FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative

Adoption of Improved Bean Varieties in Haiti: An Assessment Using Farm Surveys, Bean Seed Supply Chain Analysis, and DNA Fingerprinting

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Legume Innovation Lab

Feed the Future Innovation Lab for Collaborative Research on Grain Legumes

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Introduction

- Over the past 20 years, collaborative research has resulted in the development and release of several improved bean varieties in Haiti (e.g., DPC-40, XRAV-40-4, MEN 2201-64ML and Aifi Wuriti)
- These investments in bean research have also been accompanied by systematic efforts by the government and NGO partners in the dissemination of seeds of these varieties to bean farmers (e.g., post-earthquake efforts in 2010, BTD project in 2012-2014, post-Mathew in 2017)
- There are however, no rigorous studies that estimate the use and adoption of seeds of improved bean varieties in Haiti

Bean sector in Haiti: Salient features

- Beans are economically important and priority crop for farmers
- At the governmental level, the National Seed Service (SNS) is in charge of the seed sector. But its capacity is extremely limited
- Some agro-dealers are active in selling bean seeds of improved varieties through in-country seed multiplication efforts or seeds imported from neighboring countries
- Three main sources of bean seeds for farmers:
  - Agro-dealers
  - Government, NGOs , FAO (free or subsidized seed aid)
  - Own retained seed
  - Local bean grain market **(most important source of seed- ~ 80%)**
- Poor seed quality → farmers use higher seeding rate to compensate for poor germination rate

Challenges of estimating varietal adoption

- Facts:
  - Farmers cannot name or identify the varieties (may only know them by market class)
  - Farmers may call a variety by a local name
  - Farmer may not even know the type of variety they are growing (i.e., improved vs. local)
- These are some of the practical challenges of tracking varietal adoption in a country where formal seed system is non-existent
- Farmer elicitation (through farm survey) method of varietal adoption may not provide an 'accurate' estimates of adoption of bean varieties by name or type (i.e., IV vs. local)
- We thus take a multi-pronged approach to estimate bean varietal adoption in Haiti

Objectives

This study aims to fill the knowledge gap on bean varietal adoption in Haiti by:

- Conducting a nationally representative **farmer survey**
- Conducting **key informant interviews** with seed producers, distributors and vendors
- Collecting seed samples throughout the seed value chain (i.e., seed producers, distributors, **market vendors**, and farmers); and
- Conducting **DNA fingerprinting** of collected samples for varietal identification

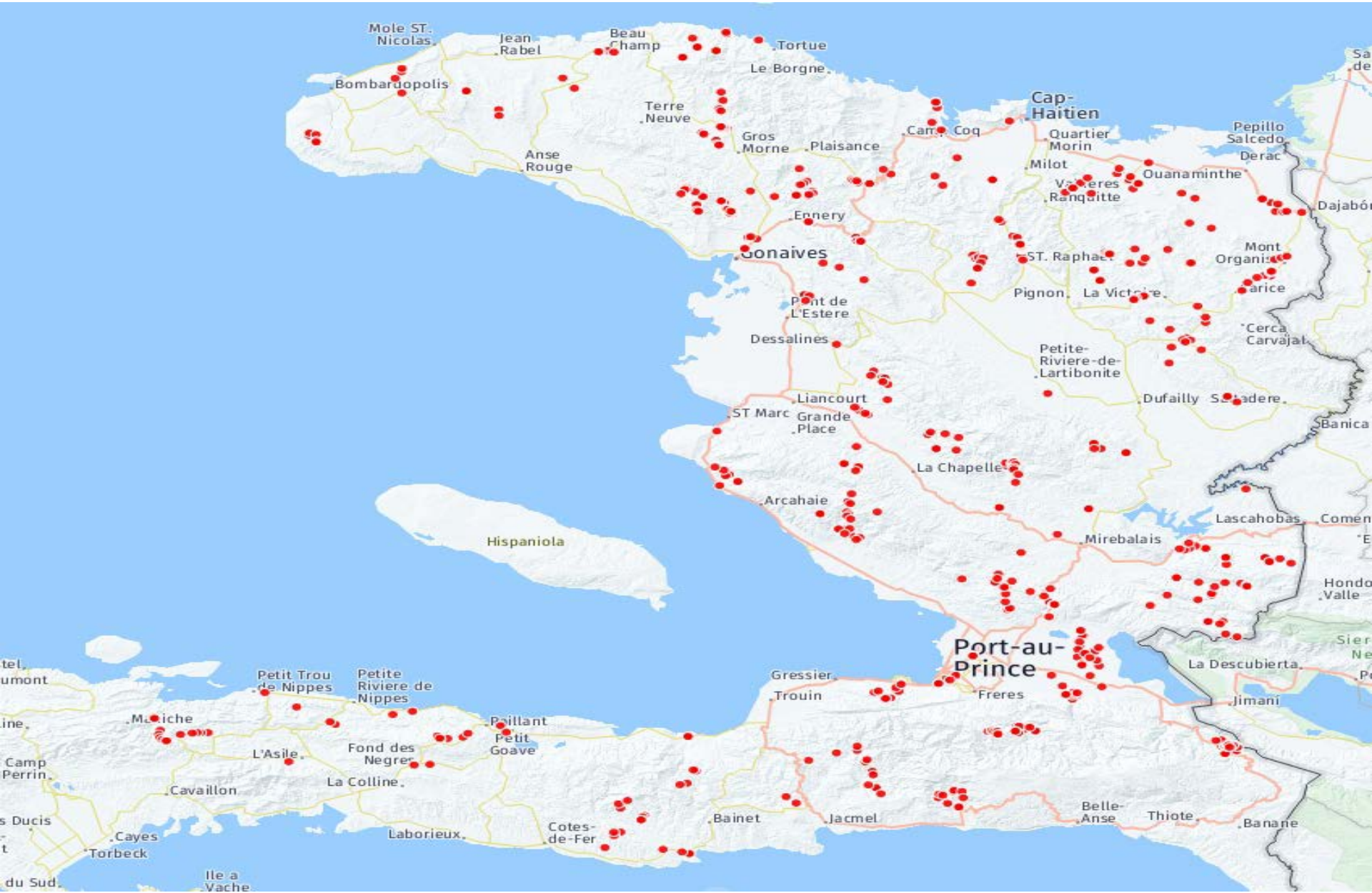
Research Questions

- What is the extent to which bean seeds of improved varieties are used by farmers and are in circulation in the seed system?
- What is the impact of past targeted seed dissemination efforts as reflected in the current use and adoption of seeds of improved varieties by project beneficiaries?
- What is the relative importance of the formal and informal bean seed channels? Who are the major players involved in each? How the bean seed flows within and between the formal and informal channels? And what types of bean seed varieties are available in the system?
- What are major constraints and opportunities for increasing the use and adoption of quality of bean seeds by farmers in Haiti?

Methods: Farmer Survey

- Sample of 700 bean farmers drawn from a nationally representative agricultural sample survey conducted by the National Agricultural Statistics Service (NASS)
  - Used probability proportional to size (PPS) method: Number of farmers per department was determined by each department's share of annual bean production area
- In addition, a sample of 300 farmers drawn from beneficiary lists of BTD farmers
  - Limited to 3 Departments with BTD participant list
- Surveys conducted in Nov-Dec 2016 in 8 Depts; and Apr-May 2017 in 2 Depts (that were affected by Matthew)

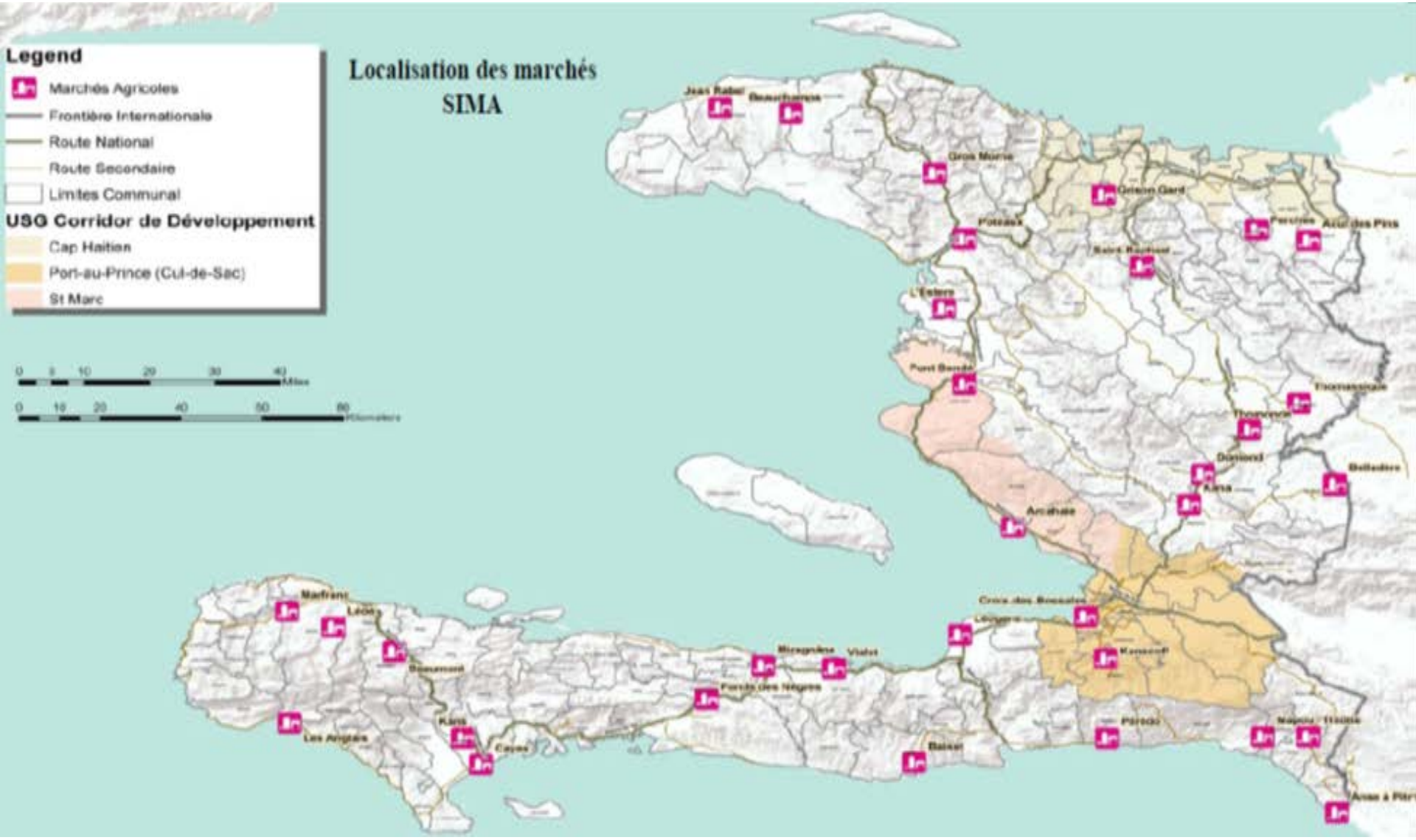
Distribution of sample of farmers surveyed



Methods: Market Vendor Survey

- NASS collects price data from 36 markets around the country on a daily or weekly basis (depending on the number of days a market is open) for different crops, including beans
- We piggybacked on this existing infrastructure managed by NASS (i.e., Systeme D'information Sur Les Marches Argricoles (SIMA) and collected bean seed samples and information from 9 bean vendors in 25 markets across the country at three time periods over a period of 12 months (to capture temporal diversity)
  - Nov-Dec 2016; Mar-Apr 2017; Aug 2017 (ongoing)

Map of SIMA Market Locations



Methods: Key Informant Interviews

- Conducted with agro-dealers, international and national NGOs, IICA, FAO, and donor funded programs across the country (June-July 2017)
  - Used a structured questionnaire
  - Sample size:
    - 50 seed distributors
    - 50 seed producers
  - These were selected from a list compiled by a consultant

Methods: DNA fingerprinting

- Bean seed samples (15-20 grains) were collected from farmers during farmer survey, SIMA market surveys (3 times a year), and KII with seed producers and distributors
- Protocols for collecting seed samples, labeling, handling, shipping and storage of seeds from the point of collection to NSS facilities in Haiti, and then shipping these seeds to Puerto Rico were developed with SO1.A4 team
- Seed germination and DNA extraction, and GBS library construction done in Puerto Rico
- DNA fingerprinting conducted at Cornell University

  Current status
  - Completed: farmer samples collected in round 1 (from 8 Depts)
  - Ongoing: Market samples collected in round 1
  - Pending: Farmer samples from round 2 (2 Depts); market samples from Round 2 and 3; and samples from seed producers and distributors

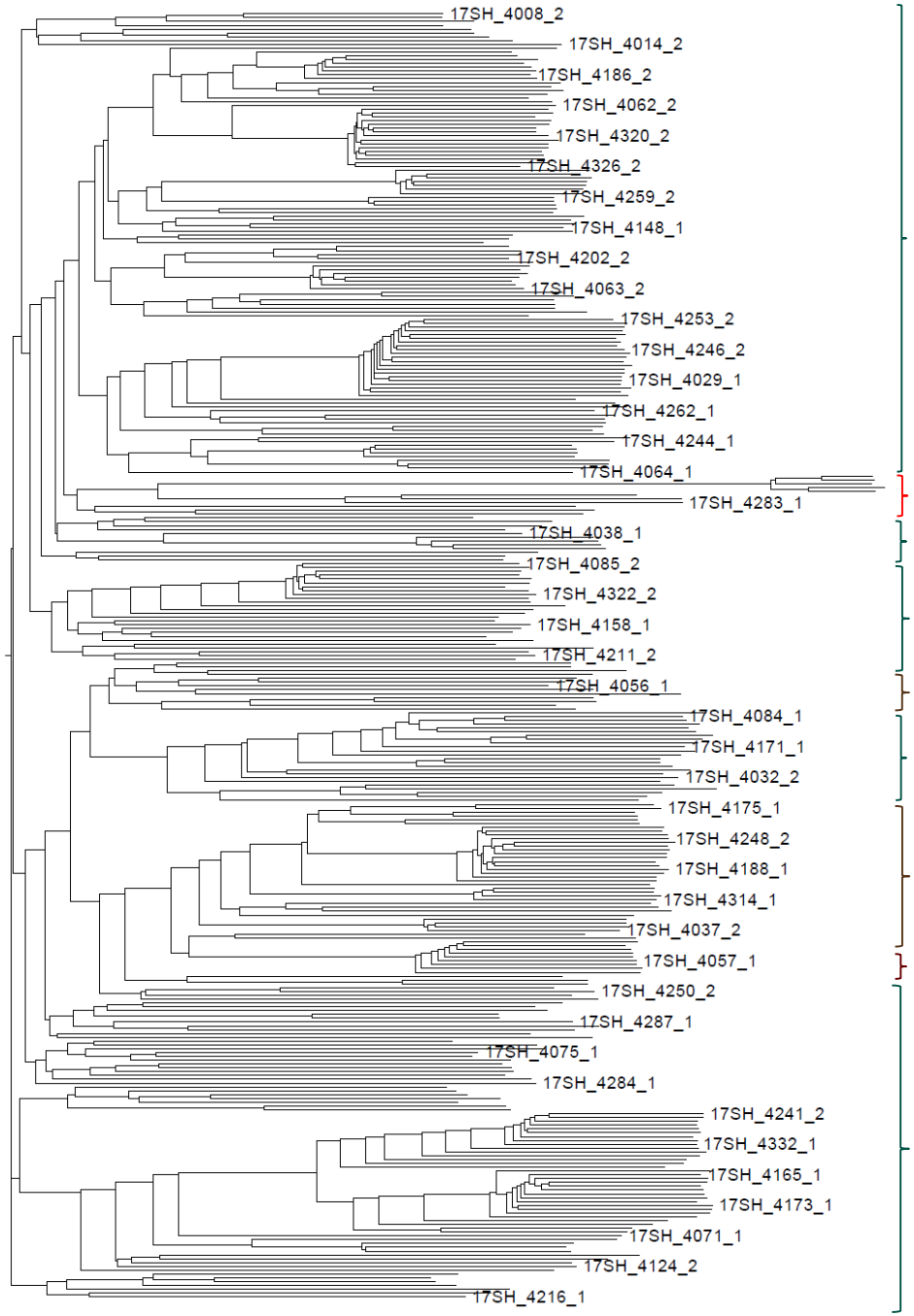
Results (very preliminary)

- Farmer surveys confirmed that farmers were not able to identify varieties by name
- Bean seed/variety types planted by farmers were referred mostly by market class (e.g., black bean)
- Farmers reported growing 9 market classes; black bean was the most common
- Cannot estimate bean varietal adoption based on farmer survey; thus DNA fingerprinting is key to address research questions 1 and 2
- Other analysis of data to understand farmer seed acquisition, sale and storage practices is ongoing

DNA results of farmer collected seed

- 410 Samples collected from farmers:
  - 57% germination rate, Grown to maturity, 2 pots of each planted and DNA extracted
  - This low germination rate helps explain why Haitian farmers tend to over-seed their plots
- 384 Samples Evaluated with SNPs using GBS and ApeKI enzyme
  - Sequenced using single lane on Illumina NextSeq500 at Cornell Weill Medical School
  - After filtering: 337 DNAs representing 221 samples with ~16k total SNPs

Seed Type	Total Sample #	% of total	SNP Analysis Sample #	% of total
Black	331	80.7	180	81.4
Brown	34	8.3	20	9.0
Cream	8	2.0	6	2.7
Red	8	2.0	3	1.4
White	8	2.0	5	2.3
Pinto	6	1.5	2	0.9
Tan	3	0.7	2	0.9
Yellow	3	0.7	3	1.4
Red Mottled (Andean)	3	0.7	0	0.0
Other	6	1.5	0	0.0
Total	410	100.0	221	100.0



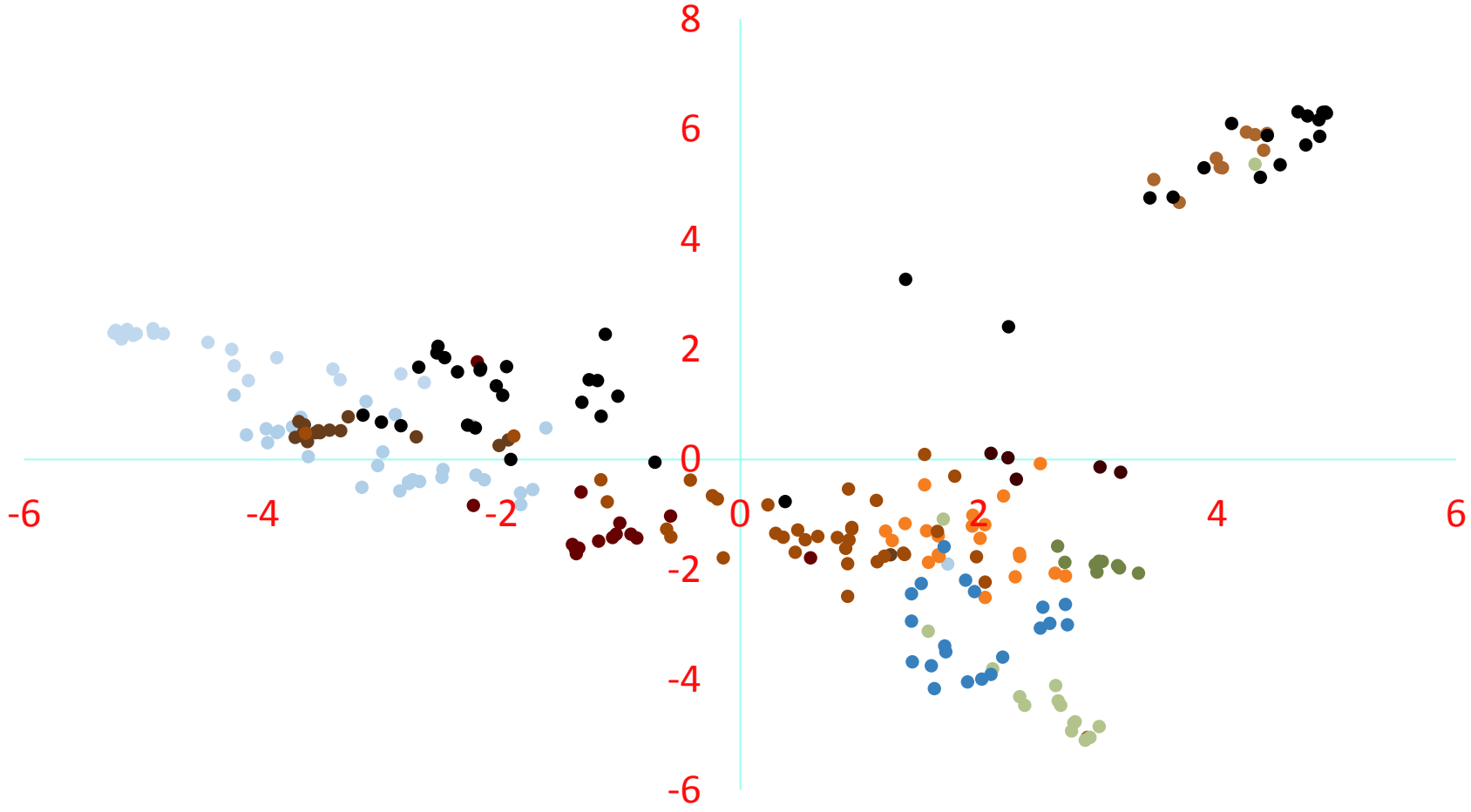
Cladogram

-based on SNP genotype data showing seed classes

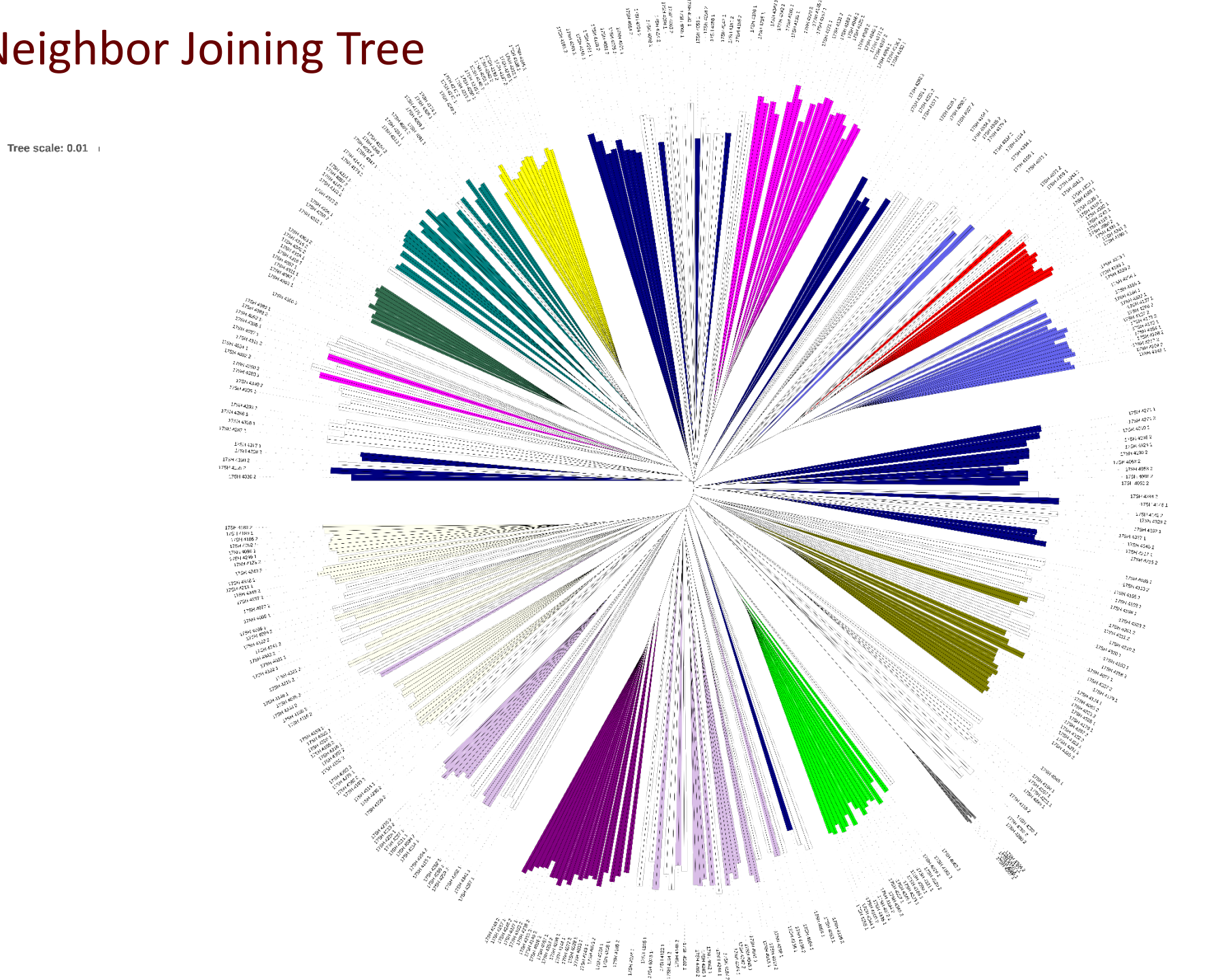
-337 genotypes

PCA Analysis (TASSEL)

-based on SNP data, 337 genotypes



Neighbor Joining Tree



Frequency of modern varieties assessed through presence of SCAR markers

- Evaluation with the codominant SCAR marker SR2 marker
  - Linked to the *bgm-1* gene for BGYMV resistance (1.6 %)
- Evaluation with the dominant SCAR marker SW13 marker
  - Linked to the *I* gene for BCMV resistance (34 %)

	BGYMV		BCMV		Total
Seed Type	SR2	% total	SW13	% total	DNA Samples #
Black	4	1	119	32	372
Brown	1	3	2	5	37
Cream	0	0	0	0	10
Red	2	40	1	20	5
White	0	0	1	13	8
Pinto	0	0	1	17	6
Tan	0	0	0	0	3
Yellow	0	0	0	0	6
Red Mottled (Andean)	0	0	0	0	0
Other	1	25	0	0	4
Total	7		124		451

Frequency of modern varieties assessed through presence of SCAR markers

- Experience indicates that all black landraces in Haiti are susceptible to BCMV so the presence of *I* gene would suggest the use of an improved cultivar, such as Arroyo Loro Negro
- Approximately 1/3 of the Farmer collected samples (34%) were improved varieties
- The SR2 marker was found in samples in proximity to Mirebalais, Jacmel and SE Haiti (Savane Zombi)
  - Areas where the LIL and B/C CRSP projects have worked and release germplasm

Conclusions (preliminary)

- Seed quality of farmer grown beans is very low
- Most of the improved varietal adoption (among farmers surveyed in Nov-Dec 2016, end of Autumn season) represents earlier generation of improved bean varieties (BCMV resistant varieties)
- Use of later generation BGYMV resistant varieties is concentrated in areas with project supported efforts; but in a broader picture, the levels of current use of these varieties is very low
  - At the aggregate level, the impact of past targeted seed dissemination efforts may be low

Thanks

Welcome questions and feedback

Acknowledgement

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