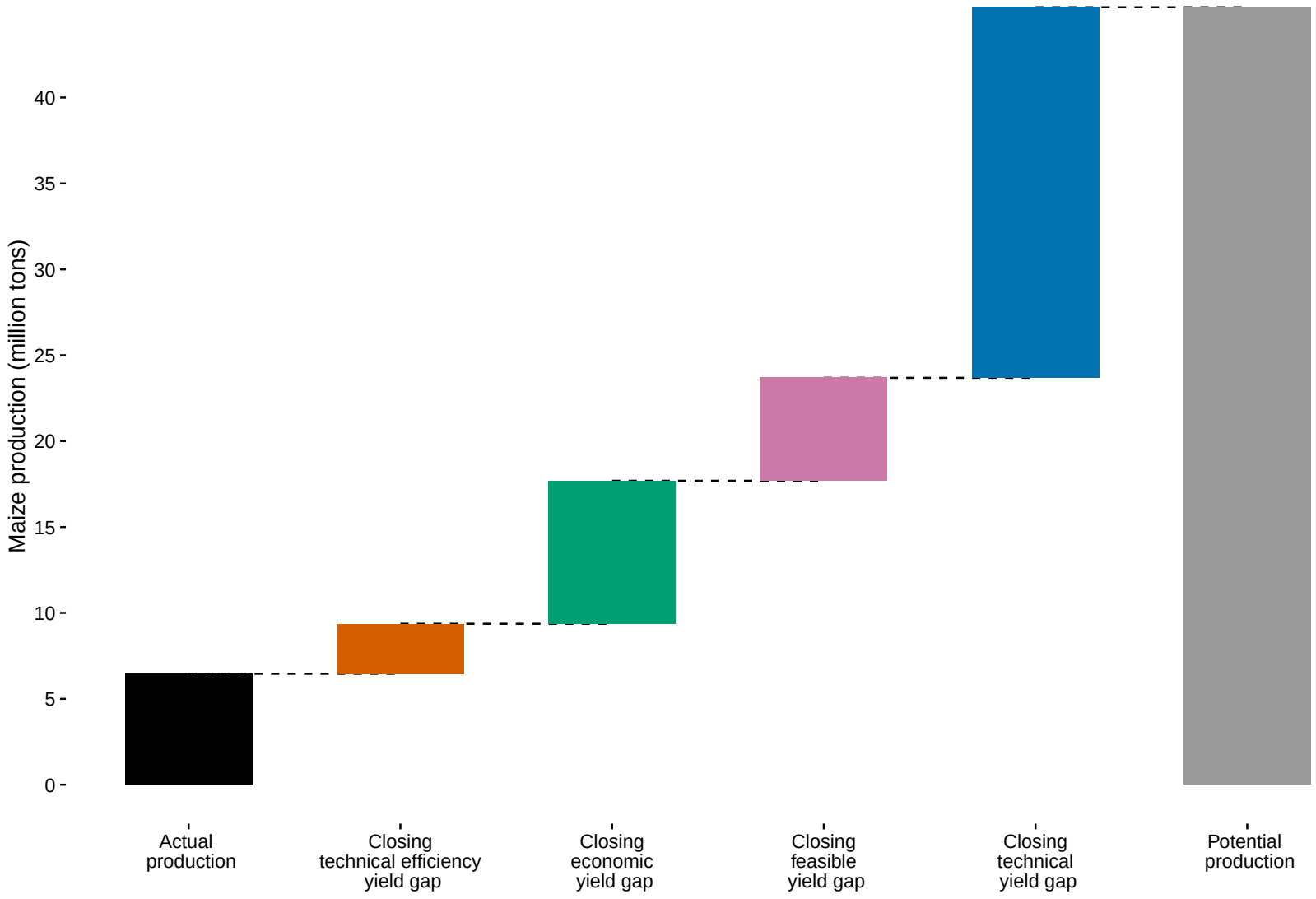
Zone	TEYG	EYG	EUYG	TYG	YG
AMHARA	8	22	13	57	100
BENSHANGULGUMUZ	7	15	20	57	100
DIRE DAWA	8	43	22	26	100
GAMBELLA	9	16	19	56	100
HARARI	8	28	20	44	100
OROMIYA	7	22	16	55	100
SNNP	9	17	15	59	100
SOMALI	5	20	15	61	100
TIGRAY	6	35	16	42	100
Total	8	21	16	56	100

Yield gap estimations

Table 4: Relative yield gap

Zone	TEYG	EYG	EUYG	TYG	YG
AMHARA	42	51	24	47	89
BENSHANGULGUMUZ	47	50	42	53	93
DIRE DAWA	43	67	25	16	88
GAMBELLA	56	43	39	51	93
HARARI	53	62	34	40	93
OROMIYA	47	57	33	48	92
SNNP	51	48	33	51	92
SOMALI	66	71	37	54	97
TIGRAY	44	67	26	29	90
Total	48	55	32	48	92

Closing the yield gap



Policies to close the yield gap

Yield gap	Problem	Policy solution
Technical efficiency yield gap (TEYG)	• Lack of knowledge on best-practice farm management, use and combination of inputs.	• Extension services • Knowledge transfer from best practice to average farmers • Farmer field schools • Gender empowerment
Economically feasible yield gap (EYG)	• Farmers cannot obtain credit to purchase inputs. • Farmers are risk averse and do not purchase inputs because of high risk of crop failure • Less effort because of missing property rights	• Credit facilities • Insurance market • Property right system
Feasible yield gap (FYG)	• High costs of inputs because of: o Transport costs o Limited number of dealers • Low price of outputs because of: o Thin markets o Limited storage	• Road infrastructure • Irrigation • Dealer network • Smart input subsidies • Storage facilities • Market information (mobile phones) • Marketing boards • Farmer organisation • Regional integration
Technology yield gap (TYG)	• No knowledge, information and enabling environment to use advanced techniques and technology (precision farming). • No appropriate technology (e.g. small scale tractors, drought resistant seeds)	• Applied research programs

Figure 2

Explaining the TEYG

Table 5: Second stage analysis

	Coef.	std. Error	
Z_sex	-0.090	0.200	
Z_age	-0.010	0.010	
Z_title	-0.010	0.140	
Z_literate	0.250	0.230	
Z_ed_any	-0.120	0.240	
Z_extension	-1.140	0.270	***
Z_credit	-0.750	0.220	***
Z_dist_hh	0.010	0.010	
Z_dist_market	0.000	0.000	***
Z_popEA	-0.000	0.000	**

Next steps

- Expand sfa model (i.e. translog function and climate variables)
- Solve data issues
- Add additional variables that explain the yield gap
- Calculate elasticities of second stage variables
- Think about how to link policies to yield gaps
- Write paper and policy briefs