Arua Scenario Analysis

KB Rural Areas in East Africa

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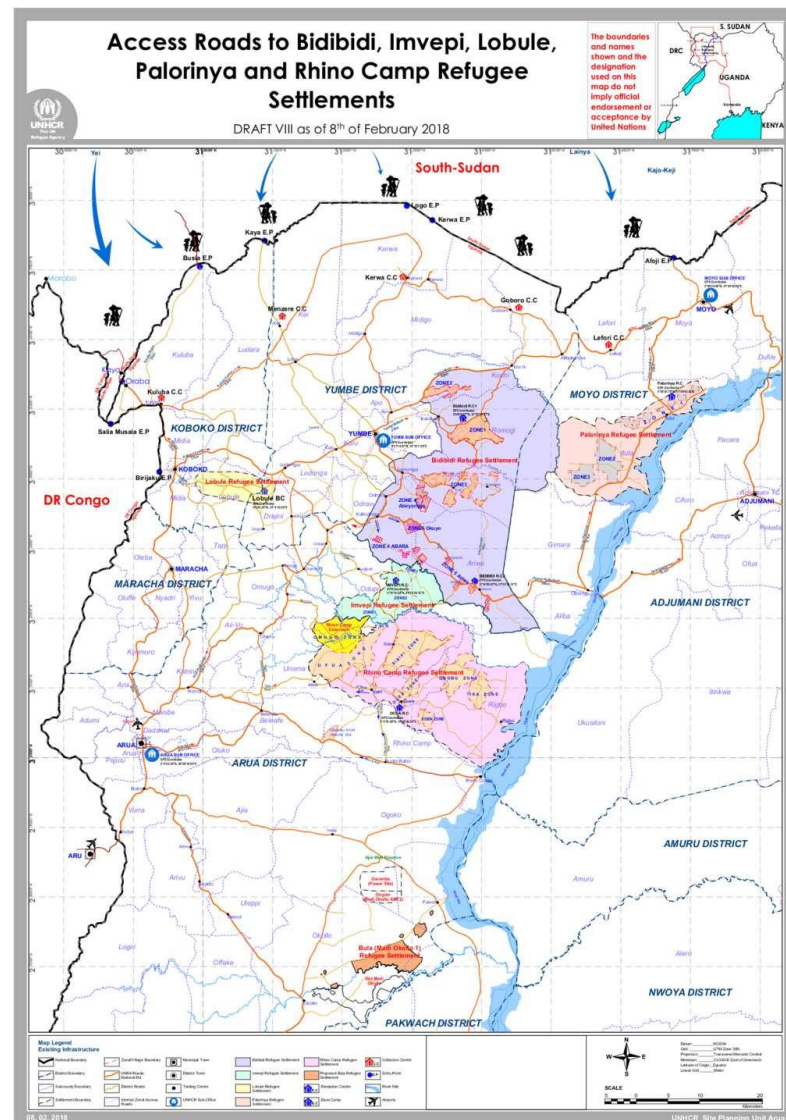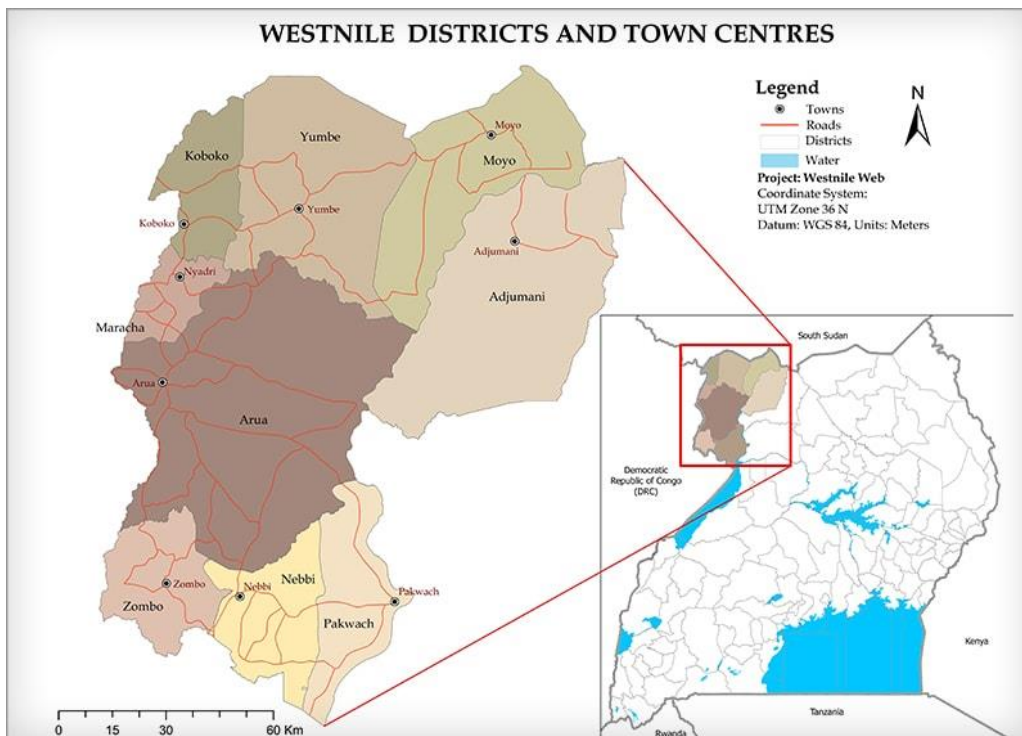Fatima Pereira da Silva
Henk Wösten

Outline

1. (Re)Introduction to Arua

2. Conceptual Scenario Analysis

3. Business as Usual

4. Optimization Model

5. Implementation of Scenario Analysis

Arua District

- District in the West Nile area. Rural with a small city.
- Refugee settlements from DRC and South Sudan
- Population: 867000 hosts & 271000 refugees

WESTNILE DISTRICTS AND TOWN CENTRES

Access Roads to Bidibidi, Imvepi, Lobule, Palorinya and Rhino Camp Refugee Settlements

DRAFT VIII as of 8th of February 2018

Qualitative Food System Analysis

1. Self-sufficiency agriculture lacking value chains
    1. Exception: tobacco (and sesame)
    2. Root and tuber dominated systems with minor role for cereals and livestock (also in diet)
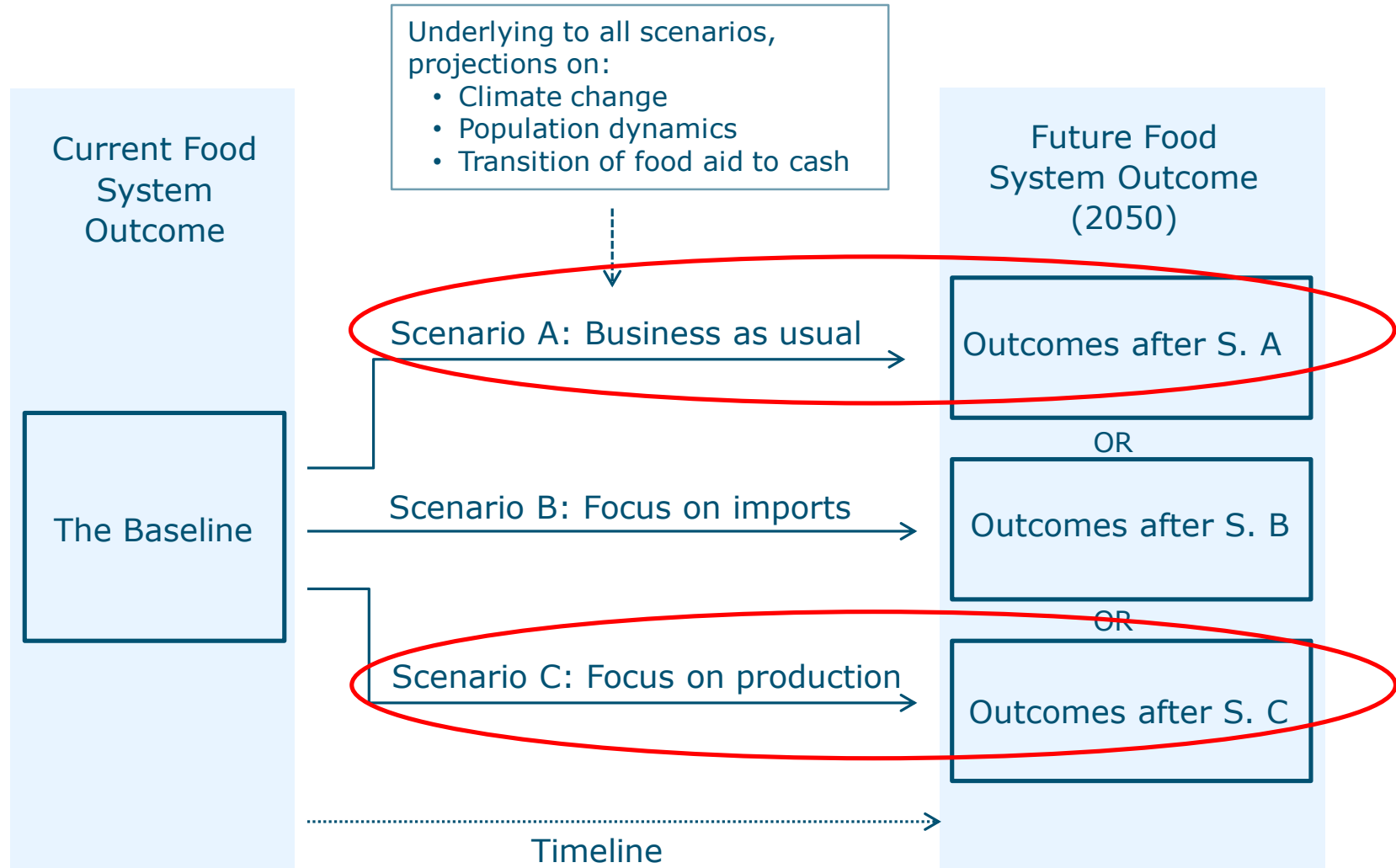2. Low input and soil nutrient depleting systems
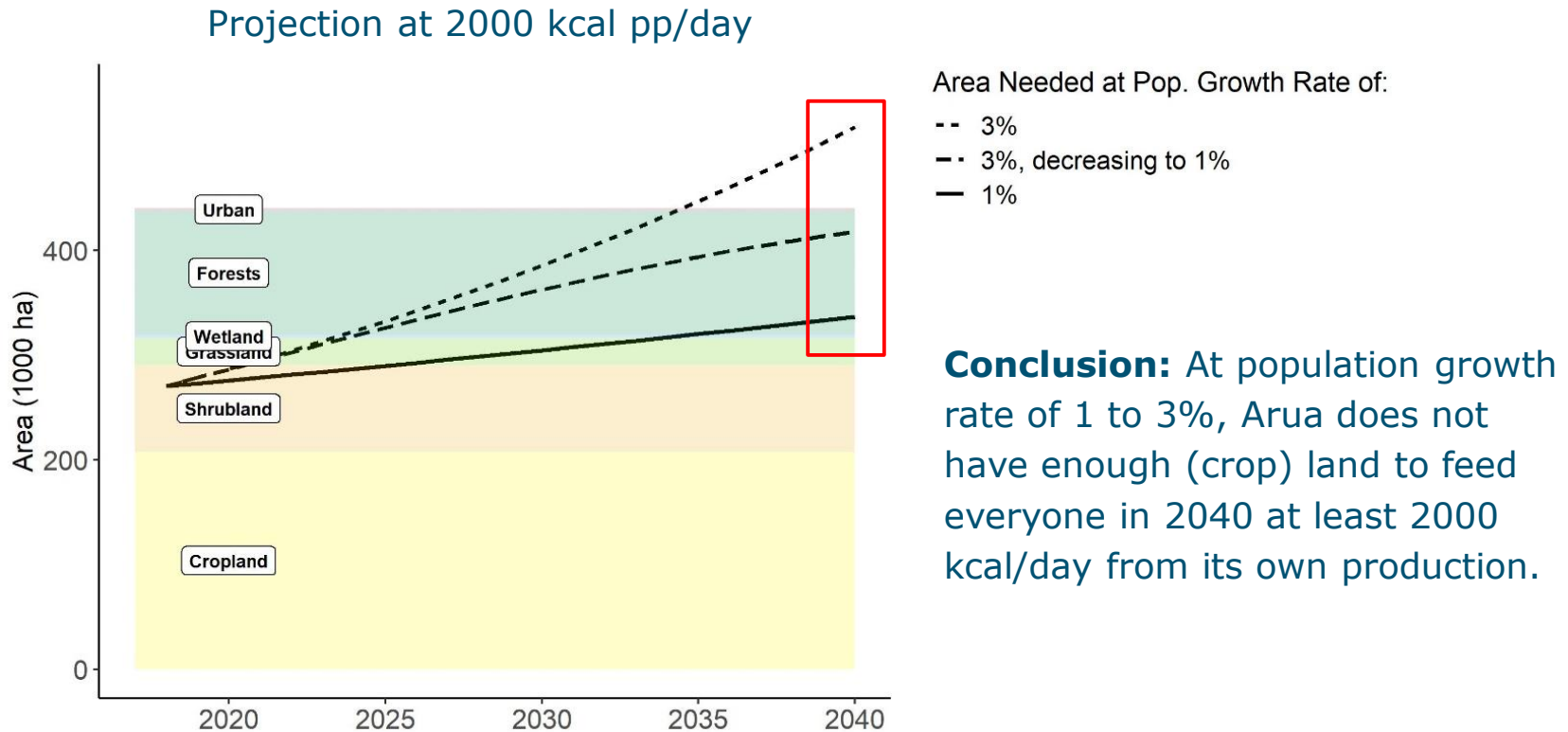
Qualitative Food System Analysis - Continued

1. Diet dominated by carbohydrates
2. Both host and refugee settlements seem food insecure
3. Refugee settlement well organized, little conflict
4. Agricultural options for refugees more limited because of poor soils
5. Institutional ignorance: poorly developed and organized enabling environment
6. Future changes: Food aid to become cash aid

Scenario Analysis

Current Food System Outcome

Underlying to all scenarios, projections on:
- Climate change
- Population dynamics
- Transition of food aid to cash

Future Food System Outcome (2050)

The Baseline

Scenario A: Business as usual → Outcomes after S. A

OR

Scenario B: Focus on imports → Outcomes after S. B

OR

Scenario C: Focus on production → Outcomes after S. C

Timeline

Scenario A: Business as Usual

Projection at 2000 kcal pp/day

Area Needed at Pop. Growth Rate of:

- -- 3%
- -·- 3%, decreasing to 1%
- — 1%

Conclusion: At population growth rate of 1 to 3%, Arua does not have enough (crop) land to feed everyone in 2040 at least 2000 kcal/day from its own production.

1. What would be the **minimum area** needed to meet healthy-diet-requirements, given the **current food system** characteristics?
2. What would be the **minimum area** needed, given an **improved food system**?

We are answering this with an OPTIMIZATION MODEL

Questions to Answer

Objective Function:

- What is the **minimum area** needed for food production?

Decision Variables:

- What area is needed of each crop?

- How many livestock units of each type need to be kept?

- How much should people eat of each product?

- What and how much should the livestock be fed (crop residues, food products, or waste products)?

Outcome Requirements: (Constraints)

Requirements for a healthy diet:

- ❑ **Nutrients:** Min intake of calories, proteins, Iron, and vitamin A
- ❑ **Food Groups:** Min & Max intake

If keeping livestock, they also have dietary requirements:

- ❑ **Dry Matter**: min intake & min from fibre source
- ❑ **Nutrients:** min & max intake of energy & protein

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What We Know: (Parameters)

- Available crop & livestock types

- Yield of each crop

- Yield of each livestock type

- Nutrient contents for humans

- Nutrient contents for livestock

- Harvest Indexes

- Edible Fractions

- Losses in supply chain

- Population composition (gender & age)

- Population growth rate (assumption)

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Product Flows
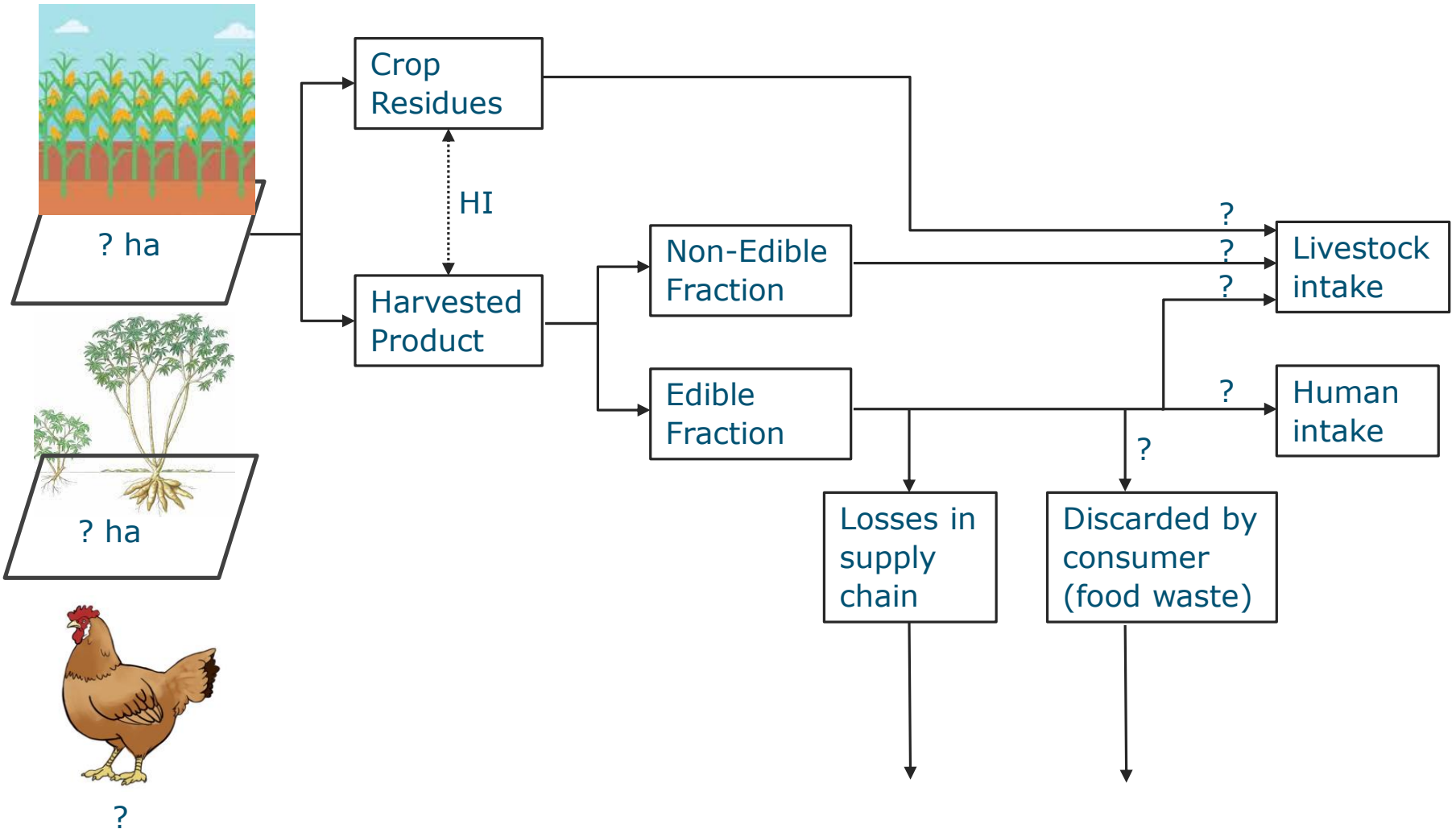
(Pilot) Model Results - Production

For Population = 1 person

Crop	Area (ha)
Maize	
Rice	0.07
Cassava	0.15
Potato	
Mango	
Banana	0.14
Beans	
Chickpeas	
Sesame	0.07
Groundnuts	
Tomato	0.11
Cabbage	
Grassland	
Total	**0.54**

Livestock Type	Nr.of Animals
Cows (dairy)	
Cows (beef)	
Goats	0.3
Chicken	6

Scenarios: Parameter changes

Assume: Scenario

- Available crop & livestock types ⟶ New crops   Diversification

- Yield of each crop ⟶ 50% higher ⎤
                                    ⎬ Intensification
- Yield of each livestock type ⟶ 50% higher ⎦

- Nutrient contents for humans

- Nutrient contents for livestock

- Harvest Indexes

- Edible Fractions

- Losses in supply chain ⟶ 30% lower   Supply Chain Improvement

- Population composition

- Population growth rate

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Pilot Model Results – Current population

Current Diet
(with Food Aid)

Crop	Area (ha)
Maize	0
Rice	39,413
Cassava	86,801
Potato	0
Mango	2,594
Banana	0
Beans	27,202
Chickpeas	0
Sesame	45,655
Groundnuts	0
Tomato	0
Cabbage	0
Grassland	0
Total	**201,665**
Difference	5,209

Arua Crop
Area:
206,874 ha

Other Objectives

- Currently: What is the **minimum area** necessary for a healthy diet?

- Plans 2021: What is the area needed for a healthy diet if we want to:

  - Minimize GHG emissions

  - Minimize production costs

  - Minimize soil mining

  - …

- With this model we can find the extremes → the outlines of what is possible.

- Real life will always be somewhere in between

Multi-Criteria Analysis

- We use this method to look at the options in between the extremes

- **Together with stakeholders,** sketch a few options, and then calculate outcome. Ex:

If..	Then	Requirements met?
5 ha maize 7 ha cassava 30 chickens	225 g cereals pppd 400 g tubers pppd 1.5 egg pppd	Yes
Yields Maize: 5 ton/ha Cassava: 20 ton/ha	**Land use** = 12 ha **Production costs** = \$1/kcal **GHG** = 8 ton CO_2/year	

- With stakeholders, assign importance to each indicator, and choose the best option of those that were sketched

Plans for 2021

- Model development

  - Model Crop-Animal-Soil nutrient cycles

  - Model Production costs

  - Model District Imports (?)

- Scenario definitions & Indicator selection

- Multi-Criteria Analysis: Scenario development with stakeholders

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Thank You!

Human Nutrient Intake Requirement

Gender: Female

Age	Pop. size	Calories	Proteins (g/d)	Iron (mg/d)	Vitamin A (mcg/d)
0 – 9	960631	1273	13	6	250
10 – 19	1432767	2269	32	4	512
20 – 39	1601936	2376	35	7	570
40 – 59	629062	2305	35	7	570
60<	221044	2102	38	6	570

Use population size of all gender-age groups & their requirements to find the **total pop. requirement**

Food Group Intake Requirements

#	FAO Food group	EAT-Lancet Diet Categories	EAT-Lancet Diet Amounts (g)	LSMS Arua Production data
1	Cereals	Rice, wheat, corn, & other	230	Finger millet, maize, rice, sorghum
2	White roots & tubers	Potatoes & cassava	50 (0 – 100)	Plantain, cassava, potato, yam
3	Vegetables:		300 (200 – 600)	
	Vit.A rich vegetables & tubers	Red & orange vegetables	100	Sweet potato, tomato
	Dark green leafy vegetables	Dark green vegetables	100	Dodo, sweet potato leaves (?), pumpkin leaves (?), cassava leaves (?)
	Other vegetables	Other vegetables	100	Cabbage, eggplant, onion
4	Vit.A rich fruits + Other fruits	All fruits	200 (100 – 300)	Avocado, mango, banana
5	Legumes, nuts & seeds	Legumes + Tree nuts + Seeds	125 (0 – 250)	Bean, chick pea, cow pea, field pea, groundnut, pigeon pea, soy bean
6	Oils, fat & butter	Palm oil + Unsaturated oil + Lard or tallow	52 (20 – 92)	Sesame
7	Meat	Beef & lamb + Pork + Chicken & other poultry	43 (0 – 86)	Bovine meat, pig meat, poultry
8	Eggs	Eggs	13 (0 - 25)	Egg
9	Milk & milk products	Milk and derivatives	250 (0 - 500)	Milk
10	Fish & seafood	Fish	28 (0 – 100)	-
11	Sweets	All sweeteners	31 (0 - 31)	Sugarcane

Animal Nutrient Intake Requirement

	Body Weight (kg)	Dry Matter (kg/d)	Energy (MjME/d)	Protein (kg/d)
Dairy cow	400	10.00	64	1.50
Beef cattle	250	6.25	40	0.75
Goat	30	0.75	8	0.06
Chicken	1.3	12	0.9	0.02

(Pilot) Model Results - Diet

Food Group	Min	Intake (g/p/d)	Max
Cereals	230	230	230
Tubers	0	100	100
Fruits	100	216	300
Legumes	0	0	250
Vegetables	200	600	600
Oils	20	88	92
Dairy	0	0	500
Meat	0	14	86
Eggs	0	25	25

Nutrient	Intake	Min Intake	Unit (/p/d)
Calories	2141	2141	kcal
Protein	58	29	g
Iron	23	6	mg
Vitamin A	425	425	mcg

Chicken

Nutrient	Intake	Min Intake	Unit (/a/y)
Dry Matter	49	12	kg
Energy	437	336	MEMj
Protein	8	8	kg

Goats

Nutrient	Intake	Min Intake	Unit (/a/y)
Dry Matter	570	274	kg
Energy	6442	6442	MEMj
Protein	22	22	kg

Process overview: Multi-Disciplinary Research