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

Collaborative Research on Sorghum and Millet

FEEDTHE FUTURE INNOVATION LAB

Expanding Markets for Sorghum and Millet Farmers in West Africa through Strengthening of Women and Youth Processors and Nutrition-based Promotion of Products

Phase II Year 8 Report

March 24, 2022

PURDUE UNIVERSITY

Arkansas Children's Research Institute | Nutrition Center

USAID FROM THE AMERICAN PEOPLE

INRAN

ITA

KANSAS STATE UNIVERSITY

Sites – Niger and Senegal
Team:

Moustapha Moussa – INRAN/Niger, Cheikh N'Diaye – ITA/Senegal

Bruce Hamaker – Purdue University, Mario Ferruzzi – North Carolina State University

INRAN Team – Moctar Alhafiz (Food Technologist, student), Yaye Hama (Economist), Yagana Kafougou (Nutritionist), Hamza Lamsso (Communications), Lawal Mahaman Inoussa (data analyst), urban processors lead by ETC (Mme. Liman), and rural processor groups affiliated with Fuma Gaskiya and Moribeen Farmer groups

ITA Team – Djibril Traore (Nutrition Scientist), Fallou Sarr (Food Technologist)

Partnering organizations

- Niger - McKnight Foundation CCRP/Niger
- Food Processing and Post-harvest Innovation Lab (FPIL)/Purdue/Senegal

General project structure

- Developed supporting system (Hub-and-Spoke Food Innovation Centers) to support existing and new processors – urban and rural
- Support urban (entrepreneurs) and rural (women's associations) processors with technologies, formulations, processes, science-based nutrition improvements to products
- Develop new formulations and consumer/market-tested products
- Processors grow markets, market-led nutrition

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

Niger - INRAN

USAID
FROM THE AMERICAN PEOPLE

Collaborative Research on Sorghum and Millet
FEED THE FUTURE INNOVATION LAB

KANSAS STATE UNIVERSITY

2021/2022 SMIL Activities at **INRAN/Niamey**

- Rural food processing
  - Geographical expansion of rural secondary/tertiary Spokes – fortified product sales and reach
- Urban entrepreneur food processors
  - Support and training
  - Increase in branded products and product sales
- Youth and women entrepreneurism – incubation of youth and women
- Screening of new millet/sorghum varieties

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

Rural Niger project report
Joint SMIL - McKnight Foundation

Develop nutritional food products that kids (and adults) want to eat, and let the market drive nutritional status improvement

Support entrepreneurism and generate income – rural

Expand local rural markets for farmers

Women and youth empowerment

USAID
FROM THE AMERICAN PEOPLE

Collaborative Research on Sorghum and Millet
FEED THE FUTURE INNOVATION LAB

KANSAS STATE UNIVERSITY

Expansion of Hub-and-Spoke Food Processing Innovation System – incubation of rural processors SMIL and McKnight Foundation CCRP

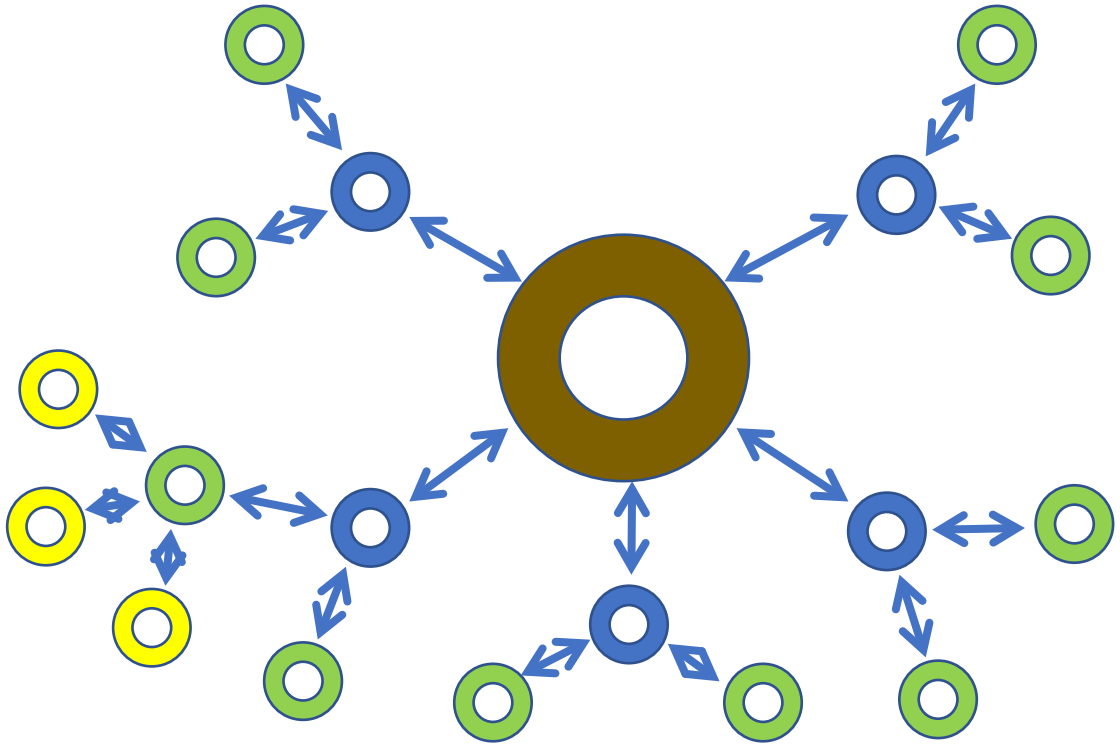
In 2021-22:

- Increase in secondary and tertiary processors in rural areas – scaling
- Increase in new formulated foods
- Varietal testing
- Increase in sales

Scaling of the rural Hub-and-Spoke System

11 Food Innovation Centers created:

- 8 in Niger
  - 1 Central Hub in Niamey
  - Primary Spokes in Falwel, Tera, Sherkin Haoussa, Gadan Iya
  - Secondary Spokes in Sae Saboua (Maradi), Kaboe Koura (Falwel), Zindigori (Tera, near border of Burkina Faso)
  - Tertiary Spokes – women in surrounding villages/communities were trained by the primary or secondary Spokes (given some basic supplies) – most around Falwel and Gadan Iya
- 2 in Burkina Faso
  - 2 rural Spokes in Lebda and Amdemtinga villages
- 1 in Mali
  - 1 rural Spoke at Dioila village

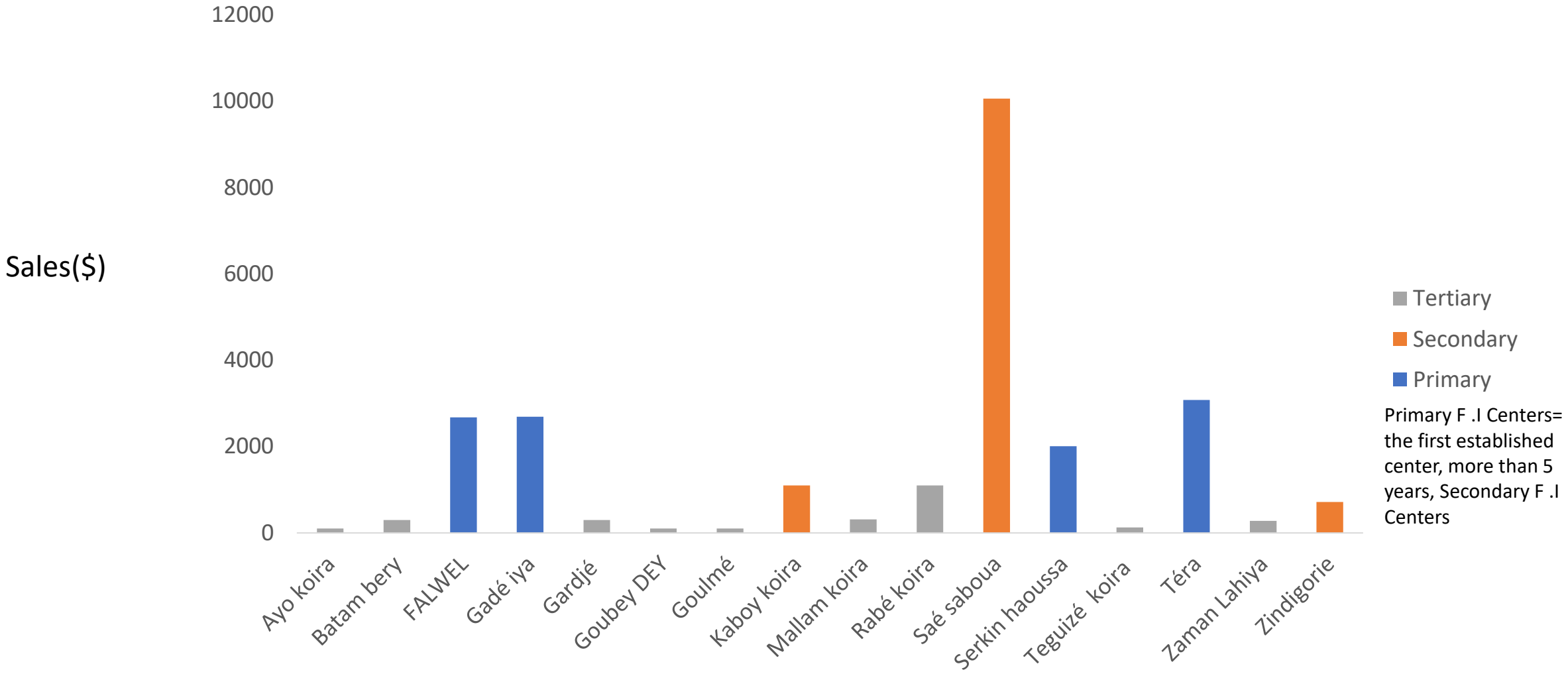


In the rural area, success in this year of the secondary/tertiary Spokes

Rural Hub-and-Spoke System

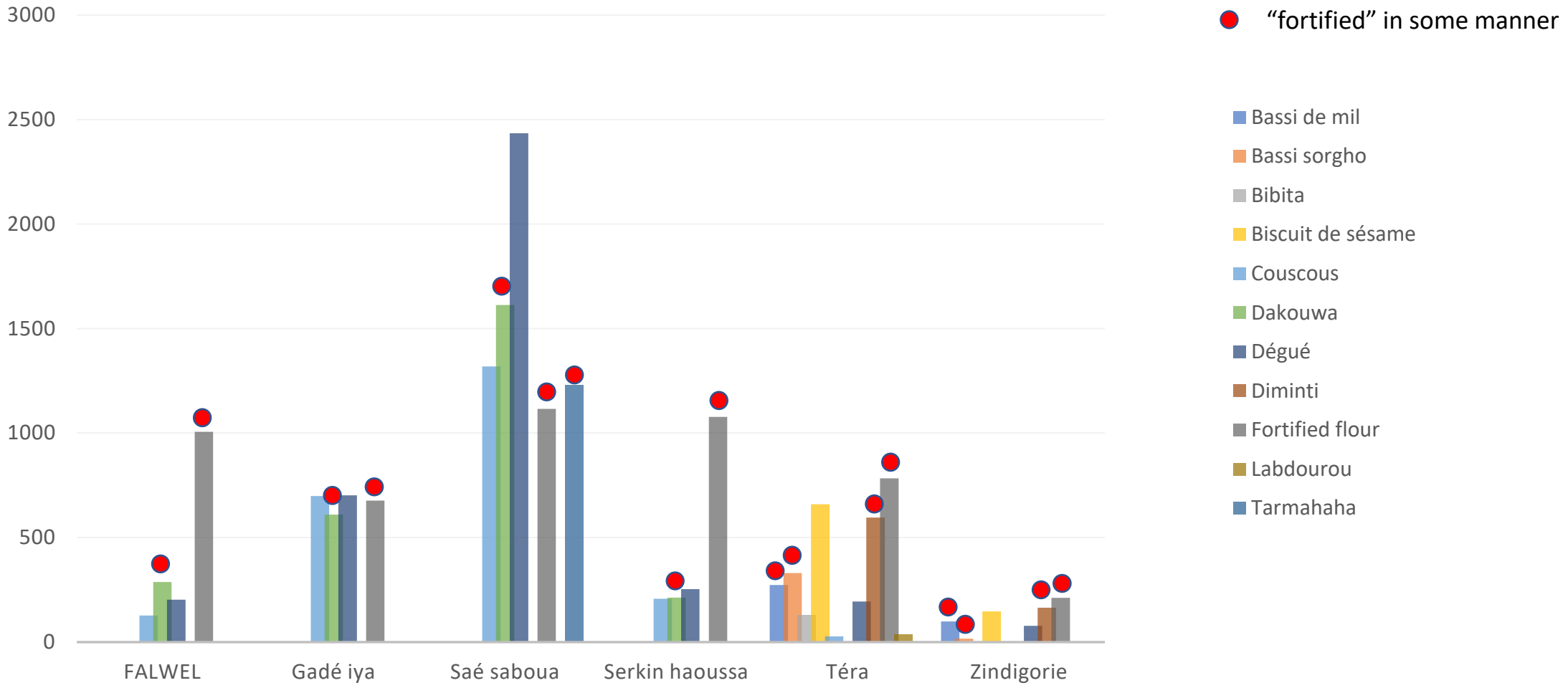
- ~ 35 weekly rural markets and 20 community health centers affiliated with Spoke Food Innovation Centers
- ~ 20 varieties tested and used through the participatory selection approach focused on the Option by Context (OXC) Local Value Chain
- 10 locally-accessible fortified flour formulas co-created, tested and marketed to benefit of several hundred of vulnerable groups, including malnourished children
- > 500 empowered women and youth, 10 students (B.S. & M.S. trained)

Millet and sorghum foods sales ($USD)of Primary, Secondary, and Tertiary Rural Spoke Food Innovation Centers in 2021, Niger

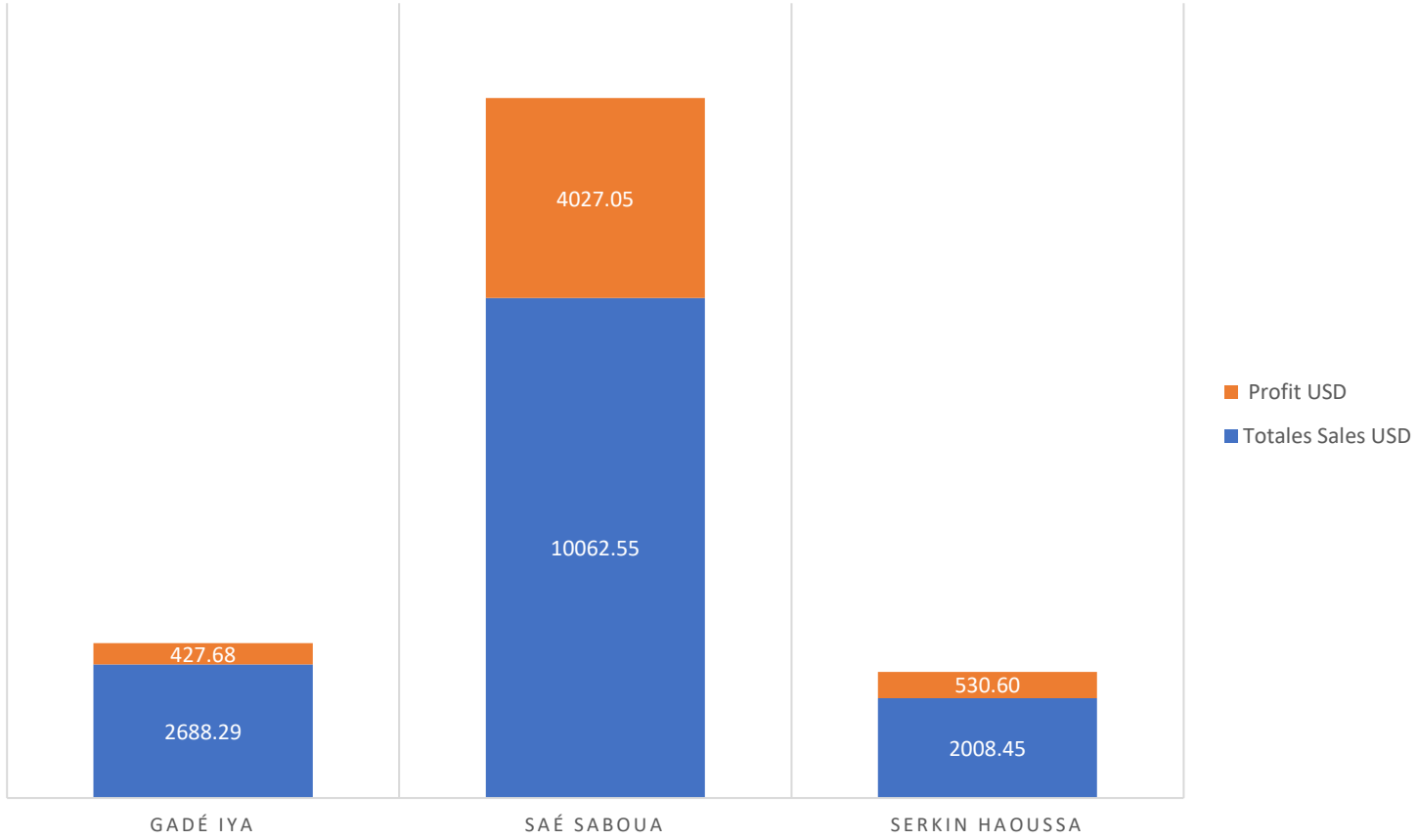


Villages with Primary, Secondary and Tertiary Rural Food Innovation Centers/Spokes, in Niger

Sales ($USD) of millet and sorghum foods made per food product type per Spoke Food Innovation Center in 2021, Niger



Sorghum and Millet Foods Sales ($) out from Maradi in 2 Primary centers (Gade Iya, Sherkin Haoussa), and 1 Secondary center(SAE SABOUA) Rural Food Innovation Centers/Spokes, in 2021, Niger



Rural Spoke branded products

Primary Rural Food Innovaton Center in Niger	Brand Name	Major Grain Type Used	Natural fortificant plants type used for Fe, Zn, and Vitamin A
Centre de TERA	BIBITA	Millet and Sorghum	
Centre de TERA	Farine Enrichie	Millet and Sorghum	moringa, baobab, pumpkin, carrot
	Dégué		
	Couscous		
	DAKOUA		
	DIMINTY	Millet, Sorghum and Peanut	
Centre de Saé Saboua	TARMAHAHA	Millet and Sorghum	
	DAGUé	Millet and Sorghum	
	Couscous	Millet and Sorghum	
	DAKOUA	Millet, Sorghum, Peanut	
	Garin Yara		moringa, baobab, pumpkin, carrot
Centre de Sarkin Haoussa	ANFANIN JAMA'A	Millet and Sorghum	moringa, baobab, pumpkin, carott
	DAGUé	Millet and Sorghum	
	Couscous	Millet and Sorghum	
	DAKOUA	Millet, Sorghum and Peanut	
Centre de FALWEL	HAMNIZE ALBARKANTA	Millet and Sorghum	moringa, baobab, pumpkin, Carott
	Dégué	Millet and Sorghum	
	Couscous	Millet and Sorghum	
	DAKOUA	Millet and Sorghum, and Peanut	
		Millet, Sorghum and Millet and Sorghum	
Total :			

Branded Sorghum and Millet Foods Sold in Rural Markets by Women groups at F. I Centers

Replication of the Hub-and-Spoke System

- Rockefeller Foundation "Strengthening African Food Processors" project
  - 3 ½-year project (extended due to Covid, ends April 2022) in Arusha, Tanzania and Nairobi, Kenya
  - Maize and mango value chains
- Arusha, Tanzania - Hub – Nelson Mandela African Institution of Science and Technology; 3 rural Spokes
  - All Spokes have sales of maize products, 2 of 3 profits similar to Niger rural Spokes
- Nairobi, Kenya – Hub – University of Nairobi, urban mango processors

Urban Niger project report

Develop new regular and nutritional food products with consumer and market testing

Support entrepreneurism and generate income – urban

Women and youth empowerment

Expand local rural markets for farmers

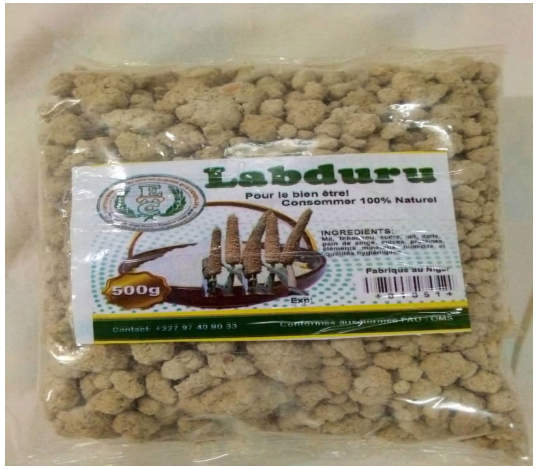
Products Formulated and In-Use/Ready-for-Use by Urban Processors/Entrepreneurs

Instant millet *fura*
Instant millet *couscous*
Instant millet *tuwo* (thick porridge)
Fortified Blends
Co-extruded millet-peanut (*lackiri*)
Co-extruded millet-fortified flour
Co-extruded sorghum-fortified flour
Roasted millet-fortified flour
Roasted sorghum-fortified flour

Branded products sold now in the urban markets in Niger

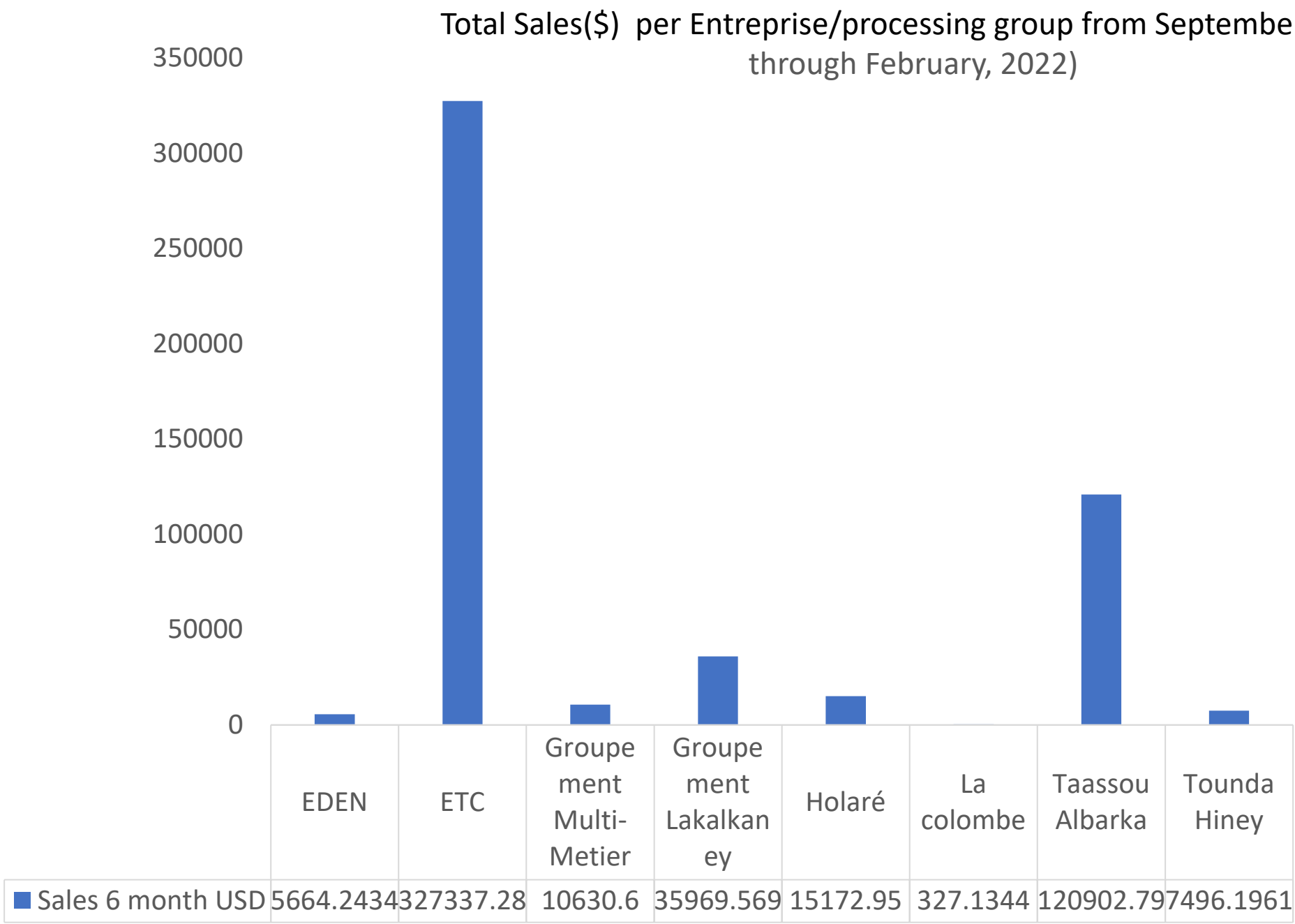
Urban Niamey Entreprise	Brand Name	Major Grain Type Used
ETC	1-LAKIRI 2-Dégué 3-Couscous 4-Dadin Kowa (fortified product) 5-Labdourou	Millet and sorghum
EDEN	Dégué NAKOWA	Millet and sorghum
HOLARE	Dégué ATAHER	Millet and sorghum
MULTI-METIER	Dégué ADILY	Millet and sorghum
TASSOU ALBARKA	FOURA ALBARKA	Millet and sorghum
LAKALKANE	FARINE ENRICHIE LAKALKANE	Millet and sorghum, peanut, cowpea

Branded millet and sorghum foods sold in urban markets by ENTREPRISE DE TRANSFORMATION DES CEREALES (ETC)-NIGER through a women entrepreneur (Mme Liman Aminatou, Director of ETC, Incubated Through INRAN FOOD Innovation Hub)



2021 Production and sales of sorghum and millet foods by Niamey grain processors in (updating is in progress)

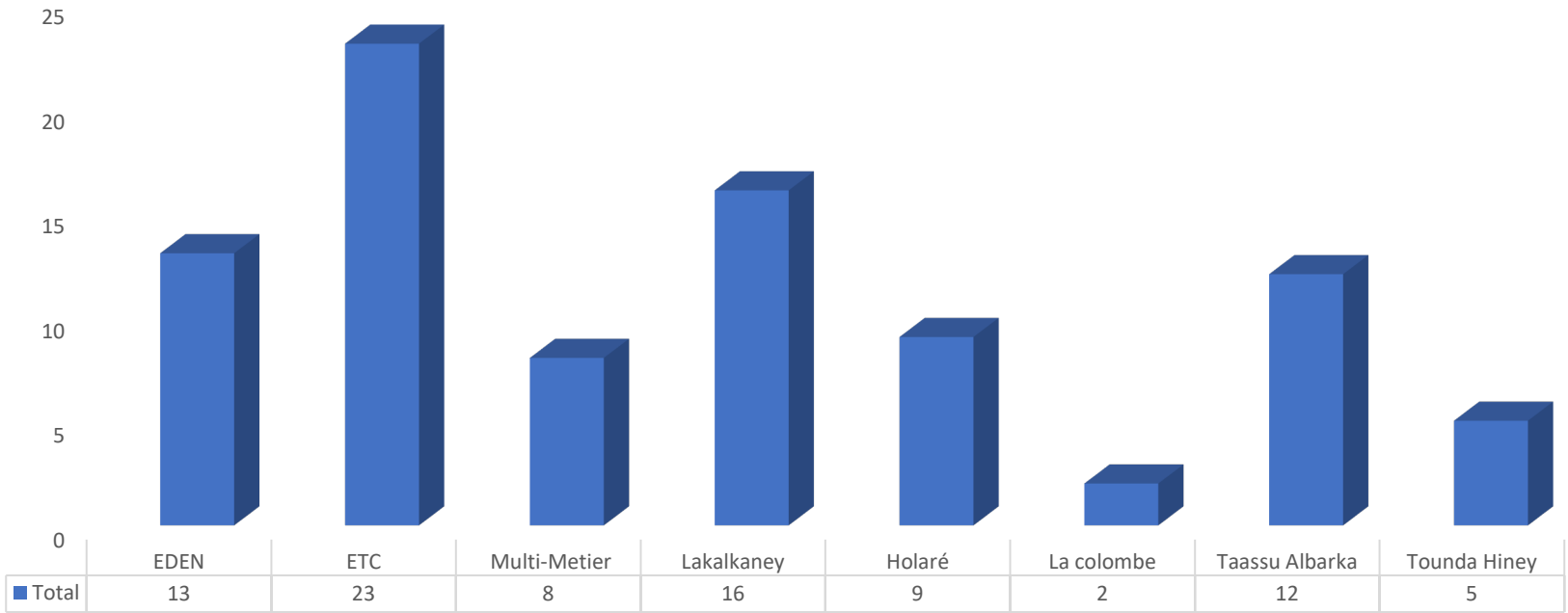
Grain Processing Entreprises in Niamey	Production of Grain Foods Products (kg) from March to August 2021	Product Sales (FCFA)	Product Sales ($)	Number of Sales Stores
UTASP-Amintchi	975	700,000	1273	3
Lakalkaney	5,115	4,639,500	8,435	6
ETC	221,589	265,822,750	483,314	42
UNITAL	6,315	6,946,500	12,630	15
La Colombe	163	175,432	319	3
Tounda Hinay	1,011	1,039,000	1,889	7
Tassou Albarka	584	549,000	998	4
KOBA	NA	NA	NA	
Harandé	2,302	1,895,100	3,445	3
UTAFF	3,300	2,970,000	5,400	7
Total: 10 enterprises				94


Total Sales($) per Entreprise/processing group from September, 2021 through February, 2022)
350000
300000
250000
200000
150000
100000
50000
0
EDEN
ETC
Groupement Multi-Metier
Groupement Lakalkaney
Holaré
La colombe
Taassou Albarka
Tounda Hiney
Sales 6 month USD
5664.2434
327337.28
10630.6
35969.569
15172.95
327.1344
120902.79
7496.1961

2020 Production and sales of sorghum and millet foods by urban grain processors in Niamey

Grain Processing Enterprises in Niamey	Monthly Production of Grain Foods Products (kg)	Product Sales (FCFA)	Product Sales ($)	Number of Sales Stores
UTASP-Amintchi	260	260,000	485	3
Lakalkaney	920	920,000	1,719	6
ETC	75,570	97,910,000	183,009	42
UNITAL	2,040	2,568,000	4,800	15
La Colombe	182	250,000	467	3
Tounda Hinay	375	387,500	724	7
Tassou Albarka	355	502,000	938	4
KOBA	510	510,000	953	4
Harandé	1,050	990,000	1,850	3
UTAFF	693	662,250	1,237	7
Total: 10 enterprises	**81,955**	**104,959,750**	**196,186**	94

Average number of Millet and Sorghum Foods processed monthly per Entreprise/processing group from September, 2021 through February, 2022)



	EDEN	ETC	Multi-Metier	Lakalkaney	Holaré	La colombe	Taassu Albarka	Tounda Hiney
Total	13	23	8	16	9	2	12	5

Youth Entrepreneurism

- Training at INRAN Hub Processing Innovation Center
- Use the Hub facilities to produce products
- Start businesses

Youth and Women Entrepreneurship at INRAN-Niamey

HUB INCUBATION CENTER

- >20 youth trained and backstopped in grain processing and fortification





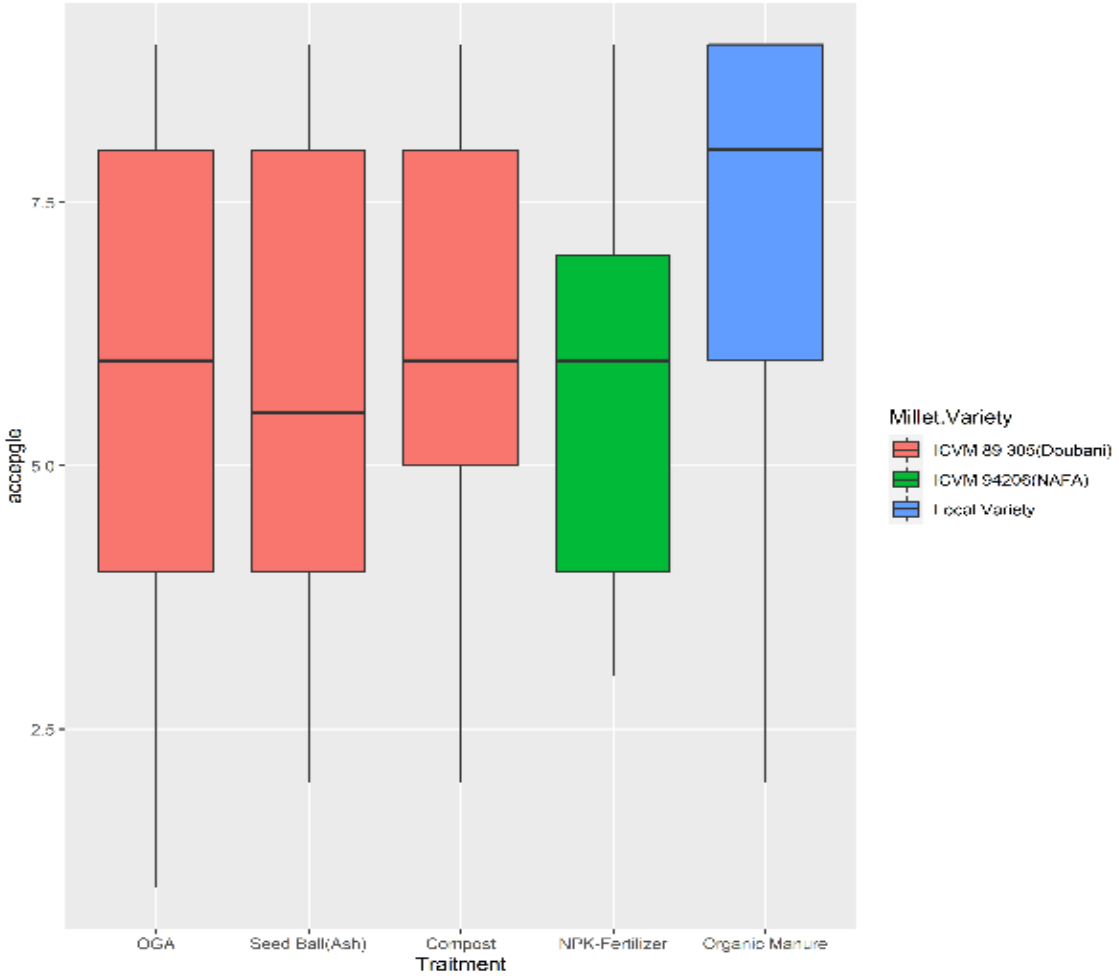



Youth and Women Entrepreneurship at INRAN-Niamey

HUB INCUBATION CENTER

Branded Sorghum and Millet Foods Sold in Urban Markets by other youth and women processors incubated and backstopped at INRAN F. IHUB

Overall acceptability of tuwo (thick porridge) made from millet varieties treated with human urine (OGA, Seed Ball-Ash based, Compost, NPK fertilizer, and Organic Manure)



An example of integrated technology package trials achieved through synergy among Mcknight and SMIL funded projects (Seed ball Technology, Women Field and Processing) and in collaboration with Fuma Gaskiya and Mooribeen (local unions) farmers

Result indicates that local consumers preferred tuwo made with millet treated with OGA, SEED BALL, COMPOST, and ORGANIC Manure than the one made with Millet treated with NPK fertilizer

Values are means determination (n=50 panelists, $P<0.05$), hedonic test scale acceptability score range 1 to 9)

Niger Nutrition Study Planning

- ***Overall Objective:*** Test whether introduction of FtFF products through rural incubation center Spokes contributes to an improved food environment and availability of micronutrients to these communities
  - Influence of secondary/tertiary rural Spokes on reach of fortified foods into rural areas

- **Approach**

  This will be tested by implementing a diet assessment questionnaire in 3 communities (Tera, Falwell and Maradi) with IC spokes and active and growing sales of FtFF products produced locally. Diet quality and nutrient intake will be estimated using relevant West African Food Composition databases and compared to comparable communities without active IC spokes or sales of FtFF products

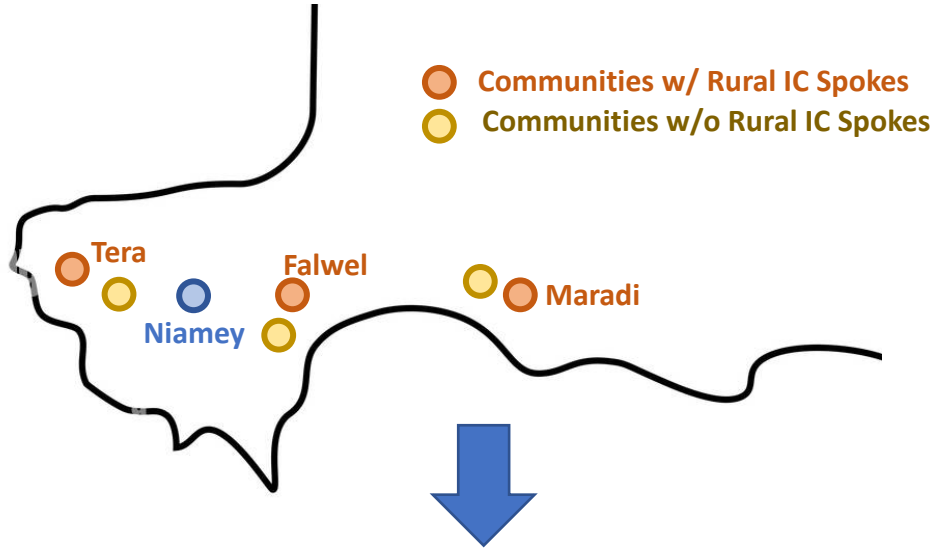
- **Study Duration: 3 months (July – September 2022)**

Niger Nutrition Study Planning
Measuring nutritional impact from introduction of Food-to-Food fortified flours

Primary hypothesis that introduction of FtFF products through rural Incubation Center (IC) Spokes contributes to an improved food environment and availability of micronutrients to these communities

Objective 1: Compare diet intake, diversity and nutrient intake in rural communities with active Primary IC Spokes and FtFF product introduction (past 3 years) with control rural communities.

- 1800 participants in total
  - 600 consumers of FtFF products in villages w/ IC
  - 600 non-consumers of FtFF in villages w/ IC
  - 600 non-consumers in villages w/out IC



Frequency of Consumption of Key Food
Child Specific Consumption of Millet Porridges
Diet Diversity Questionnaire

Diet quality
Nutrient intake

Outcomes:
- Is Diet Quality impacted by introduction of FtFF flours through IC Spokes?
- How do increased sales impact nutrient availability/intake in target groups?

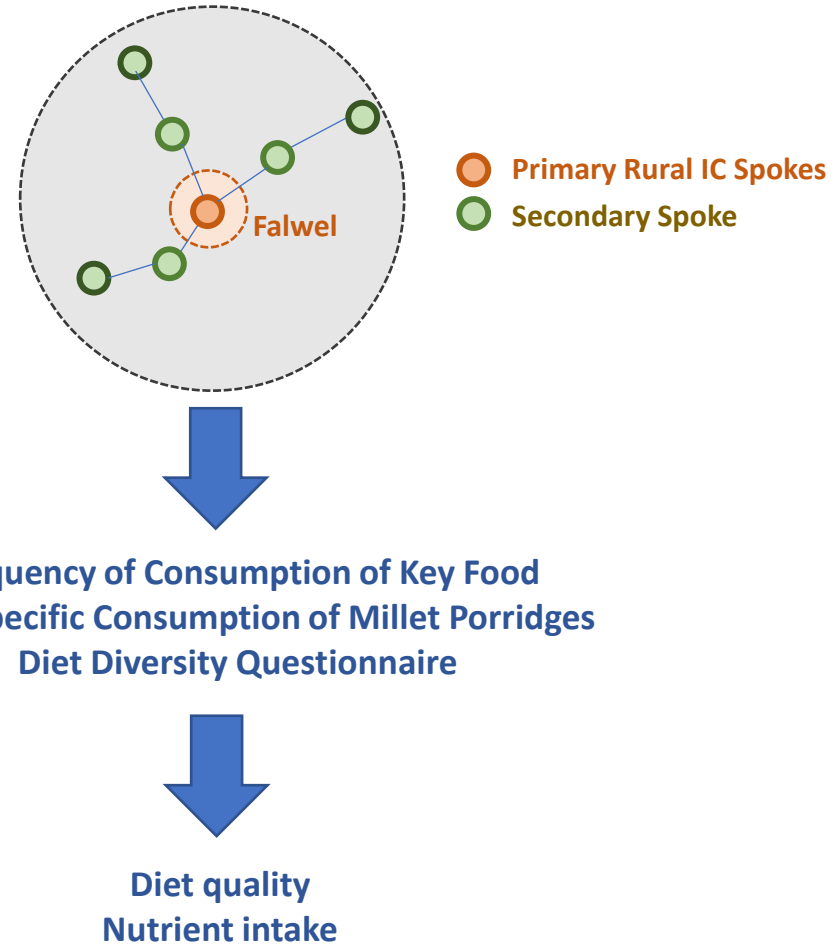
Niger Nutrition Study Planning
Estimating geographical range of impact driven from Primary IC Spokes

Secondary hypothesis that influence of Primary rural IC Spokes can enhance rural food environments through creation of Secondary and rural IC spokes that disseminate improved FtFF products.

Objective 2: Assess the ability of Primary IC Spokes to drive improvement in the local food environment through Secondary Spokes in peripheral communities

- 1200 participants in Secondary Spokes
  - 600 consumers in villages w/ Secondary IC Spoke
  - 600 non-consumers in villages w/ Secondary IC Spoke

Outcomes to address:
- Can improvements from Primary Spokes drive benefits in Secondary Spokes?
- Do these differ based on access to health centers?
- What is geographical range of impact from Primary IC Spokes?



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

Senegal - ITA

USAID
FROM THE AMERICAN PEOPLE

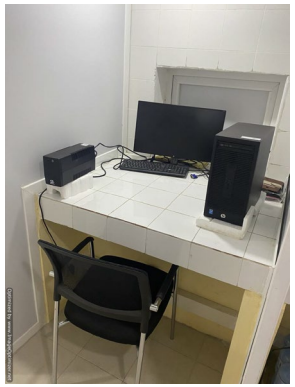
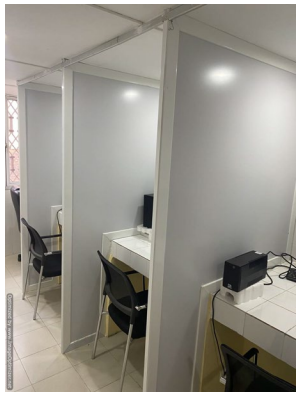
Collaborative Research on Sorghum and Millet
FEED THE FUTURE INNOVATION LAB

KANSAS STATE UNIVERSITY

2021/2022 SMIL Activities at **ITA Dakar**

- Sensory Science Laboratory
- Products with commercialization potential
- Incubation of youth and women entrepreneurs

Sensory laboratory activities


Booths with computers connected to a centralized system. A certification training is being finalized with CIRAD (France). Sensory tests have been started with procedures from Pretoria Sensory lab being applied.


Accessories in the preparation room include refrigerator. freezer. stove and store spots have been purchased for running the laboratory

Variety and aptitude test with ISRA

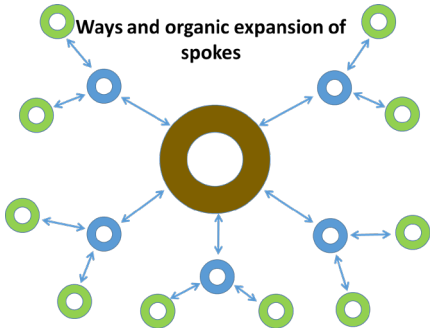
Varieties	Locations	Iron	Zinc	Magnesium	Proteins
MT	*Local Nioro* : **entry 1**	5.59 ±0.01a	3,24 ±0,01c	118,13 ±0,01bc	12.85±0.02a
ME90	*E90* : **entry 2**	5.72 ±0.02ab	2,76 ±0,02a	110,54 ±0 ,01a	13.17±0.01ab
MSE1	*Sanio Sefa* : **entry 4**	6.11 ±0.03ab	3,50 ±0,01d	115,87 ±0,01b	13.21±0.01b
MST	*Souna Tardif* : **entry 3**	6.87 ±0.76ab	3,00 ±0,02b	109,01 ±0,01a	13.77±0.02c
ME34	*E34* : **entry 1**	7.14 ±0.56b	3,28 ±0,01c	117,57 ±0,01bc	13.92±0.01c
MSE2	*Salam* : **entry 5**	11.61 ±0.39c	2,86 ±0,01ab	123,84 ±0,04c	14.36±0.01d

It is recommended that the use of MSE2 variety could be interesting on increasing protein, magnesium, and iron levels in cereal product when adopted by producers.

For the MES1 the zinc content is higher but still relatively low for recovering the daily allowance. These two varieties are being seeing as promising.

In order to homologate these varieties, further tests on aptitude are being finalized such as: dehulling, rolling and cooking properties. Thus could better oriented these varieties to processors in order to pull the production after ISRA's homologation.

Hub-and-Spoke model : example of an incubated enterprise



Mbakhouss (Traditional product)	Formula 1		Formula 2		Formula 3	
	Kg	%	Kg	%	Kg	%
Roasted millet	1	57.3	0.8	45.8	0.8	48.6
Peanut paste	0.4	22.9	0.4	22.9	0.4	24.3
Baobab	0	0.0	0.2	11.5	0.1	6.1
Sugar	0.3	17.2	0.3	17.2	0.3	18.2
Nutmeg	0.02	1.1	0.02	1.1	0.02	1.2
Vanilla sugar	0.025	1.4	0.03	1.4	0.03	1.5
Total	1.745	100.0	1.75	100.0	1.65	100.0

Product development and testing markets will start at ITA (**Hub**). Thus will facilitate the production and the nutritional analyses that need to be done in order to better promote products with safety.

Incubation of enterprises

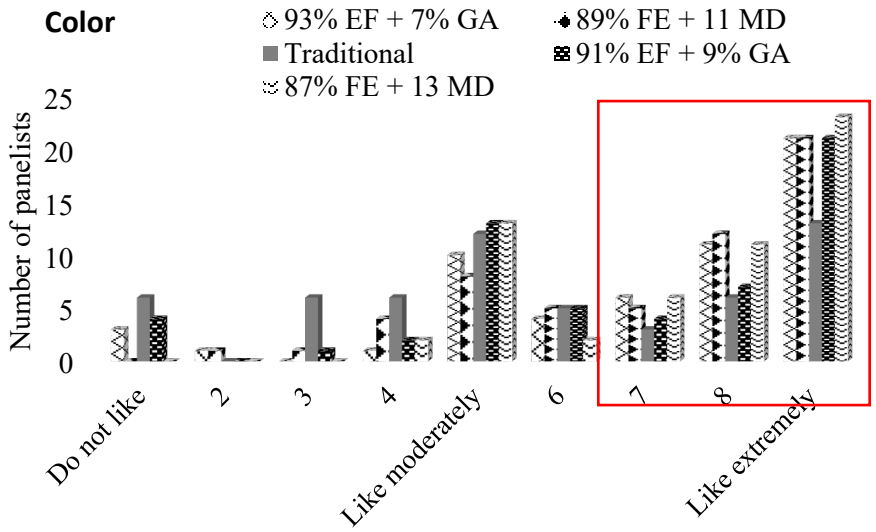
Products are being analyzed for nutritional tables. and packaging stability test (for the first stage).
Then, products will be tested in the markets.

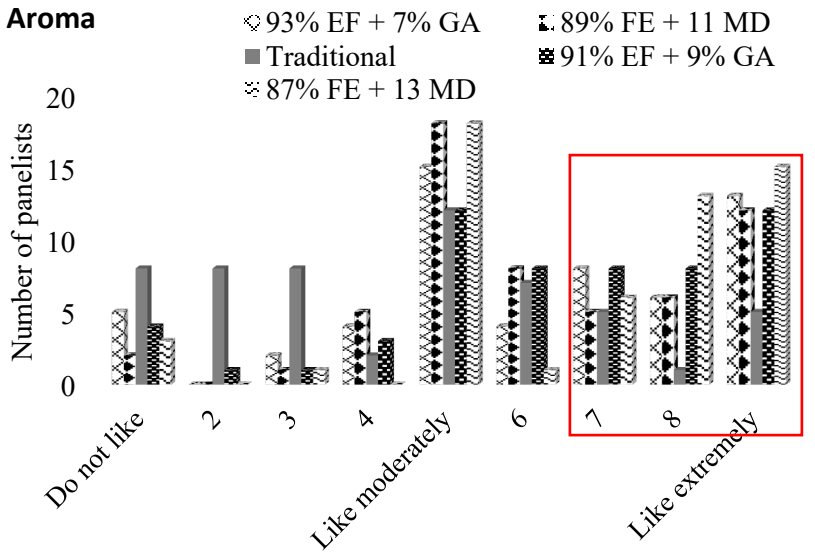
African Developement Bank Project would follow up with financial loan to get the incubated enterprises to start their own business (in **Spoke** incubator).
With the Enterpreneurship and Investment project funded by USAID/Senegal, more loans could be provided after incubations.

New products being deployed for the markets

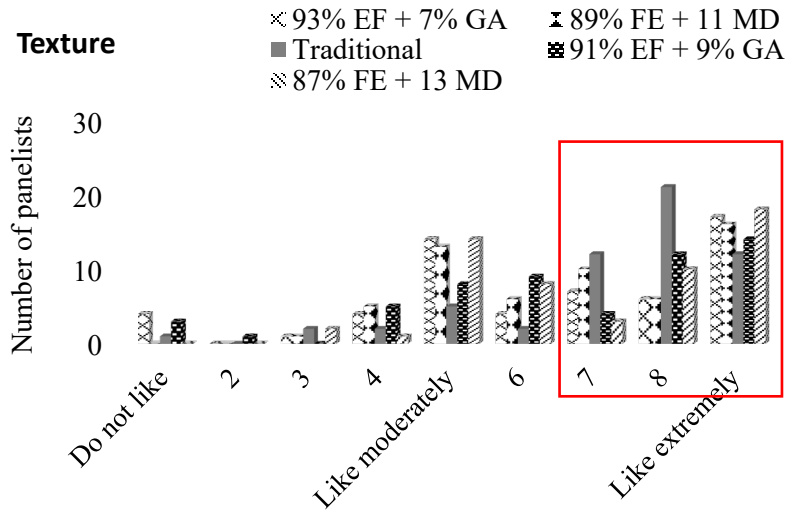
Maria Distribution and Free Work Service on:

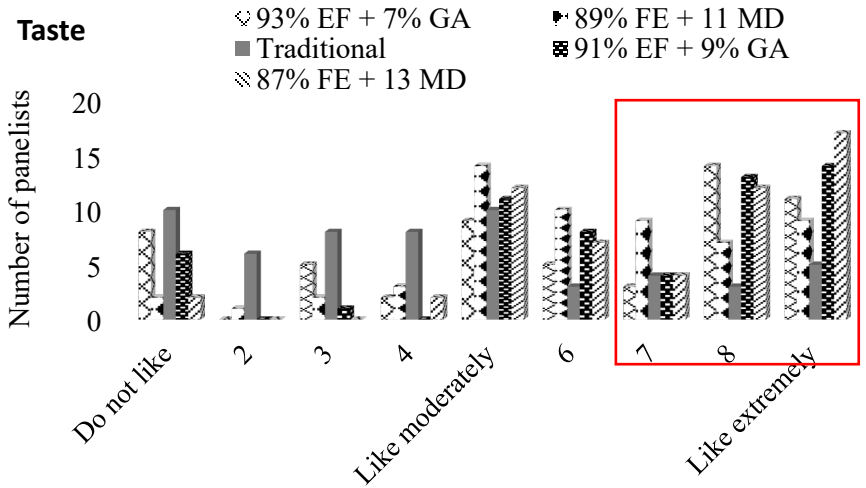
Instant arraw product is being deployed (with gum arabic and maltodextrin/extrusion technology). Large sensory test was done in order to see how people will react on the developed products.

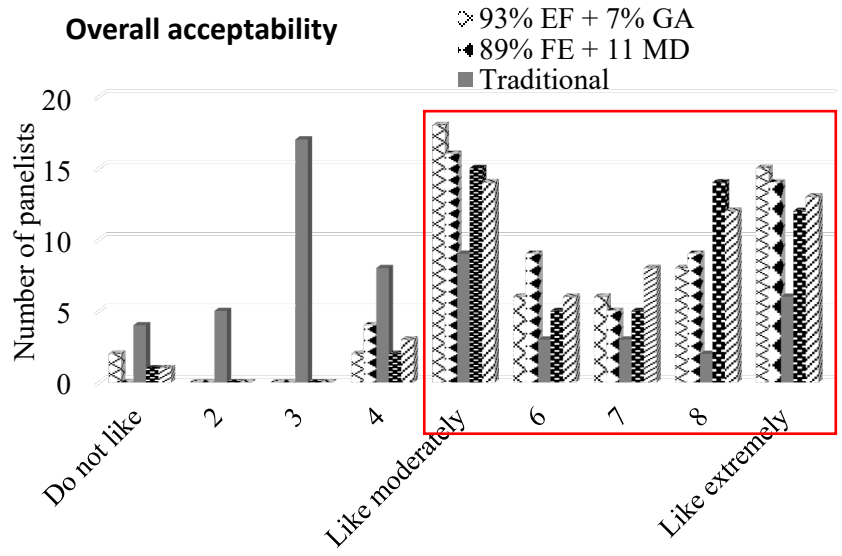




Maria Distribution and Free Work Service on:







Tested new arraw products showed higher sensory scores compared to the traditional one on color, texture, aroma, taste, and overall acceptability.

Therefore, the incorporation of binding agents in rolled extruded flour reduce cooking time as well as improving sensory attributes.

New products being deployed for the markets

Fermented economic couscous is getting close to market tests for many interested cereal enterprises as acidity and organoleptic properties are being provided by ongoing tests.

Imported strains

	Without inoculation			
Without strains	Conditions	Control	Ambiant T°	Control 37°C
	Acidity (%)	0.1	0.38	0.44
	With inoculation			
Strain names	Concentrations	6log	7log	8log
L. plantarum		0.53	0.57	0.68
L. plantarum	Acidity (%)	0.68	0.74	0.72
W. cibaria		0.79	0.55	0.51

Isolated strains at ITA

	Without inoculation			
Without strains	Conditions	Control	Ambiant T°	Control 37°C
	Acidity (%)	0.09	0.41	0.45
	With inoculation			
Strain names	Concentrations	6log	7log	8log
Cocci		0.80	0.76	0.71
Cocci	Acidity (%)	0.52	0.65	0.69
coccobacillus		0.79	0.75	0.81

From these results, we could see that the isolated strains are able to produce strong acidity taste in tested couscous.

Regarding control (To) and ambient temperature, for up to 24 hours acidity increased (natural fermentation).

By using strains, we found that acidities increased in imported and locally isolated ones.

This shows that strains (from local or imported) are able to produce lactic acid.

Sensory analyses are providing interesting results that could be decisive before entering in market tests.

Need to further charcaterize the isolated strains for better understanding.

New products being tested in Dakar market by youth enterpreneurs

YAFALI (young entrepreneurs in Dakar)

Products are being enriched in proteins, minerals and vitamins. All ingredients used are made locally. Products are instant and they are being tested in the markets.

Products

Food Tech (young entrepreneurs in Dakar)

Graduate students working on product development are being hosted in ITA for providing high quality food to the market. Products are being fortified naturally with proteins and minerals.

New products being tested in Dakar market by youth and women enterpreneurs

Fuzion enterprise and GIE Sunu Mbay Tey (woman entrepreneurs in Dakar)

Woman enterpreneurs are being helped to develop products from their own formulations. Packaging test and product stability are the main focal points as they face. Staple crops could vary from millet to maize with natural fortifiants/ and or premix.

Natural Production enterprise (youthentrepreneurs in Thiès urban areas)

Food entreprise with cereal-based products with protein and energy fortificants for work-out persons is being follow up on formulations and product development. Products are well commercialized. We are working on getting them instanized.

Products

FEED THE FUTURE

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

This study is made possible through funding by the Feed the Future Innovation Lab for Collaborative Research on Sorghum and Millet through grants from American People provided to the United States Agency for International Development (USAID) under cooperative agreement number AID-OAA-A-13-00047. The contents are the sole responsibility of the authors and do not necessarily reflect the views of USAID or the US Government.

www.feedthefuture.gov

USAID FROM THE AMERICAN PEOPLE

Purdue University

ITA

NC STATE UNIVERSITY

ISRA

Kansas State University