Connecter les chaines de valeur de la biodiversité agricole à l'adaptation au climat et à la nutrition

Autonomisation des pauvres pour la gestion des risques

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Nutritional aspects of NUS: INCO FONIO Project

Nutrition burden in Mali

- Undernutrition: stunting, wasting, underweight
- Micronutrient deficiencies: iron and zinc, vitamin A and C
- Overnutrition: overweight; obesity and related risk factors (hypertension; CVD)
- Vulnerable groups
  - women of reproductive age (15-49 yrs);
  - Infant and young children
  - School age children

Neglected and Underutilised Species (NUS)

Starchy staples

- Grains: millet and sorghum, yellow maize, fonio,…

Millet

Sorghum

Yellow maize

Fonio

- Tubers: sweet potatoes; cocoyam; yellow yam; …

Cocoyam

Yellow yam

Sweet potato

Starchy staples

- Staple foods, especially in West Africa
- Contribute to energy (calories) intake from varied sources
- Good source of complex carbohydrates when unrefined/ whole flour
  - Complex carbohydrates (= dietary starch): made of sugar molecules strung or branched; often rich in fiber, thus satisfying and health promoting vs Simple carbohydrates (= sugars): made of just one or two sugar molecules; quickest source of energy, as very rapidly digested
  - Whole grain/flour: bran, germ and endosperm components retained during the milling process vs refined four: removal of the bran and germ components during the milling process produces refined flour
- Contribute partly to micronutrient intake

Other NUS

- Fruits and vegetables (mainly leafy vegetables)
- Animal products: shrimps, small fishes; fish products (eggs)
- Other natural resources

- Good sources of varied micronutrients
  - Minerals: iron, zinc, calcium
  - Vitamines: A, C
- Rich in antioxydants→ prevention of CVD

Nutritional aspects of FONIO project

Fonio, a traditional cereal

Field of fonio

Fonio plant...

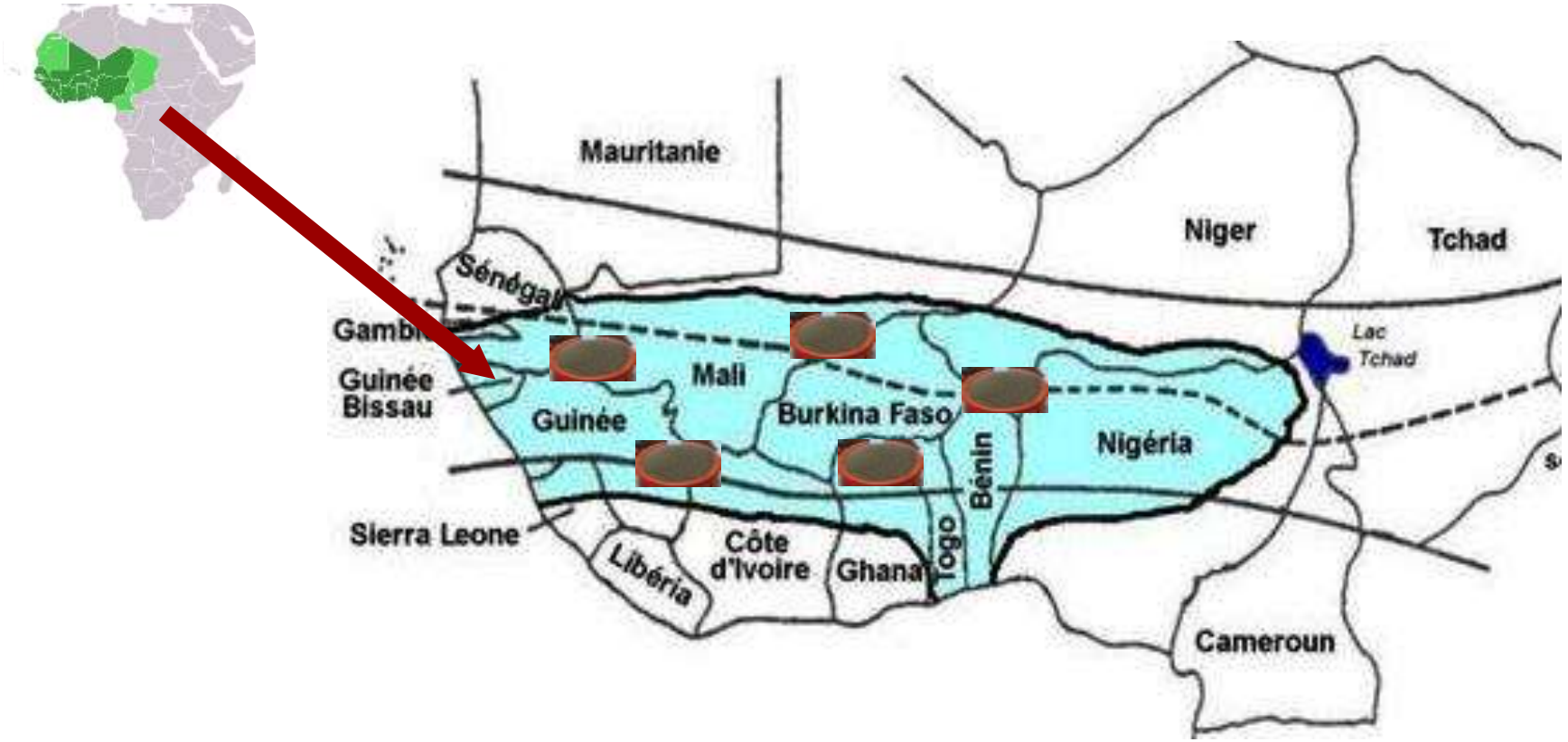
...ready for harvesting

Smallest size

Washed fonio

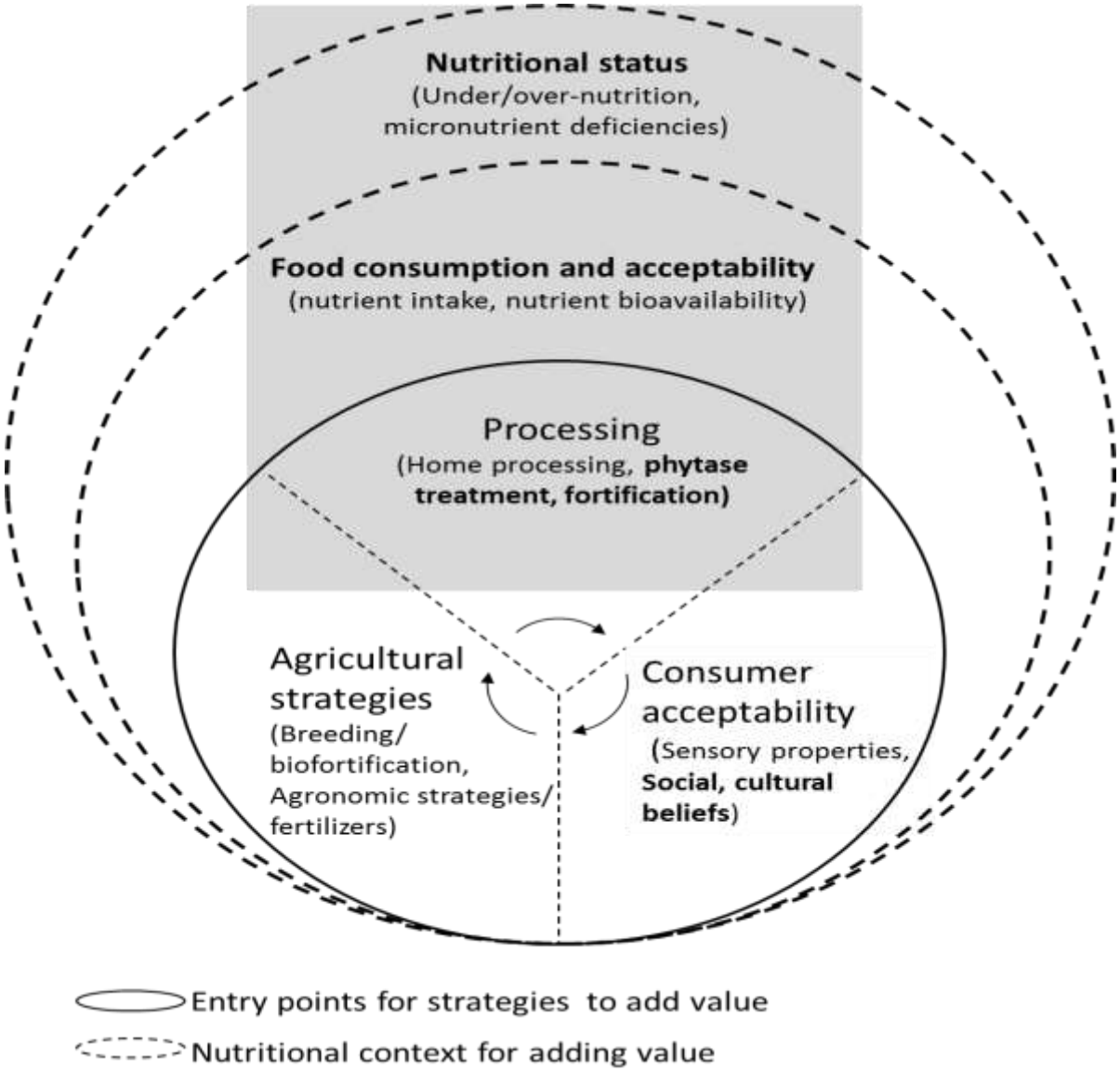
Whole grains

Main staple grain in West Africa

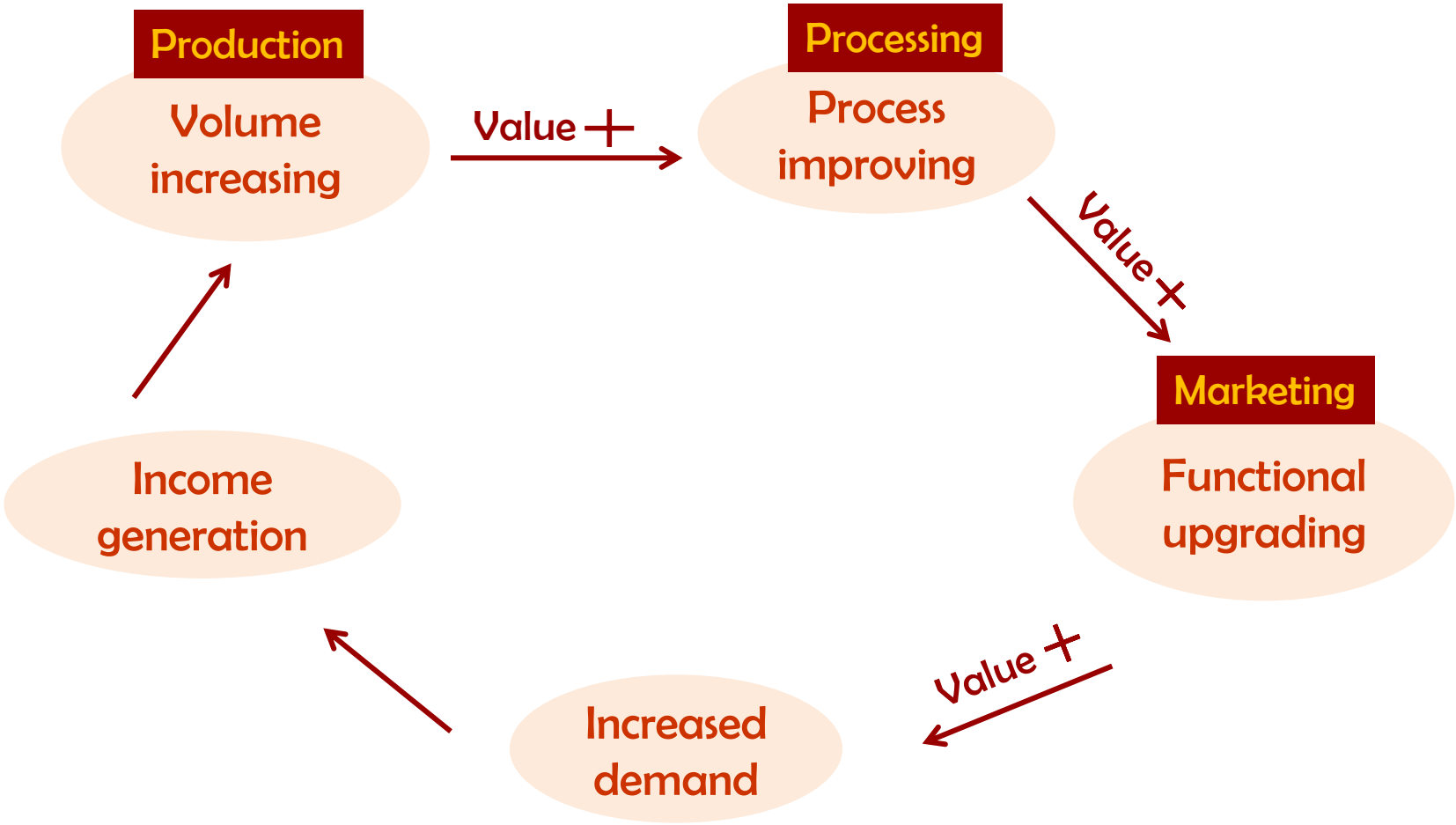


- Especially during food shortages
- Potential contribution to nutrition/health

Conceptual framework for adding value to a product: the value chain approach for nutritional goals



The value chain approach



- Adding value to a product for increasing economic value

Fonio in the value chain for nutrition

Healthy consumer with improved nutritional status

Increased availability and intake of nutritious food

- Nutritional issues
  - Iron deficiency
  - Overweight/obesity
  - Low and inadequate intake

Improved processing

- Nutritive value
- Home processing

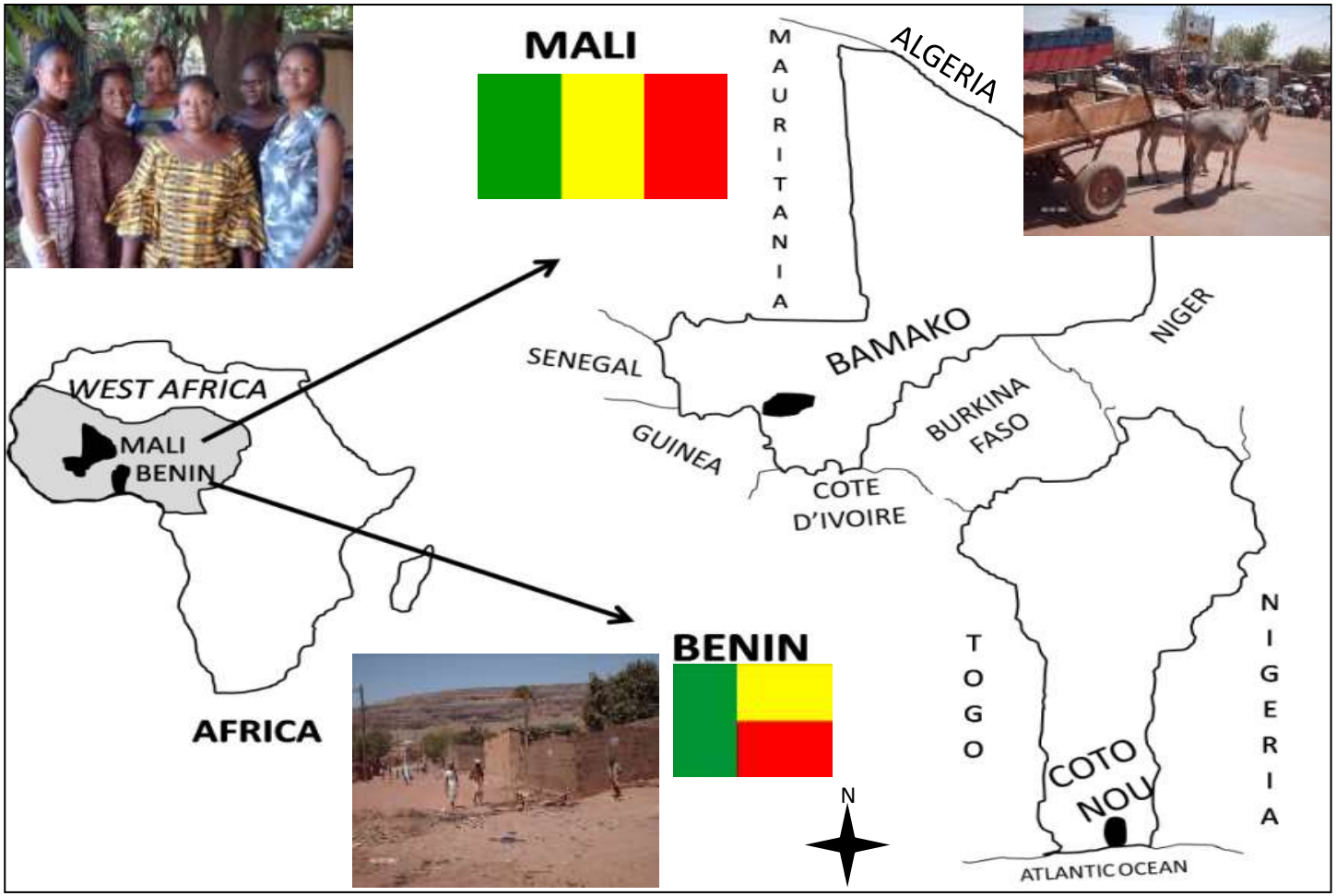
Improved Agricultural strategies

Improved consumer acceptability

- Socio-cultural acceptability

Study area and target

- West African women (15 – 45 y-old)



Objectives

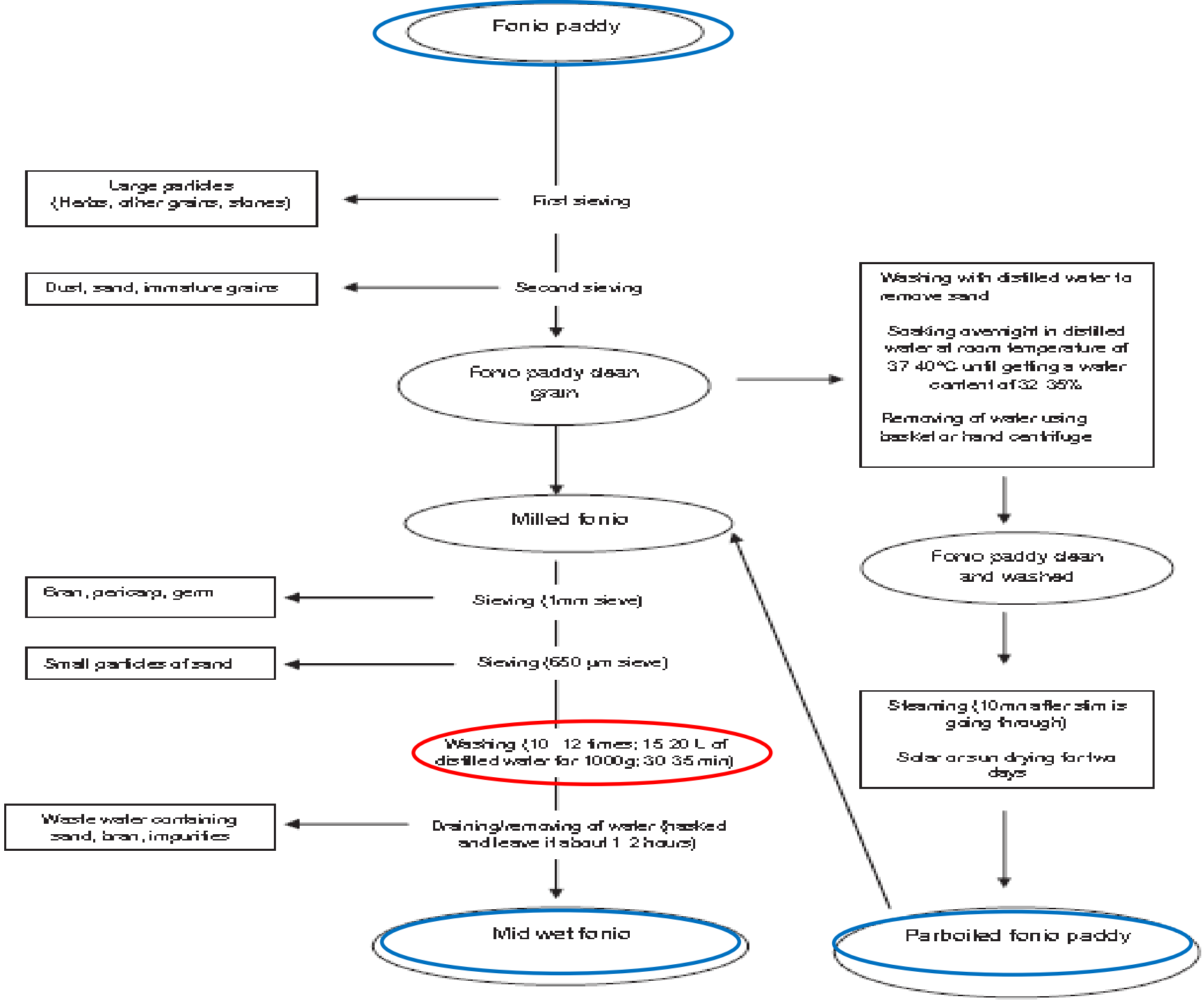
- To determine the nutritive value of fonio and fonio products and its contribution to nutrient intake and nutrition status
  - Nutritional value of different fonio varieties, milled fonio and diverse fonio products
  - Socio-cultural acceptability of fonio
  - Contribution of fonio to nutrient intake and nutrition status
  - Bioavailability of iron from fonio-based diets

Nutritional value

- Assess the genetic diversity of fonio landraces in Mali,
- Determine the nutrient and phytate content in fonio products
- Assess the effect of processing on nutrient content of fonio products

Procedures

- 12 fonio landraces 10 kg/farmer/landrace in paddy form
- Collected from farmers in central and southern regions of Mali (Segou and Sikasso regions)
- Grains cleaned and processed into paddy, mid wet, cooked and parboiled fonio
- Proximate and nutrient composition using the standard AOAC methods
- Genetic diversity with Amplified Fragment Length Polymorphisms (AFLPs) method


Fonio paddy
Large particles (Herbs, other grains, stones)
First sieving
Dust, sand, immature grains
Second sieving
Fonio paddy clean grain
Washing with distilled water to remove sand
Soaking overnight in distilled water at room temperature of 37 40°C until getting a water content of 32 36%
Removing of water using basket or hand centrifuge
Milled fonio
Fonio paddy clean and washed
Bran, pericarp, germ
Sieving (1mm sieve)
Small particles of sand
Sieving (650 µm sieve)
Steaming (10 min after rice is going through)
Solar or sun drying for two days
Washing (10 12 times; 15 20 L of distilled water for 1000g; 30 35 min)
Waste water containing sand, bran, impurities
Draining/removing of water (basked and leave it about 1 2 hours)
Mid wet fonio
Parboiled fonio paddy

Nutritive value

- Mean iron, zinc and phytate concentrations in paddy were 34.6 mg/100 g, 3.2 mg/100 g and 513.7 mg/100 g dry weight
- Processing reduced significantly iron, zinc and phytate content to 1.3 mg/100 g, 2.2 mg/100g and 129.2 mg/100 g dry weight
- [Phytate]/[iron] molar ratio in processed products was above the critical value of 1, suggesting poor iron absorption
- Parboiling did not reduce iron and zinc losses due to processing

Nutritive value

Cultivars	Fer (mg/100g m.s)	Zinc (mg/100g m.s)
Diéni	-	-
Kassangara	29.6	3.0
Finiba	52. 8	2.9
Finiba / Kassangara	29.8	3.1
Peazo1	28.2	3.4
Péazo2	41.8	3.2
Tama	29.1	3.0
Tamatioi	14.5	3.3
Tamabé	57.3	3.2
Tioi	17.3	3.1
Pétama	25.8	3.5
Pèyè	55.0	3.6
Moyenne ± SD	34.6 ± 14.2 (n=34)	3.2 ± 0.8 (n=34)

Nutrition and iron status

- Height / weight measurement and **blood samples collection in Mali**



- 19% (9%) overweight (obesity)
- 35% anemia and 25% iron deficiency

Iron and micronutrients intake

- Food consumption survey in Mali

- Mean iron intake of 16.1±8.8 mg/day
- 46% women with inadequate intake of iron
- 53% with inadequate intake of micronutrients

Food availability on markets

Food groups	Foods
Cereals	Wheat, maize, rice, millet, sorghum, fonio
Starchy roots and tubers	Potato, sweet potato, cassava, yam (white and yellow), plantain
Legumes/ nuts/seeds	Cashew nuts, groundnut, bambara groundnut (white and red), coconut, cocoa, African locust bean seeds, cowpea (white and red), Hibiscus seed, green peas, baobab seeds, tamarind seeds
Fruits and sweeties	Orange, lemon (yellow and green), tangerine, avocado, Pineapple, melon, Pear, Liana fruit, apple (green, yellow and red), Papaya, plum (yellow and red), nectarine, grape fruit (red and green), dates, banana (yellow and green), Mango, shea fruit, sugar powder, Chocolate, Honey, guinea sorrel juice, orange juice, soft drinks,

Food availability on markets

Food groups	Foods
Vegetables	Cucumber, tomato (fruit and paste concentrated), okra, onion, shallot, shallot leaves, Hot pepper, sweet pepper green, Egg plant, Bitter tomato, cabbage, lettuce, Parsley leaves, Turnip, Carrot, Beet root, french bean, baobab leaves, Hibiscus leaves, Green leaves,
Meat/poultry	Beef, veal, goat, lamb, pork, chicken, Duck
Fish and fisheries	carp (red and grey), pink trout, grouper, sardine, catfish, threadfin, shrimp, freshwater fish, sea crab, gamba
Dairy/eggs	cow milk, yoghourt, cheese, chicken eggs
Oil and fats	sunflower oil, olive oil, palm oil (white and red), peanut oil, soya oil, butter, Shea butter,
Spices	pepper grain, aniseed, garlic, curry, ginger, clove, laurel leaves, vinegar, maggi cube, mustard
Stimulants	Coffea, tea, colanut

Fonio in dietary patterns

- Availability, consumption forms and food attributes study in Mali




- Consumed 1-3 times per month by 68% of women
- As snack (working days), or main dish (weekend days)
- Average daily portion of 152 g/day.

Fonio in dietary patterns

- Most common fonio products available in supermarkets
  - Dried precooked fonio,
  - Djouka
  - Dèguè (mixture of fonio and curdled milk).
- Most common fonio products served in restaurants,
  - foyo accompanied with various sauces
  - Djouka
- Most common fonio products consumed at home,
  - foyo accompanied with various sauces

Main fonio dishes

- Fôyô:
  - Couscous de fonio
  - Consommé avec sauce oignon, sauce tomate, sauce pâte d'arachide

- Djouka:
  - Couscous de fonio melangé avec poudre arachide et legumes

- Fini zamè:
  - Préparé comme le riz au gras

Frequency of consuming fonio among women in Bamako

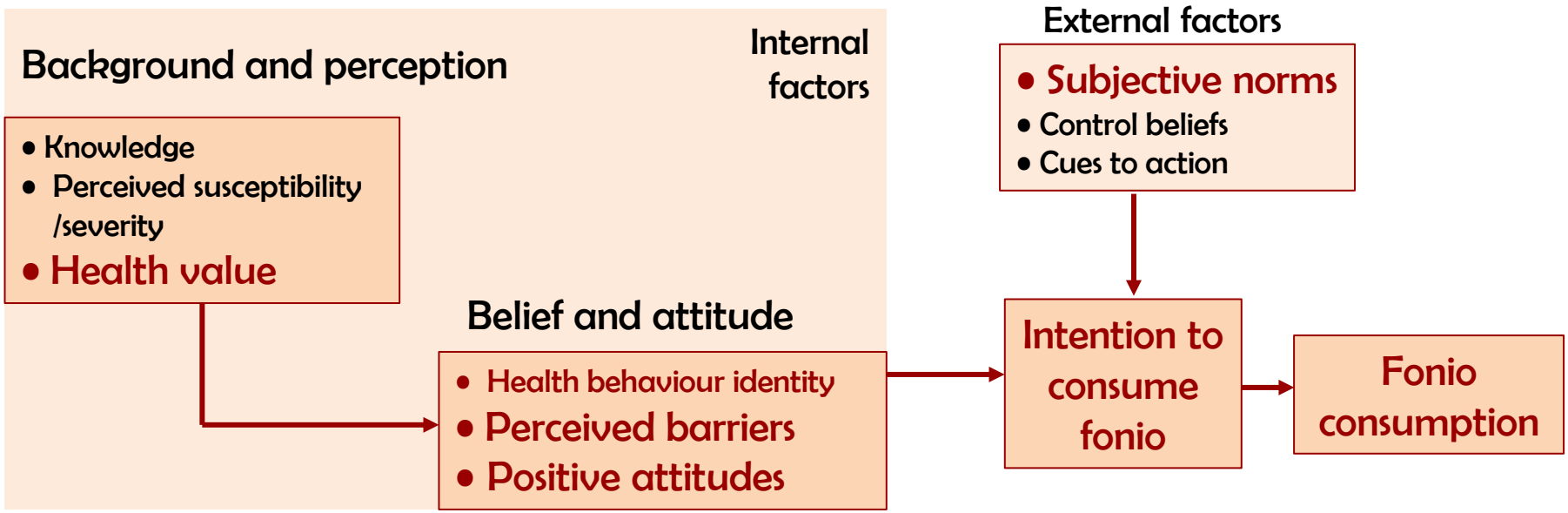
	Times / month									
	1	2	3	4	5	6	8	10	13	Total
Number of women consuming all fonio dishes	31	12	7	6	3	6	2	4	2	73
	Number of women consuming by dish									Total
Djouka fonio	14	5	4	4	3	3	2	3	2	40
Foyo	15	6	3	2	0	3	0	1	0	30
Fini zamé	2	1	0	0	0	0	0	0	0	3
Days of consumption	Number of women									
	Working days			Weekend days			Event days			Total
	45			19			9			73

Frequency of consuming fonio among women in Bamako

- Of the 15 fonio- based dishes, djouka, foyo and fini zamé (fried fonio) were eaten by 73 out of 102 women (71%)
- Among those consumers, foyo and djouka were eaten by 41% and 55%, respectively
- Among those consuming foyo and djouka, 68% reported a consumption frequency of one to three times per month.
- Few women (8%) reported consumption of more than 10 times per month
- Fonio was more frequently consumed as snack (djouka) on working days (62%) than on weekend (26%) and special event (baptism and wedding) days (13%)

Socio cultural acceptability of fonio

- Factors influencing fonio consumption with behavioural model in Mali



- Positive attitudes about fonio
- Weak skills of women in processing fonio
- Household's heads, family and neighbors' opinions

Beliefs about fonio consumption

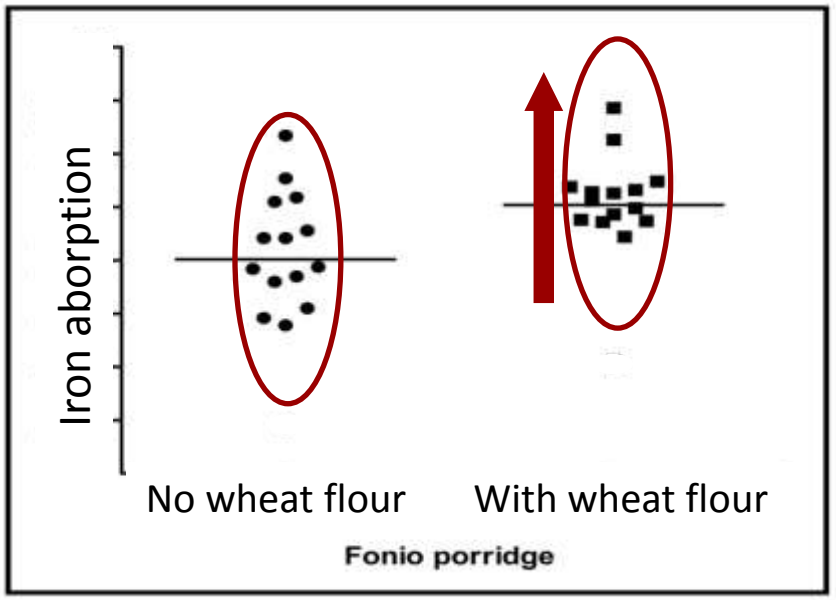
Topic	Questions	Percent
Knowledge	Fonio is important to treat diabetes	88
	Fonio can prevent anaemia	70.4
	Fonio contains iron	64.8
Outcomes from fonio consumption	Eating fonio is good for my household members	95.4
	Eating fonio is good for me	94.4
Fonio attributes	Fonio has good taste, swells up well during cooking, is pleasant in mouth	99.6
	Fonio is a traditional food and diversifies meals	94.5
	Fonio stimulates appetite, easy digestible, nutritious, healthy, good for weight loosing	92.8
	Eating fonio helps to treat diseases and to prevent stomach problems	91.2
Perceived barriers	Fonio not available throughout the year	76.9

Beliefs about fonio consumption

Topic	Questions	Percent
Information source, people and factors enhancing fonio consumption	The media favourably affect decision to eat fonio	93.5
	Nurse, social workers, favourably affect decision to eat fonio	93.5
	Fonio consumed mostly during important ceremonies, like weddings, funerals or baptism	92.1
	Household members suffering from anaemia favourably affect decision to buy fonio	90.8
	Friends, members of my association, neighbours favourably affect decision to eat fonio	85.8
	People around me buying fonio makes me want to eat fonio	85.2
	Husband, household members, mother-in-law favourably affect decision to eat fonio	83.9
	A shortage of food favourably affects decision to eat fonio	81.5
	Fonio sellers favourably affect decision to buy fonio	79.7
	Fonio consumed mostly in restaurants and when guests in household	74.1
Subjective	Fonio is for rich people	58.3

Home processing to add value

- Phytate degradation with wheat flour in fonio porridge
- Iron fortification of low-phytate fonio porridges



- Increased iron absorption from low-phytate fonio porridges

Implications for public health issues

- Fonio *could be*...

... appropriate for improving iron status through iron fortification

Implications and future research

- Investigate the feasability of phytate degradation with native wheat phytase

Implications and future research

- Assess the impact of value-added fonio products on fonio smallholders' income and livelihoods

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