

USING DNA FINGERPRINTING TO ESTIMATE THE DIFFUSION OF IMPROVED CROP VARIETIES IN ETHIOPIA

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What Do We Know about Farmer Use of Improved Varieties?

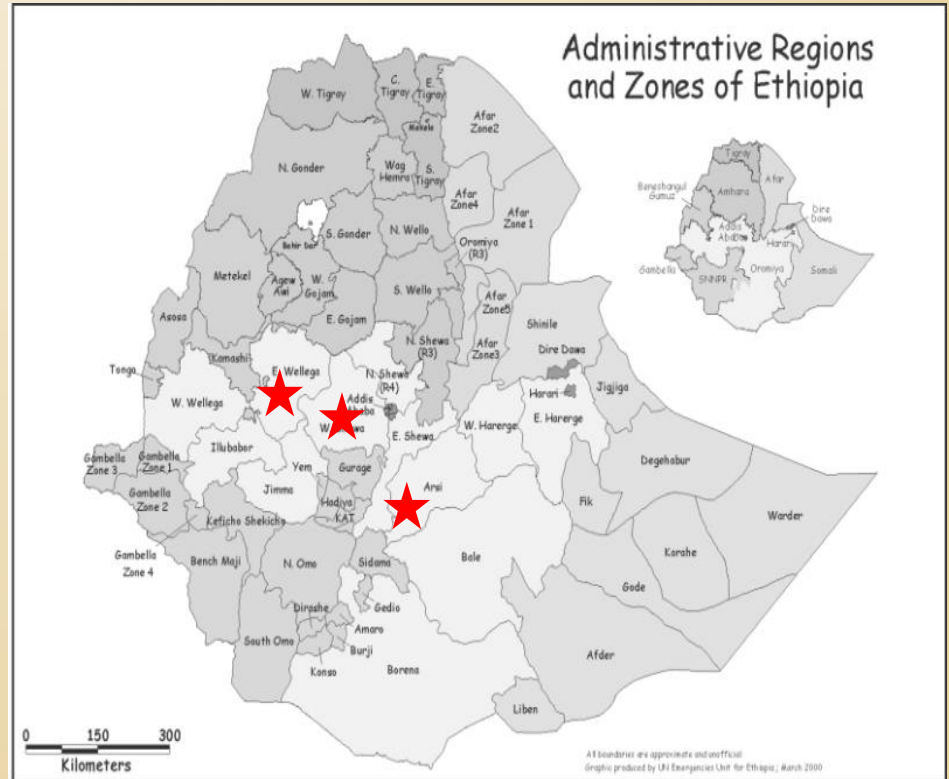
- Dalrymple
 - Documentation of the Green Revolution “Modern Varieties”
- Evenson and Gollin (1998)
 - Global estimates of diffusion and impact of individual CGIAR varieties
- Diffusion and Impact of Improved Varieties in Africa (DIIVA, 2010)
 - Diffusion assessed for 20 crops, 30 SSA countries, 1150 cultivars
- All current estimates of variety use are based on variety identification from Expert Opinion or Farmer Surveys
 - Estimates using these approaches suffer from *unknown amount and direction of bias and lack of standard errors of estimates*
 - These are the dependent variables in all existing variety adoption studies
- Ballpark estimates useful for general studies of Agricultural Development
- Not useful for monitoring crop improvement progress, seed system effectiveness, or for planning for seed multiplication and distribution

Pilot Study Questions – Is DNA fingerprinting a viable technical approach?

1. Can DNA fingerprinting discriminate among closely related varieties?
2. Can the identify be preserved for 100's of samples through field collection, DNA extraction and lab analysis?
3. Can sample contamination and biological degradation be controlled?
4. Are costs per sample low enough to show promise for widespread use in monitoring diffusion?
5. Do diffusion estimates differ from farmer survey estimates?
6. What is the level of interest in key institutions in using fingerprinting?

The Pilot Study Area: Oromiya Region of Ethiopia

- Sub-national sample is not representative of Ethiopia, but Oromiya accounts for 70% of wheat and 58% of maize output
- The Agriculture Sample Survey (AgSS). Central Statistical Agency (CSA) conducts an annual crop cut survey of 5000-7000 samples for each major crop
- Single digit estimates of “use of improved varieties”



Steps

1. Construct DNA *Reference Library* – DArT using EIAR & private sector breeder seed
2. Collect farm samples – CSA
3. Extract DNA – EIAR Holeta
4. DNA Fingerprinting – DArT
5. Analysis of fingerprinting – EIAR ss & IFPRI

Institutions

- Diversity Arrays Technology Pty Ltd ("DArT") - Australia
- Central Statistical Agency (CSA)
- Ethiopian Institute of Agricultural Research (EIAR)
 - Social Science Unit
 - Biotechnology Unit – Holeta
 - Crop Improvement Programs
- Bill & Melinda Gates Foundation
- IFPRI

Technical Choices

1. Leaf vs. grain
2. Fingerprinting approach & partner
3. Variety Match Definition (% purity)

Number of Wheat and Maize Variety Releases by Decade

Year	Wheat	Maize OPV	Maize Hybrid	Total Maize
Before 1980	3	3	-	3
1981-1990	4	-	1	1
1991-2000	23	5	3	8
2001-2011	45	17	23	40
Total	85	25	27	52

Number of Samples in Releases Reference Library and Number of Samples Collected from Farmers

	Wheat	Maize	Total
Variety release reference library	75	39	114
DNA Samples Collected from Farmers	393	472	865

DNA Library results - Clear discrimination among 75 wheat and 39 maize reference varieties

WHEAT: 92% Avg. purity

MAIZE: 78% Avg. purity

- *Size of the sphere for each reference represents “diversity” within it*
- *Distance between centers represents genetic distance between cultivars/references*

Comparing Farmer Response to DNA Fingerprinting

WHEAT	Farmer Response	DNA
Number of Varieties Identified	13	23
Farmer Declares "Using MV"	47%	96%
Farmer Declared Variety is on Release List	55%	
% Farmers Correctly Identifying Variety	33%	
Average Purity of DNA	92%	

MAIZE	Farmer Response	DNA
Number of Varieties Identified	12	13
Farmer Declares "Using MV"	57%	61%
Farmer Declared Variety is on Release List	44%	
% Farmers Correctly Identifying Variety	30%	
Average Purity of DNA	78%	

70% purity cutoff

Cost-Estimates

Main Cost Components

- Survey Costs
 - Can tissue sample collection be piggybacked on existing surveys?
 - Sampling strategy
 - Timing and Leaf vs. Grain sample
- DNA Extraction from collected samples
 - \$2-\$10
- DNA fingerprinting Analysis Costs:
 1. Reference Library: \$400 per variety (one-time)
 2. Field samples: \$30-\$50
 3. At scale, commercial provider: \$5-\$20

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CGIAR centers

National agricultural research systems

National statistical agencies

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