AFRICAYAM PROJECT Phase II

Enhancing yam breeding for increased productivity and improved quality in West Africa

Year 2 Report – April 1, 2021 to March 31, 2022

Prof. Alexandre A. DANSI, Dr Anicet DASSOU, Dr Igor YELOMEY, Israël AGBOGBA (MSc), OGOU Honorine (MSc)

Laboratory of Biotechnology, Genetic Resources and Plant and Animal Breeding (BIORAVE)
University of Abomey-Calavi
(*Republic of Benin*)

BILL & MELINDA GATES foundation

CGIAR Research Program on Roots, Tubers and Bananas

Primary Outcome 1. Enhanced capacity for more efficient and effective yam breeding programs in Ghana, Nigeria, Benin, Côte d'Ivoire and IITA.

Several training courses organized

- Identification of popular Guinea yam using distribution and extent analysis, trait profiling and benchmark setting for breeding programs : **6Th to 9th June 2021**

- A practical training course on SAH and tissue culture: **2nd – 31st July 2021** // **5** newly graduated BSc students in plant biotechnology

- **Tricot Approach in speeding up agricultural innovation through large-scale participatory experiments**: **5th to 7th August 2021** // 5 technicians and one researcher

- Use of **R package** for the analysis of the survey data on **farmers' preference criteria**. **2nd to 5th February 2022** // 4 technicians and one researcher

- Assessment and screening of **OP and hybrids** of the program using **relative productivity, tuber characteristics and food quality traits. December 2021 – February 2022 //** 5 BSc graduated students

- **Training on methodologies for sensory evaluation, textural determination and food quality assessment developed by RTBfoods // Benin, November (22nd to 26th) 2021. 4 members of our team attended**

Scientists from the lab also participated to two online training workshops:

- **Training workshop on Machine Learning Tools for Genomic Selection:** Two scientists (**Dr. Laura Loko and Dr. Igor Yelome**) participated // **7th to 11th June 2021**
- **Digitization training for yam. (Dr. Laura Loko and Dr. Igor Yelome). 2nd to 4th August 2021**

Participation in key conferences and visit of breeding companies

- COVID19 issue: no scientist visited breeding companies during the project year

- **Dr. Igor Yelome** and **Eric Dadonougbo (MSc)** participated to the **virtual** 14th Symposium of (ISTRC – AB), Zambia **20th to 24th September 2021**.

❑SAH infrastructure (with all the required compartments) well Installed at Dassa and well equipped

More training for the technical staff. A technician (Israel Agbogba) being trained at IITA (SAH unit)

❑Yam barns and screen houses updated at Dassa and Massi

❑ **Field and lab equipments acquired are doing well**

- *Tablets / magnifying lens /Drying oven; autoclave, Water distiller, Balances, pounding machines, Computers, etc..*

❑ **Vehicles, tricycle and Motorcycle in very good state**

Exchange visit among the national partners

The program received the visit of :

- RTBfood team (**Dr Alexandre Bouniol, Dr Laurent Adinsi, Dr Dominique Dufour**) at **Massi on 30 July 2021** and on the other sites (Dassa, Assaba, Tallou and Tokotoko) from **18th to 20th October 2021** to discuss possible collaboration in the genotype selection process with regards to food technology aspects
- Ibadan team (*Dr Agre Paterne and Dr Pelemo Olugboyega*) from **9 to 13 November 2021 to the different sites (**Frignou, Salmanga, Akaradè, Dendougou **) and to the labs including** the SAH facility

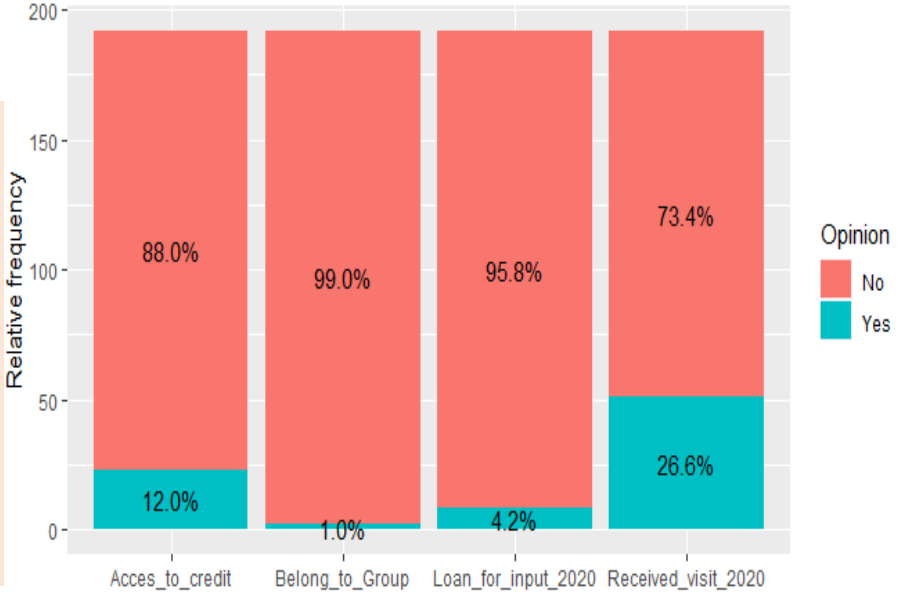
Primary Outcome 3. Next-generation of superior yam varieties for traditional and emerging products/markets.

Report on survey to document farmer's and consumers trait preferences and demand for improved yam per NARS partners

- **June 2021: 192 farmers** surveyed in **24 villages (5 to 7 villages per zone)**
- **Selection Parameters used:** ethnic groups, the agroecological zones, the marginal areas (drought, poor soil, lowland, etc.)
- **Q**uestionnaire developed at IITA.

Geographical location of the sites selected for the surveys on varieties' preference criteria

- Very low access to credit
- Individual work
- Low assistance from extensionnist
- **No significant Variation in the land area used**



The top six constraints faced in yam farming

- Climate factors (55.21 %)
- Poor fertility of the soil (52.08 %)
- Pest and disease attacks (40.10 %)
- Tuber rot in mounds (34.90 %)
- Low productivity (25 %)
- Lack of good quality seeds (16.15)

The three most important traits farmers like with improved yam varieties

- Good culinary quality (64.04%)
- Good drought tolerance (44.27 %)
- high yield (28.13 %)
- Attractive plant vigor) (26.04 %),
- Resistant to pests and diseases (23.96 %),
- Tolerance to low fertile soils (21.88 %).

10 most popular varieties

Môrôkôrou, Ahimon, Katala, Labôko, Kratchi, Tchée, Adoro, Oroutani, Amoula, Gnidou

Importance of traits/characteristics in YAM variety selection decision

N°	TRAITS	Percentage of respondents
1	Tuber storability (Long shelf-life)	100
2	High germination or sprout emergence	98,44
3	Drought resistance	96,35
4	Tolerance to low soil fertility	93,23
5	PEST and diseases	91,8
6	Early maturity	91,67
7	Tuber size	91,14
8	Tuber yield	88,55
9	Peel loss	88,54
10	FOOD quality	81,12

Type of important traits that breeders should consider/include in their programs

- High yield (26.56 %)
- Good quality of pounded yam (12.50 %)
- Pest /disease resistance (9.38 %)
- tolerance to any type of soil (5.73 %)
- Early maturity (4.69 %)
- Drought tolerance (4.17 %)

10 most popular varieties phenotyped on station and in their production zones for agronomic, pest, disease and food quality traits

	Landraces	Yield (Kg/mound)			MTW	NMTH	MTL (cm)	MTWi (cm)
		Mean ± SD	Min	Max				
1	Adoro	3.9 ± 0.6	3.1	4.5	3.9 ± 0.6	1.0 ± 0.0	29.4 ± 1.9	14.2 ± 2.5
2	Ahimon	6.6 ± 0.6	4.9	6.4	5.7 ± 1.7	1.6 ± 0.9	35.5 ± 7.8	30.9 ± 5.2
3	Amoula	8.6 ± 0.8	3.9	10	7.6 ± 2.2	1.4 ± 0.8	48.1 ± 15.6	31.8 ± 6.8
4	Danwari	5.1 ± 1.3	3.9	6.7	4.8 ± 1.1	1.2 ± 0.4	37.6 ± 9.3	35.5 ± 10.2
5	Gnidou	4.8 ± 1.1	3.3	6.0	4.8 ± 1.1	1.0 ± 0.0	42.5 ± 13.8	25.0 ± 7.2
6	Kratchi	3.2 ± 0.8	2.5	4.5	2.9 ± 0.9	1.4 ± 0.5	35.5 ± 1.9	18.3 ± 9.2
7	Laboko	2.9 ± 0.9	1.7	4.1	1.8 ± 0.6	1.6 ± 0.5	41.0 ± 11.5	32.0 ± 2.7
8	Tchéé	6.9 ± 1.1	5.8	8.4	6.9 ± 1.1	1.0 ± 0.0	64.4 ± 2.8	34.5 ± 16
9	Morokorou	5.7 ± 0.5	5.1	6.2	5.7 ± 0.5	1.0 ± 0.0a	44.9 ± 0.8	42.5 ± 3.2
10	Oroutani	3.6 ± 1.3	1.7	4.9	3.6 ± 1.3	1.0 ± 0.0a	42.4 ± 3.2	31.2 ± 5.6

SD: Standard deviation; **MTW**: Marketable tubers weight per mound; **NMTH**: Number of marketable tubers harvested per mound; **MTL**: Marketable tuber length; **MWi**: Marketable tuber width

Landraces	YMV		ANTHRACNOSE		NEMATODES	
	Inc	Ms	Inc	Ms	Inc	Ms
Adoro	70	2.0	90	2.2	0	1.0
Ahimon	90	1.5	40	1.4	50	2.0
Amoula	50	1.5	10	1.33	50	1.5
Danwari	50	1.5	50	1.5	50	1.5
Gnindou	100	2.2	60	1.9	0	1.0
Kratchi	54.7	2.0	48	1.4	0	1.0
Laboko	90	2.0	50	1.9	50	2.3
Morokorou	70	2.1	56	1.4	50	1.5
Oroutani	50	1.8	40	1.3	50	1.5
Tchéé	56.7	2.3	30	1.4	0	1.0

Boiled yam and pounded yam quality (% of responses)

S/N	Cultivar name	Quality of boiled yam			Quality of pounded yam		
		Very good	Good	Fair	Very good	Good	Fair
1	Adoro	70	30	0	0	38	62
2	Ahimon	80	20	0	78	22	0
3	Amoula	89	11	0	81	29	0
4	Danwari	78	22	0	77	23	0
5	Gnidou	0	22	78	0	10	90
6	Kratchi	72	28	0	74	26	0
7	Laboko	100	0	0	100	0	0
8	Morokorou	77	23	0	72	28	0
9	Oroutani	74	26	0	69	31	0
10	Tchee	79	21	0	75	25	0

Adôrô

Positive attributes

Good yield,

- Tolerant to YMV and nematodes,
- White tuber flesh, good taste,
- Good DM,
- Cylindrical shape,
- Good quality of pounded yam
- Excellent quality of boiled yam;
- good storage aptitude.

Negative traits

- Spines on the roots;
- Require stacking

Landraces	Mean score for attributes (boiled and pounded yam)						
	Time (min)	Colour	Sweetness	Aroma	Hardness	Lumps	Elasticity
Adoro	23	1	2.5	0	3	0	1.4
Ahimon	27	1.9	2.5	0	2	0	1.9
Amoula	22	0.8	2.1	0.1	1.7	0	2.8
Danwari	20	1	1.9	0	2.	0	3
Gnidou	16	1	1.8	0	2.7	0	1.3
Kratchi	25	1.8	2.1	0	2.8	0.1	2.9
Laboko	18	1.9	4	1	1.5	0	3.6
Morokorou	19	1	2.1	0	1.9	0	2.3
Orout ani	24	1	2.1	0.2	2.8	0.1	3.4
Tchee	31	0.9	3.7	0.8	3.8	1	1.9

Dry mater, Mineral and primate composition also evaluated

Promising varieties established in SAH system

As recommended **10 promising varieties** were selected and introduced into SAH.

- **Laboko**
- The six best genotypes regional evaluation clones: **TDr 1000078; TDr 0002405; TDr 0900067; TDr 1000179; TDr 1000344; TDr 1400633**
- Three good performing varieties released: **TDr A5-2003 (Irô); TDr A39-2003 (Agbara); TDr A65-2003 (Foutoukpètè)**
- 1500 plantlets introduced in the SAH at initial stage, we were able to save only 26 plants in the field
- **We are test running the SAH with some difficulties now detected**
- **A technician also sent to Ibadan for more training.**

Crossing blocks established, seedling and tuber progenies generated (*D. rotundata)*

- laboko crossed with **10 best market varieties, 9 females** of the regional evaluation and **7 OP**

- **172 GENOTYPES SAVED AND planted at Tallou**
- **Crossing repeated for Kratchi and Amoula**

Crossing	Number seeds germinated	Number of tubers saved
Laboko X Kratchi	11	9
Laboko X Adigbiri	12	10
Laboko X Foutoukpete	10	8
Laboko X Effourou	13	12
Laboko X Bakpanatini	11	6
Laboko X Dodo	15	10
Laboko X Mondji	12	6
Laboko X Zambe	16	12
Laboko X Agatun	19	9
Laboko X Katala	22	12
Laboko X OP1817	19	6
Laboko X OP1832	17	6
Laboko X OP1415	22	6
Laboko X OP1419	25	8
Laboko X OP1830	12	3
Laboko X OP1826	15	4
Laboko X OP1414	12	2
Laboko X TDr 1000360	13	3
Laboko X TDr 1400633	13	4
Laboko X TDr 0900067	13	4
Laboko X TDr 1000459	15	2
Laboko X TDr 1000016	14	5
Laboko X TDr 1000048	13	7
Laboko X TDr 1000344	22	6
Laboko X TDr1000006	32	6
Laboko X TDr 1000003	18	6
Total	**416**	**172**

Elite breeding lines *D. rotundata* identified for multi-location testing and validation

- ❑ 319 clones (OP and hybrids from control crosses) of the programme screened
- ❑ Selection parameters
- ✓ Oxydation
- ✓ Quality boiled yam
- ✓ Quality pounded yam
- ✓ Pest and Disease score
- ✓ Vigor and thorniness of root and stem
- ✓ Dry matter

30 clones selected and planted in January 2022 at Dassa for multiplication and MLT

15 other OP with sufficient seeds selected for MLT

number	Accession name	yield	Dry mater	Boiled yam quality		pounded yam	
				score	comment	score	comment
1	OP282	37.4	22.22	3.5	Good	3.2	Good
2	OP187	34.55	24.04	3.2	Good	3.5	Good
3	OP21	34.65	26.68	3.3	Good	3.3	Good
4	OP255	51.115	24.68	4.95	Very good	4.25	Very good
5	OP20	44.2	25.72	3.5	Good	3.4	Good
6	OP184	34.1	24.35	3.25	Good	3.2	Good
7	OP09	38.82	26.6	3.5	Good	3.3	Good
8	OP199	41.1	23.36	3.6	Good	3.5	Good
9	OP149	55.85	21.41	3.2	Good	3.1	Good
10	OP78	47.2	31.01	3.75	Good	3.55	Good
11	OP30	37.55	22.66	3.4	Good	3.2	Good
12	OP205	38	24.05	3.6	Good	3.25	Good
13	OP107	45.7	30.01	3.8	Good	3.4	Good
14	OP426	40.5	27.71	3.7	Good	3.3	Good
15	KK28	29.67	24.21	3.5	Good	3.4	Good
16	AA10	39.645	26.56	3.9	Good	3.9	Good
17	KK06	37.925	23.54	3.8	Good	3.2	Good
18	AA17	40.135	24.26	3.3	Good	3.3	Good
19	LK10	46.67	10.75	4.5	Very good	4.1	Very good
20	AA13	41.9	26.95	3.4	Good	3.4	Good
21	BK01	40.9	28.06	3.1	Good	3.1	Good
22	LK09	37.75	23.87	3.6	Good	3.6	Good
23	LGa04	31.15	28.66	4.6	Very good	4.9	Very good
24	LGa11	33.15	27.02	3.5	Good	3.2	Good
25	TDr15042UAC93	30.6	28.31	3.6	Good	3.8	Good
26	TDr15042UAC42	45.75	30.35	4.4	Very good	4.1	Very good
27	TDr15042UAC11	37.8	26.5	4.6	Very good	4.8	Very good
28	TDr15042UAC47	47.58	29.83	3.7	Good	3.9	Good
29	TDr89/02415	40.35	28.58	4.3	Very good	4.5	Very good
30	TDr95/177	40.75	28.75	4.7	Very good	4.6	Very good

Number of botanical seeds of breeding populations collected or shared among partners

- **1300 seeds** of *D. rotundata* from **three populations** received
- **140 genotypes** saved and planted at Tallou in january 2022 for phenotyping and evaluation

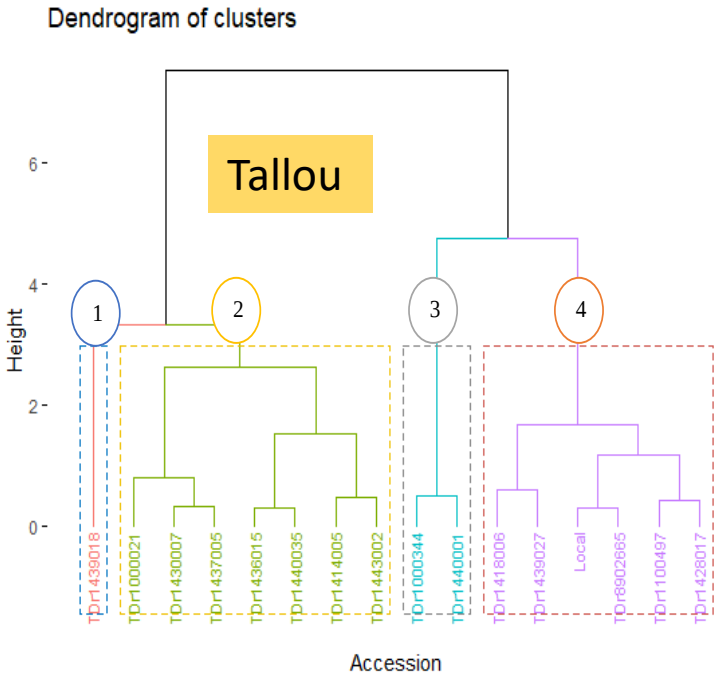
S/N	Family	Number of seeds received/planted	Number of mini tubers harvested	Number of mini tubers saved /germinated	Number of genotypes of clean tubers harvested and planted at Tallou
1	**TDr 19023**	500	**156**	**135**	**80**
2	**TDr 19055**	500	**121**	**60**	**30**
3	**TDr 19063**	300	**107**	**75**	**30**

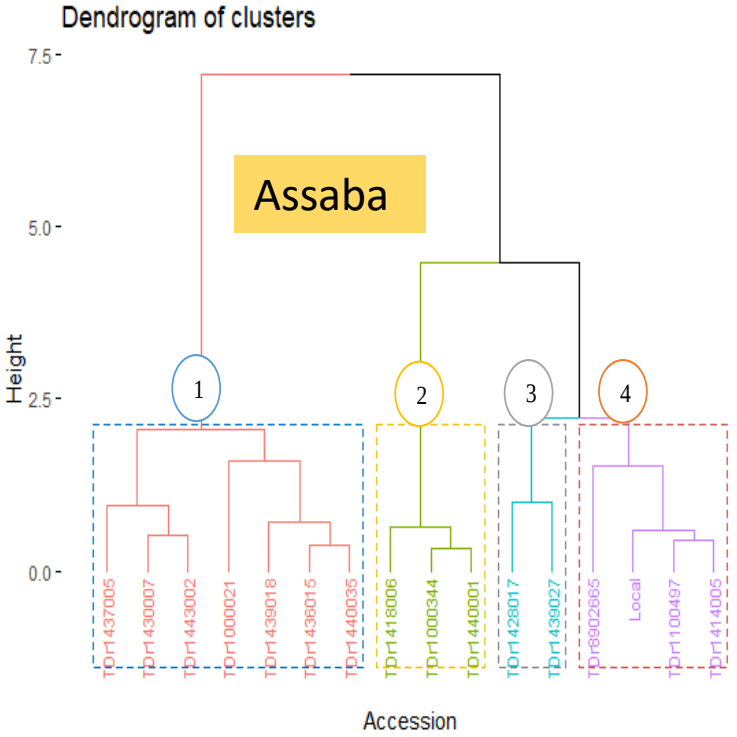
Report on the sharing, initiation and multiplication of promising advanced clones (14 test clones and one standard variety, and one check) for seed bulking per program for white and water yam

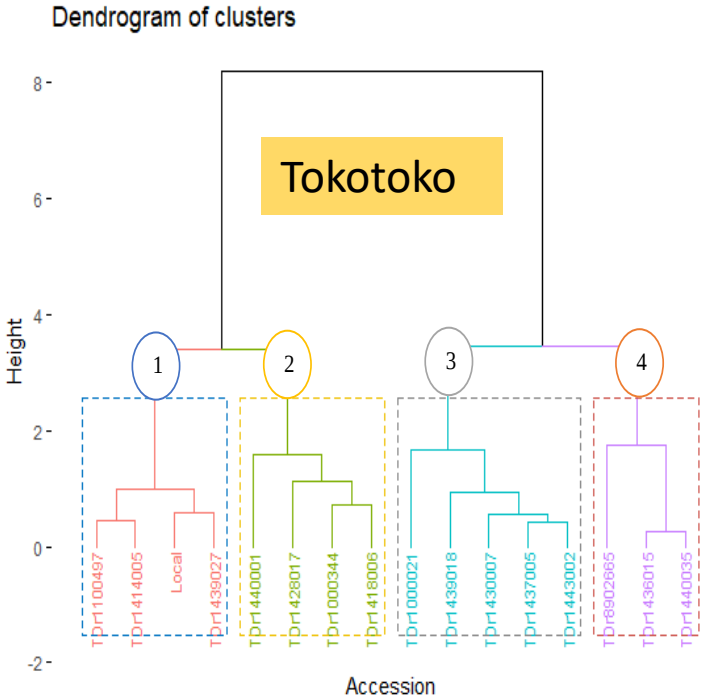
- Tuber seeds of **15** promising clones of ***D. rotundata*** received from IITA
- regional trial using **lattice 4x4**
- **three localities** (Tallou, Tokotoko, Assaba)
- Genotypes received were:
  TDr (1418006, 1000344, 1439027, 1430007, 1440001, 1428017, 1437005, 1443002, 1000021, 8902665, 1440035, 1414005, 1436015, 1100497, 1439018)
- **Amoula** (local check)

- **15** promising clones of ***D. alata*** also received
- **TDa** (1520009, 1506142, 1520050, 1510119, 1510010, 1511008, 1515032, 1515030, 1510043, 1510152, 1510080, 0000194, 1520002, 1508044, 1520008)
- **three localities** (Tallou, Tokotoko, Assaba)

- **Statistical analysis done for** :
  - ✓ number of tubers per mound (NTM)
  - ✓ weight of total tubers per mound
  - ✓ number of marketable tubers per mound
  - ✓ length of marketable tuber per mound
  - ✓ width of marketable tuber per mound
  - ✓ etc

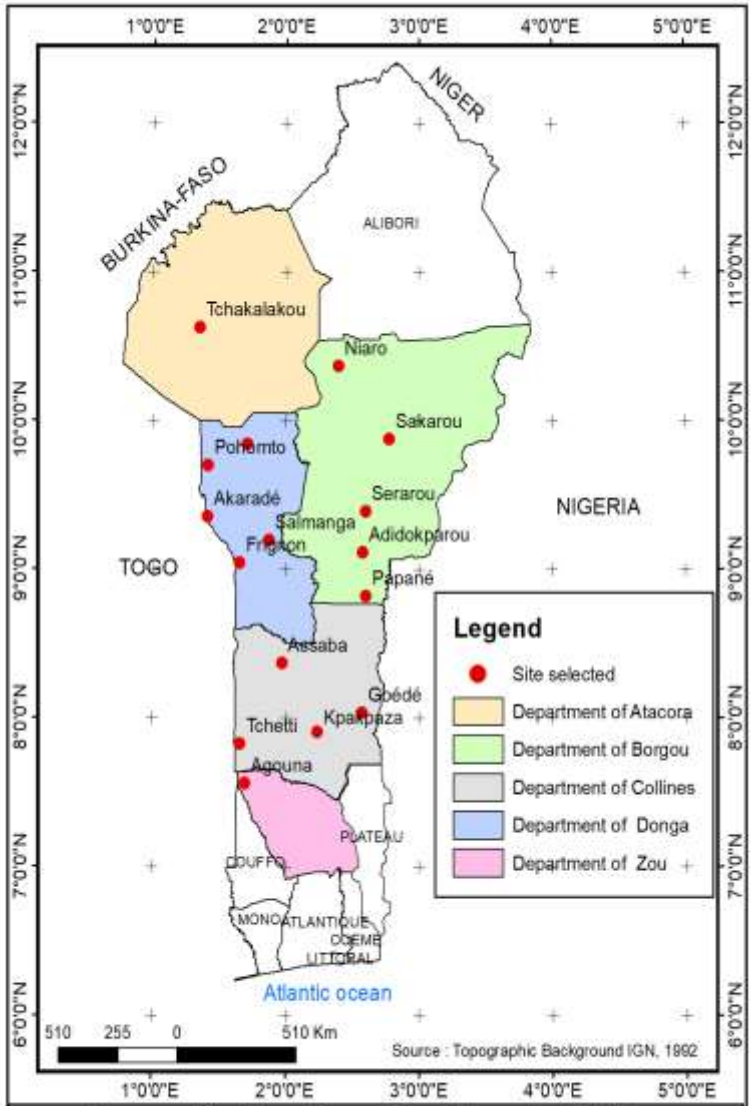

Dendrogram of clusters
Tallou
Height
Accession
1
2
3
4
TDr1439018
TDr1000021
TDr1430007
TDr1437005
TDr1436015
TDr1440035
TDr1414005
TDr1443002
TDr1000344
TDr1440001
TDr1418006
TDr1439027
Local
TDr8902665
TDr1100497
TDr1428017


Dendrogram of clusters
Assaba
Height
Accession
1
2
3
4
TDr1437005
TDr1430007
TDr1443002
TDr1000021
TDr1439018
TDr1436015
TDr1440035
TDr1418006
TDr1000344
TDr1440001
TDr1428017
TDr1439027
TDr8902665
Local
TDr1100497
TDr1414005


Dendrogram of clusters
Tokotoko
Height
Accession
1
2
3
4
TDr1100497
TDr1414005
Local
TDr1439027
TDr1440001
TDr1428017
TDr1000344
TDr1418006
TDr1000021
TDr1439018
TDr1430007
TDr1437005
TDr1443002
TDr8902665
TDr1436015
TDr1440035

On-farm testing network established per program with at least 25% female members

- An On-farm testing network of 50 farmers is established in 16 villages across production zones
- 16 females farmers considered
- 3 to 4 farmers **(including one female)** having good experience in yam production selected per village
- **Criteria for selecting villages were:**
  - **good yam production level,**
  - **distance,**
  - **Accessibility,**
  - **regular rain across years,**
  - **necessity to capture environment variability**



Geographical location of the sites selected for on- farm testing (OFT) using the tricot approach

Test clones (at least six) identified – (three alata and three rotundata), planting material or seed yam estimate for on-farm testing determined, and planting material or seed multiplication initiated

On-farm testing (OFT) of yam varieties using the tricot approach and ClimMob digital platform

- **Three rotundata (**TDr-A5-2003; TDr-A39-2003, TDr-A65-2003**)** and **two alata** (Metchassa, Kpèguèlèhoun) identified and multiplied
- **56 farmers** selected in **14 villages** received Seed yam of the 5 clones for evaluation
- 10 Seed yam per clone per farmer
- *colored stick used to differentiate clone*

Region	accession name	Number of tuber per mound	Total tuber weight	Weight marketable tuber	YMV	YAD	YN
Atakora	Sakata Kpeguelehoun	1,72	5,26	4,40	1,48	1,68	1,2
	Sakata Metchassa	1,52	4,89	4,35	1,44	1,664	1,3
	TDr-A39-2003	1,64	4,99	4,18	1,88	1,92	1,2
	TDr-A5-2003	1,8	5,13	4,25	1,48	1,72	1,2
	TDr-A65-2003	1,36	4,45	4,06	1,8	1,72	1,4
Borgou	Sakata Kpeguelehoun	1,3	4,48	4,15	1,7	1,85	1,4
	Sakata Metchassa	1,55	4,73	4,02	2	1,8	1,4
	TDr-A39-2003	1,7	4,69	3,84	1,8	1,7	1,2
	TDr-A5-2003	1,5	4,59	3,94	1,85	1,8	1,4
	TDr-A65-2003	1,55	4,81	4,10	1,7	1,95	1,3
Collines	Sakata Kpeguelehoun	1,4	4,78	4,34	2	2,04	1,2
	Sakata Metchassa	1,44	4,35	3,93	1,8	1,8	1,4
	TDr-A39-2003	1,56	4,67	3,98	1,92	1,8	1,3
	TDr-A5-2003	1,92	5,12	4,07	2	1,88	1,37
	TDr-A65-2003	1,52	4,53	3,90	2	1,8	1,37

Report of updated list of breeders working collection maintained per program

- A field of the national collection and breeding stock **(145 clones)** composed of:
  - 10 *D. alata* (popular/best market yam varieties)
  - 85 *D. rotundata* (popular/best market yam varieties)
  - 15 genotypes for regional trial
  - 5 genotypes resistant to virus and anthracnose selected from two mapping populations from IITA
  - 15 advance clones
  - 25 Various OP and hybrids

- Collection of rare varieties with specific and benefit traits scheduled for December

General Remarks

Contribution to Scientific Knowledge

PLOS ONE

RESEARCH ARTICLE

White Guinea yam (*Dioscorea rotundata* Poir.) landraces trait profiling and setting benchmark for breeding programs in the Republic of Benin

Yêyinou Laura Estelle Loko[1,2]*, Charlemagne D. S. J. Gbemavo[1], Pateme A. Agre[3], Anicet G. Dassou[1], Octaviano Igor Yelome[1], Roger Idossou[1], S. Alban Etchiha Afoha[1], Eric Dadonougbo[1], Jeannette Fakorede[1], Alexandre A. Dansi[1]

1 Laboratory of Biotechnology, Genetic Resources and Plant and Animal Breeding (BIORAVE), National High School of Applied Biosciences and Biotechnologies (ENSBBA/UNSTIM), Dassa-Zoumé, Benin, 2 Laboratory of Applied Entomology (LEnA), National High School of Applied Biosciences and Biotechnologies (ENSBBA), National University of Sciences, Technologies, Engineering and Mathematics, Dassa, Benin, 3 International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria

* lokoestelle@yahoo.fr

Check for updates

Publication on the survey data in preparation

- **Challenges:** **No specific challenge**
- **Lessons Learnt:** farmers are highly motivated to closely work with yam breeders

Many thanks to :

- ✓ BMGF
- ✓ IITA and AFRICAYAM management team for good coordination of the project
- ✓ My collaborators at different levels
- ✓ **Yam Farmers**