Applying geo-spatial information for integrating crop, food, and nutrition for a healthier food system in rural Ethiopia

PhD Qualifier

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Outline

- Background
- Problem and research gaps
- Conceptual framework
- Research objective
- Methodology
- Expected outcomes

Background

- Globally (FAO, 2018; GLOP, 2016) :

  1 out of nine people undernourished
  2 Billion lacking vital micronutrients (e.g., iron, zinc, vitamin A)
  3 Billion people having low-quality diets

- Access to food and healthy diets still remains a major concern in developing countries.
- Majority of undernourished people are smallholder farmers living in rural areas
- '*How smallholder agriculture can be made more responsive to improve nutrition*' is crucial.
- Nutrition is not well integrated in the assessment of food system.

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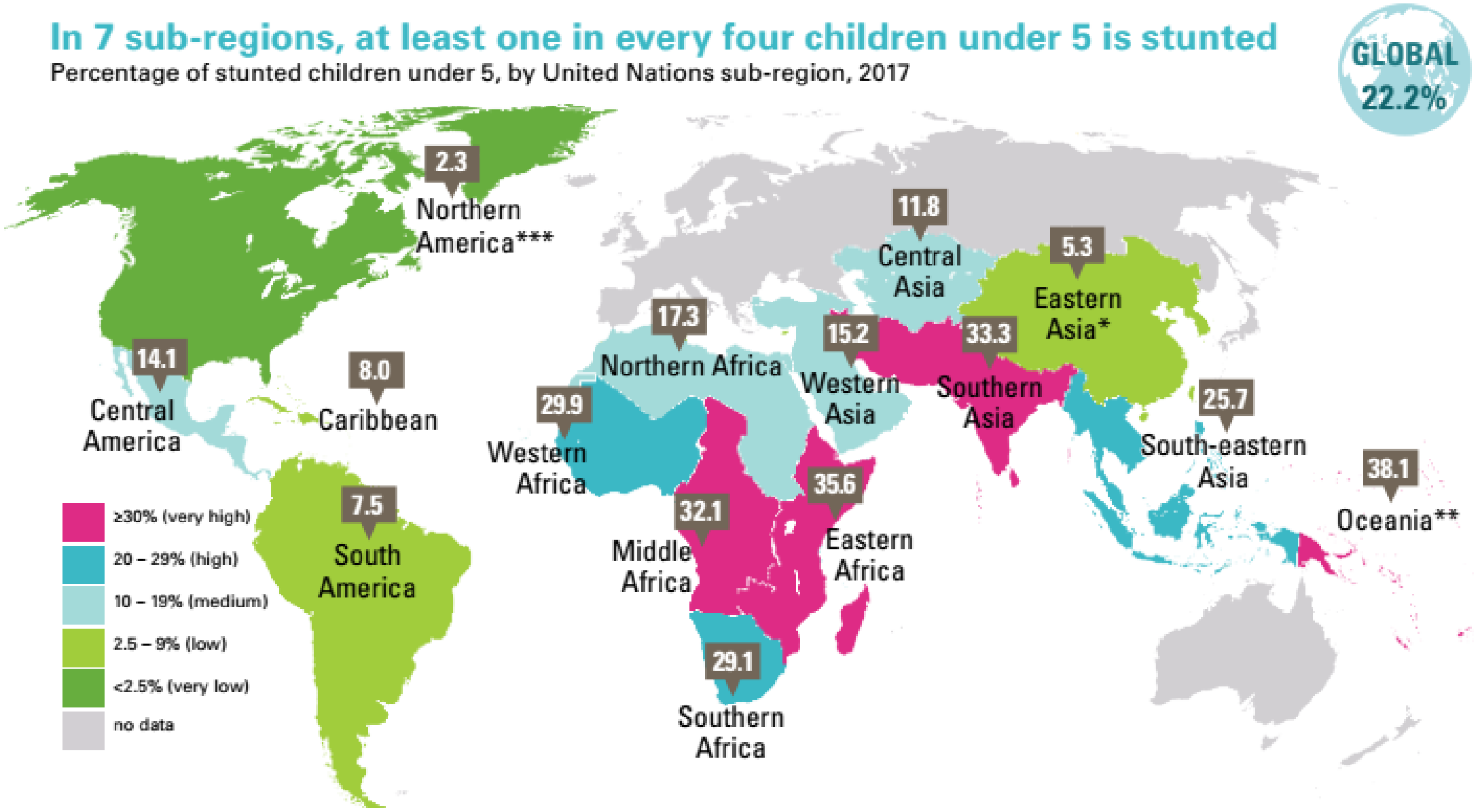


Global prevalence of stunting (low height-for-age)

UNICEF, WHO, World Bank Group joint malnutrition estimates, 2018 edition

Background Cont'd

- SDG – 2: End hunger and all forms of malnutrition by 2030

Undernutrition
Overnutrition
Micronutrient deficiency

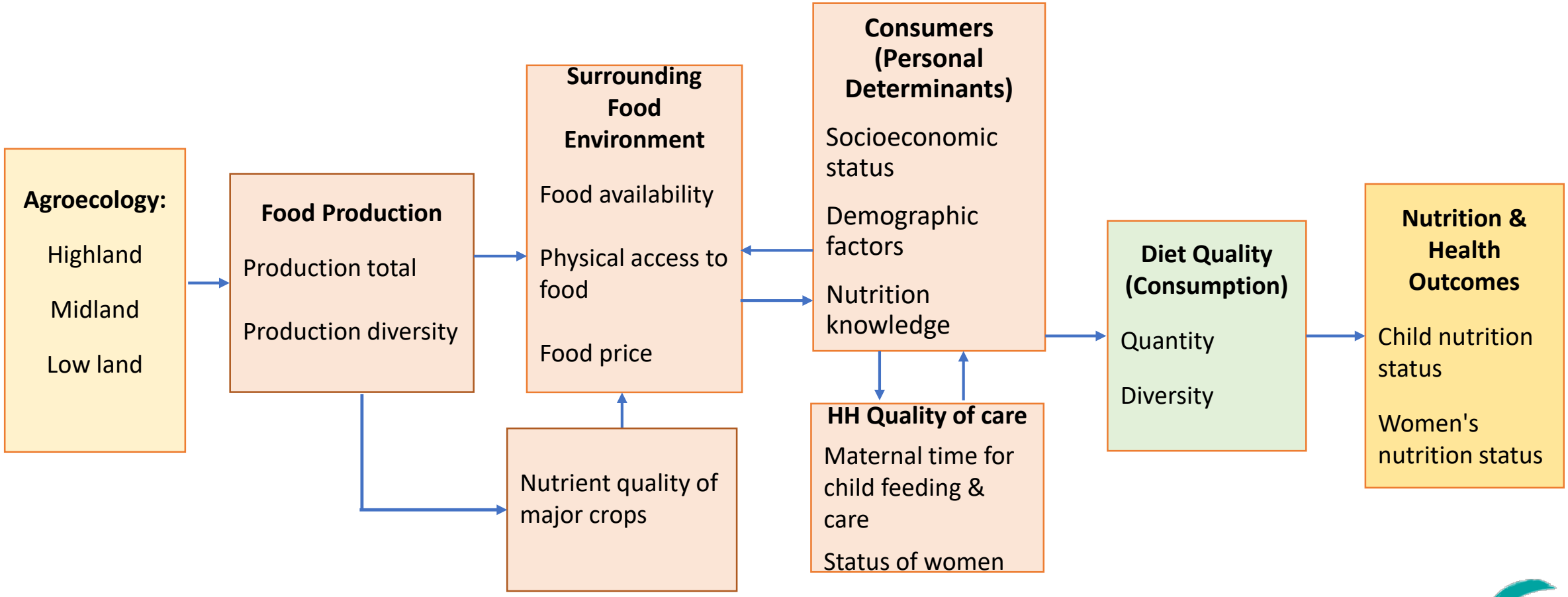
Quality Diet:
Adequacy
Diversity
Safety

- Evaluating the existing food system from production to consumption through the lens of diet quality is crucial.

Problem and research gaps

- Ethiopia has a diverse agroecology; however, dietary patterns and gaps have not yet been studied to this heterogeneity.
- To achieve a healthy food systems evaluating nutrients provided by major food crops is important but updated data are missing.
- Relationship between farm production diversity and dietary diversity is context specific and existing studies present varying findings.
- Prevalence undernutrition varies among regions; however, the spatial distribution is remains to be studied.

Conceptual Framework:



HH: Household

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General objective:
To assess diet quality from food production to consumption
& evaluate the outcome of the existing food system through assessing nutrition status of women & children

Remote sensing

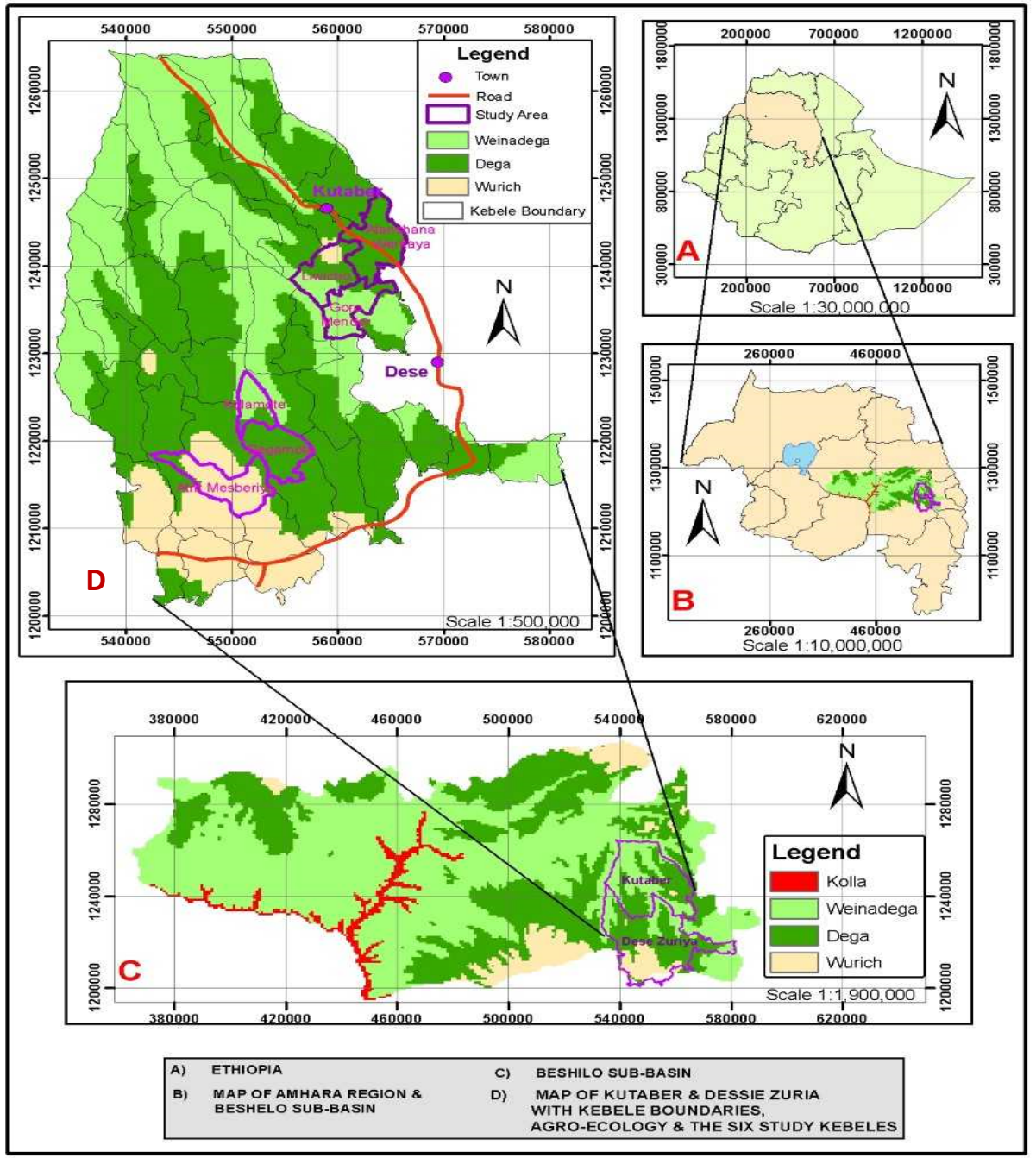
Women & Children

Field

Household

Methodology

- **Study area:** Beshelo basin in Amhara regional state, Ethiopia.
- Two districts of south Wollo zone:
  - Representing agroecology of the study area and rural villages
- **Research design:** community based cross-sectional study.
- **Study subjects:** Children & women
- **Sampling procedure:** systematic random sampling
- **Data collection:** Satellite, field, household & individual.



Specific objective-1: Combining remote sensing techniques and household survey to investigate relationship between production diversity and dietary diversity

Research Questions:

- How does remote sensing based village level estimate of production and production diversity differ along agroecologic zones?
- Is production diversity relate to dietary diversity?

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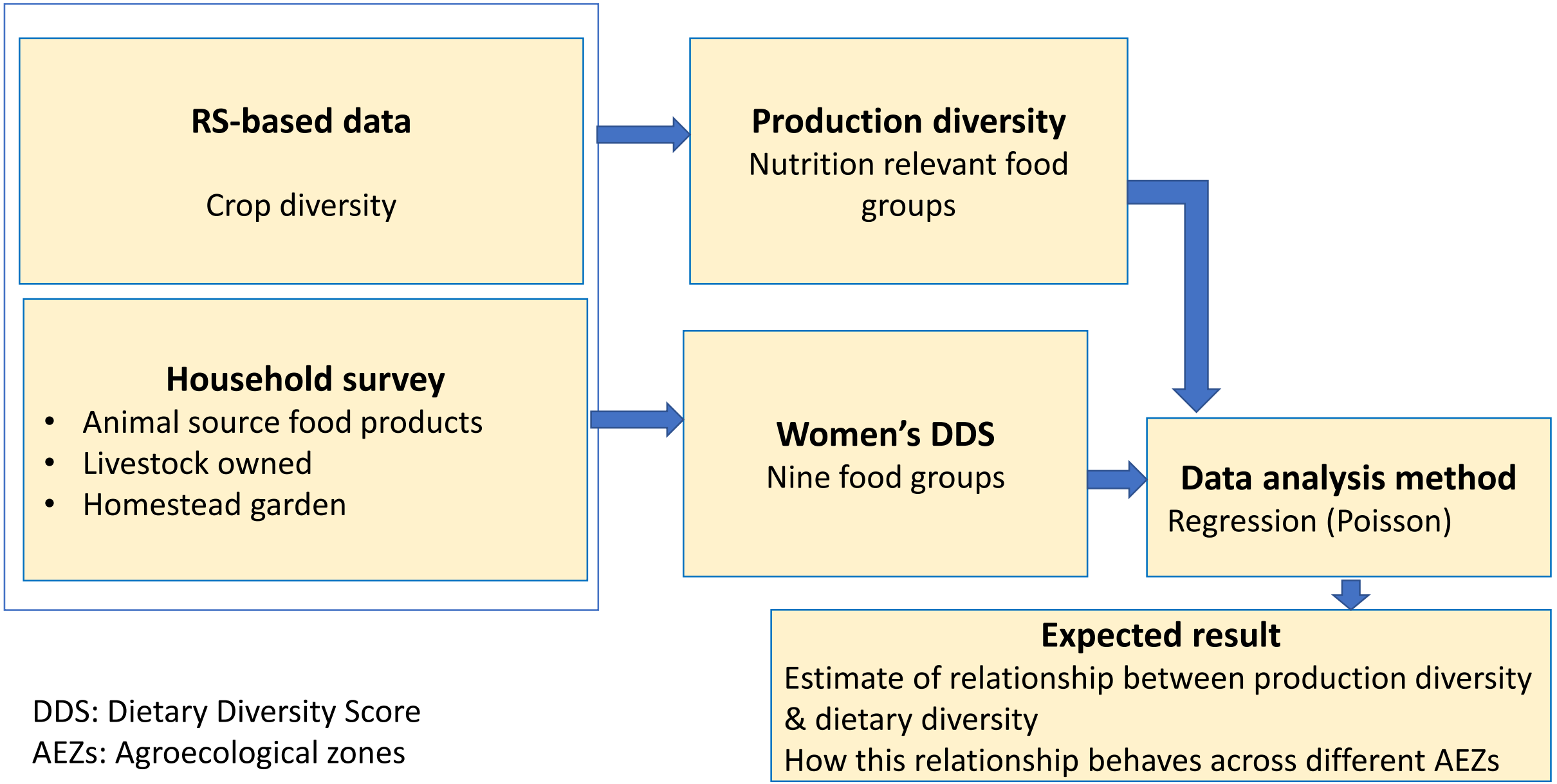
Method: Specific objective 1



DDS: Dietary Diversity Score
AEZs: Agroecological zones

Specific objective-2: Determining nutrient composition of major crops

- Appropriate dietary recommendations are derived from context-specific nutrient composition.

Research questions:

- Does nutrient composition of major crops vary between the agro-ecologic zones?
- Do estimates of relative bioavailability of major crops vary for iron, zinc and calcium?

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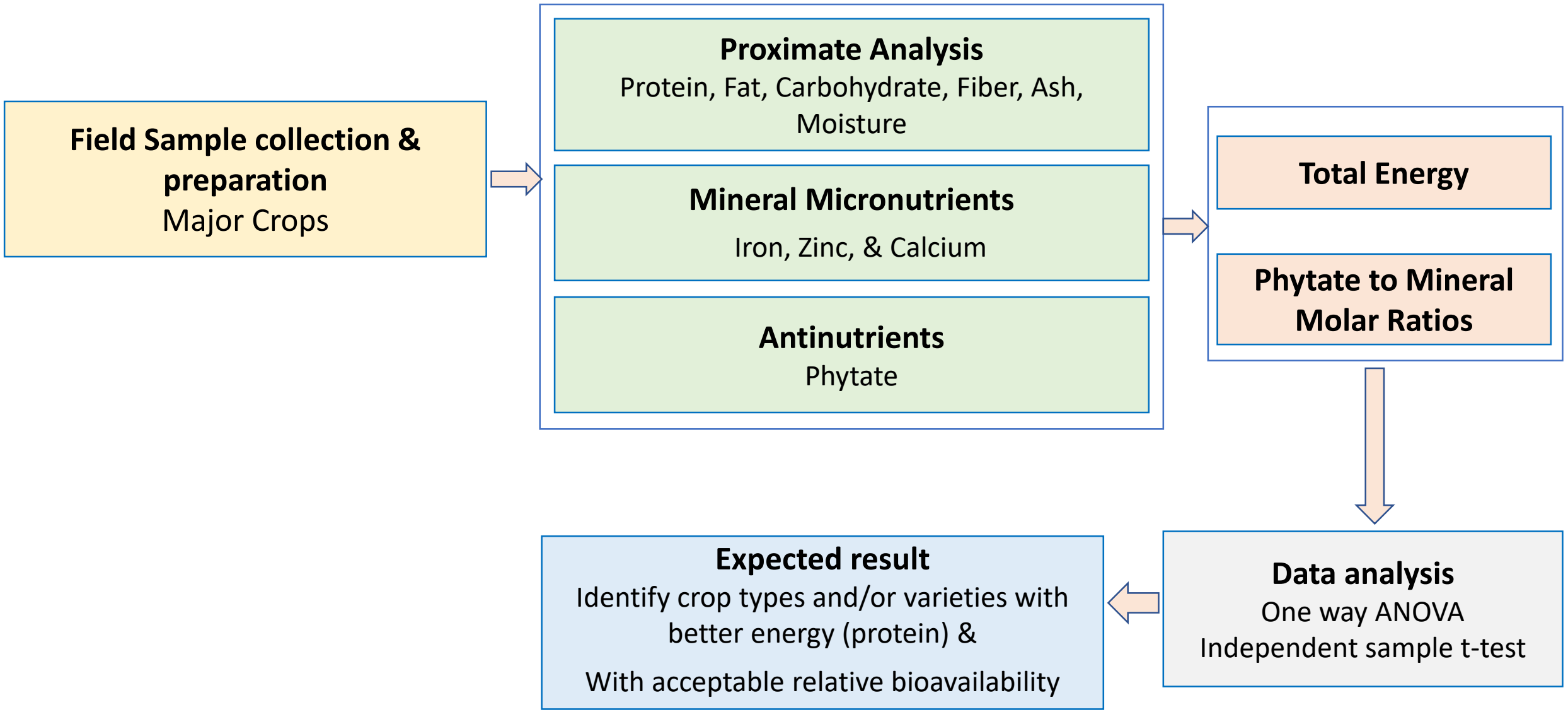
Methodology: Specific objective-2



Specific objective-3: Assessing the status of household food insecurity and intrahousehold food consumption

Research Questions:

- What is the level of household food insecurity status and adopted coping strategies?
- What is the status of household and intra-household variability in food consumption?
- What are the determinants of household food preference or choice?

Methodology : Specific objective-3

Data collection
Structured questionnaire: HH food access, coping strategy index, diversity of consumption (women & child), HH Scio-economic, demographic characteristics

Indicators
HFIAS, comparative coping strategy index, HH & individual DDS

Data analysis
Descriptive statistics, Chi-square test, Poisson regression

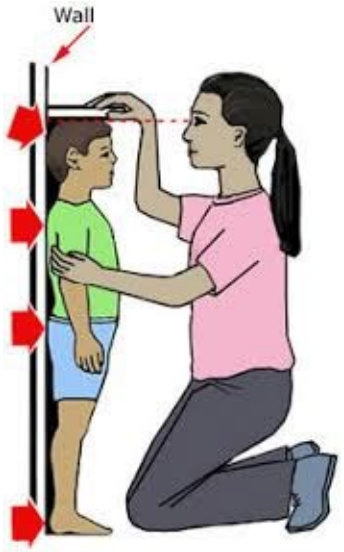
Expected result
Food security status of household, adopted coping strategy, determinants of HHDDS, variation in women and child DDS

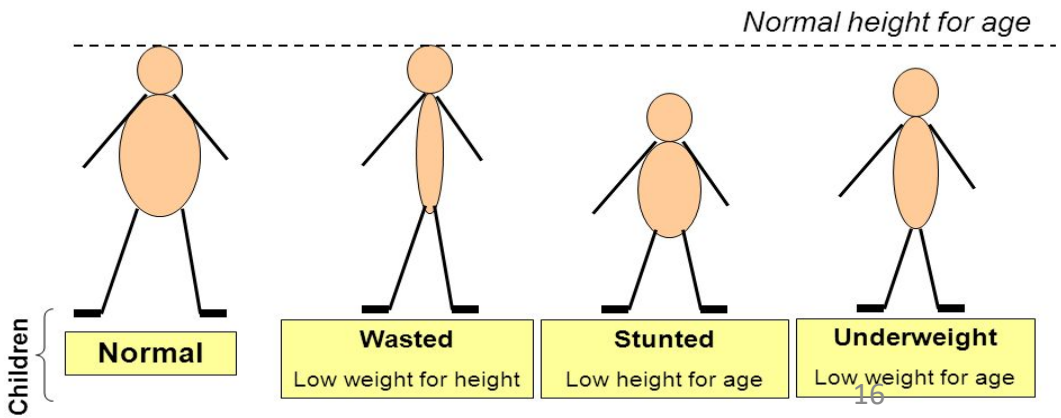
HFIAS: Household Food Insecurity Access Scale
HH: Household
DDS: Dietary Diversity Score

Specific objective-4: Evaluating diet quality through nutritional status assessment and identifying hotspot areas of malnutrition

Research questions:

- What is the prevalence of undernutrition in children and women?
- Are the distributions of children and women undernutrition spatially correlated?
- How do village, household and individual level characteristics are related to child and women nutritional status?





Methodology: Specific objective-4

Data Collection:

Child

Anthropometry: Body weight, Height/Length, [Age]

Women

Anthropometry: Body weight, Height, MUAC

Micronutrient: Blood specimen,

Geographic coordinate of the house

Child Anthropometry cut-off

WHO 2006 Growth standard classification;

WHO-Anthro

Z-score < -2

Women Anthropometry cut-off

BMI < 18.5 kg/m^2 & MUAC < 22 cm

Women Micronutrient cut-off

Hgb < 12g/dL anaemic

Data analysis

Descriptive statistics,

Anselin Local Moran's *I*

Expected result

Proportion of women & child undernutrition

Spatial distribution of women & child undernutrition

Methodology: Specific objective-4 Cont'd…

Input variables (Independent variables)

Agroecological zones
AEZ_1, AEZ_2, & AEZ_3

Village level:
Food Production total & diversity,
Nutrient composition of major crops

Household:
Food security status,
Dietary diversity,
Socio-economic, demographic characteristics, etc.

Individual:
Child DDS, ICFI
Women DDS

Dependent variables (Binary outcomes)

Child
Underweight or not

Women
Micronutrient deficient or not

Women
Underweight or not

Data analysis
Regression

Expected result
Identify potential predictor factors for the occurrences of child and women undernutrition (At different levels)

Expected outcome

- Identifies geographic areas at high risk of undernutrition
  - Provide responsible factors at various levels: village, HH & individual
  - Support informed decision in addressing vulnerable groups in rural Ethiopia

- Support nutrition sensitive Agri strategy in Ethiopia
  - Providence evidence for implementation & ongoing assessment
  - RS-based metrics in agriculture nutrition assessment

- Comprehensive assessment method of diet quality
  - Could be used in other similar contexts

THANK YOU!

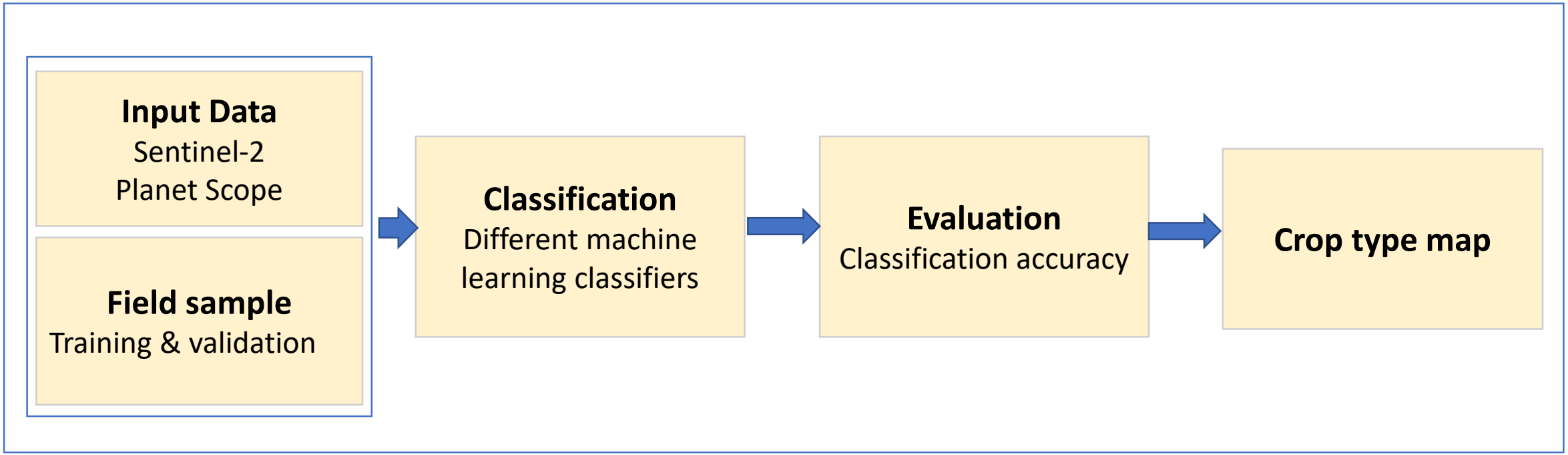
Remote sensing

Women & Children

Field

Household

Method: Specific objective 1



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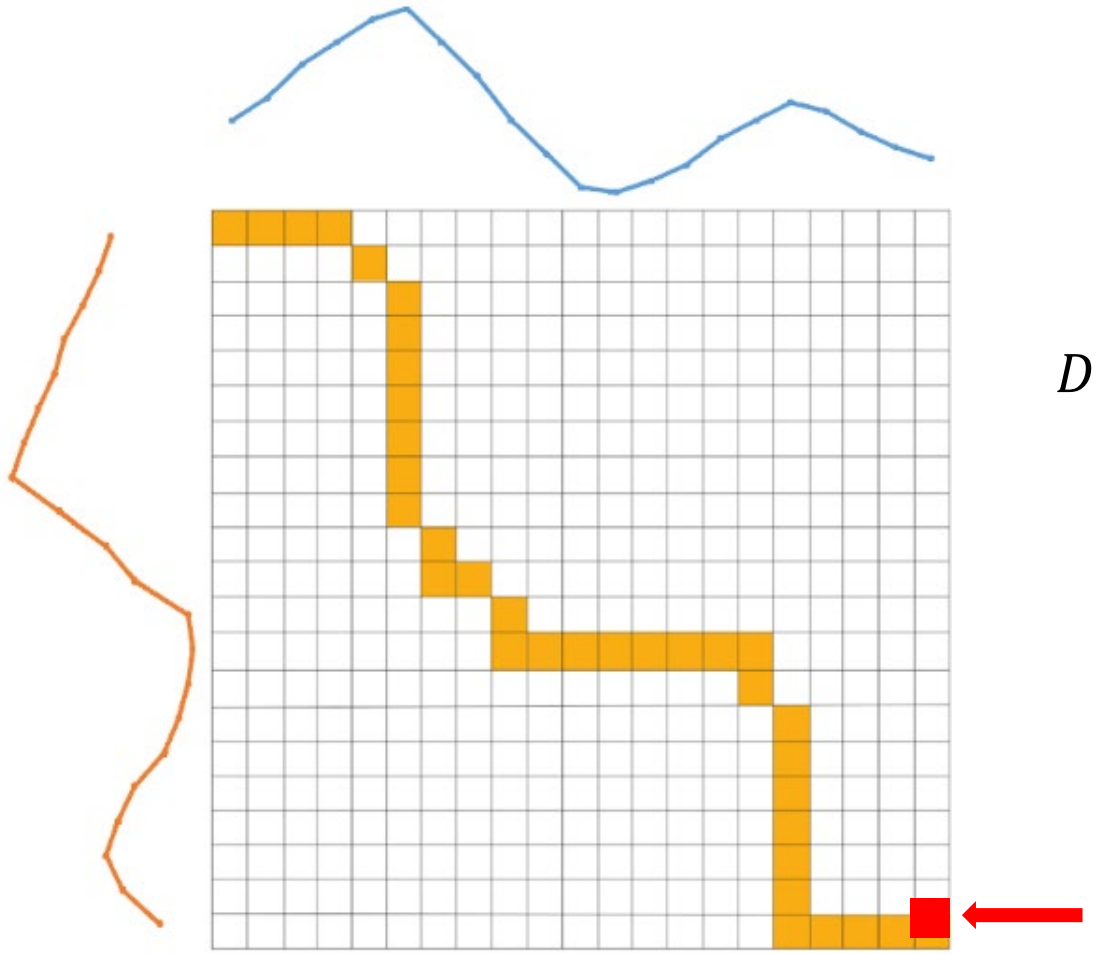
Dynamic time warping (DTW)

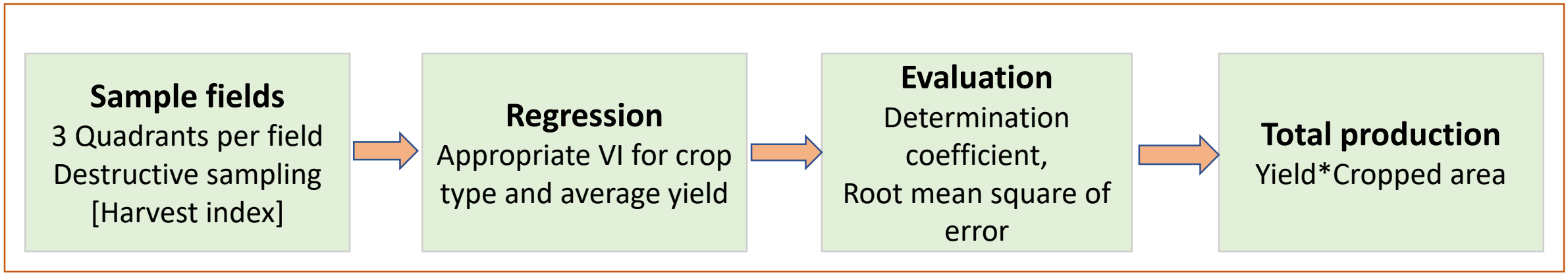


DTW dissimilarity value

$$DTW\left(A_i, B_j\right) = d\left(a_i, b_j\right) + min\begin{cases} DTW(A_{i-1}, B_{j-1}) \\ DTW(\ A_i\ , B_{j-1}) \\ DTW(A_{i-1},\ B_j\ ) \end{cases}$$

Euclidean distance

Method: Specific objective 1



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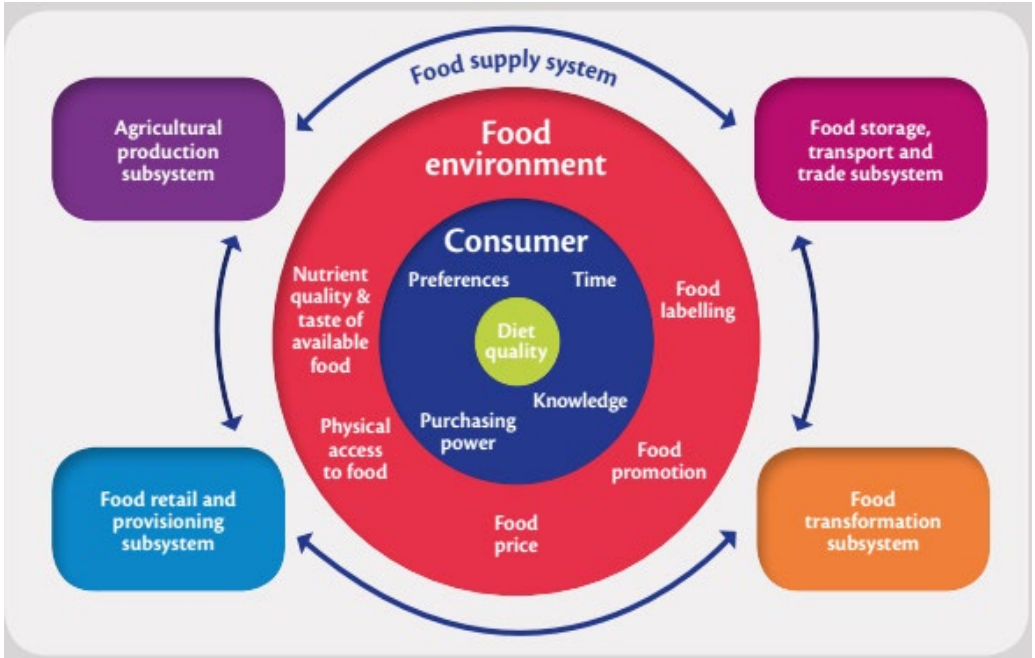
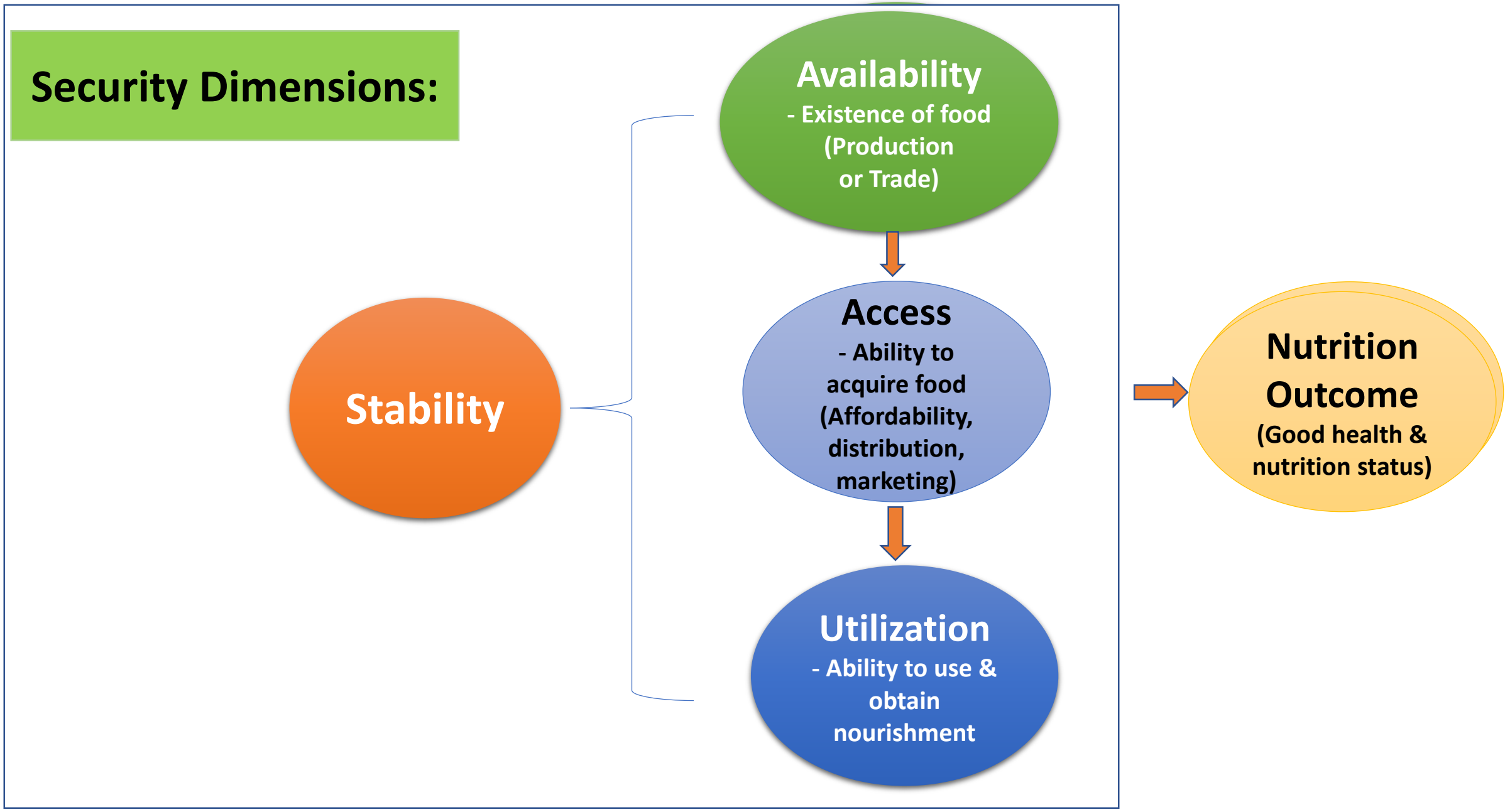
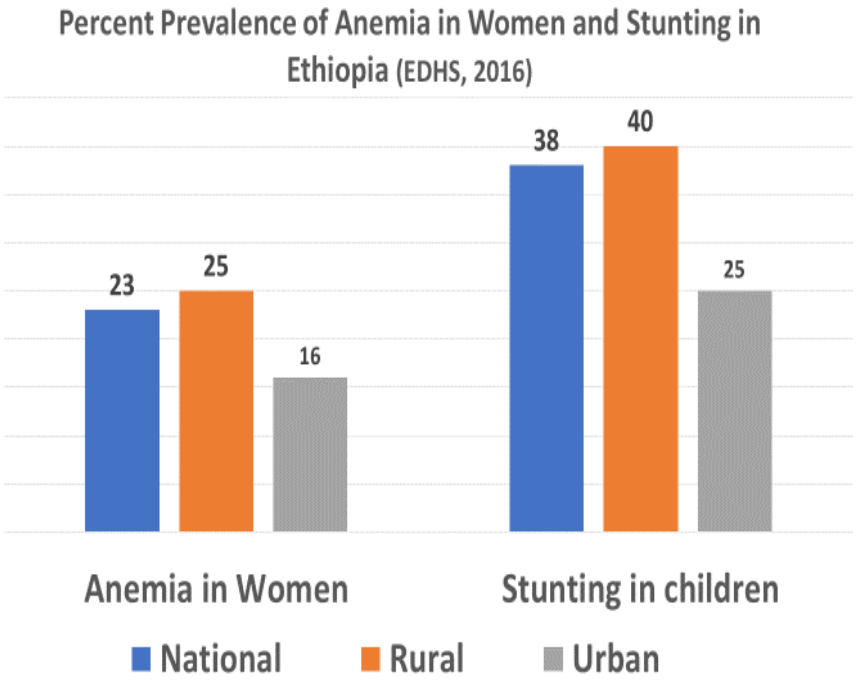

Food supply system
Agricultural production subsystem
Food storage, transport and trade subsystem
Food environment
Consumer
Preferences
Time
Diet quality
Knowledge
Purchasing power
Nutrient quality & taste of available food
Food labelling
Physical access to food
Food promotion
Food price
Food retail and provisioning subsystem
Food transformation subsystem

Security Dimensions:



Research gap specific objective-4:

- Geographical location has an impact on the underlying determinants of nutrition
- Variation in the diet consumption pattern over a small geographic scale in southern Ethiopia has presented a significant variation in vitamin A status.
- Prevalence of undernutrition in Ethiopia
  - Vary among regions
  - Rural-urban variation
- Little is known about the geographic correlates in distribution of child and women undernutrition and the associated responsible factors.
- Only few studies have assessed the geographic correlates of child undernutrition
- However, the geographic correlates in the distribution of undernutrition, women's nutrition status were not included as a predictor in child nutrition outcomes.



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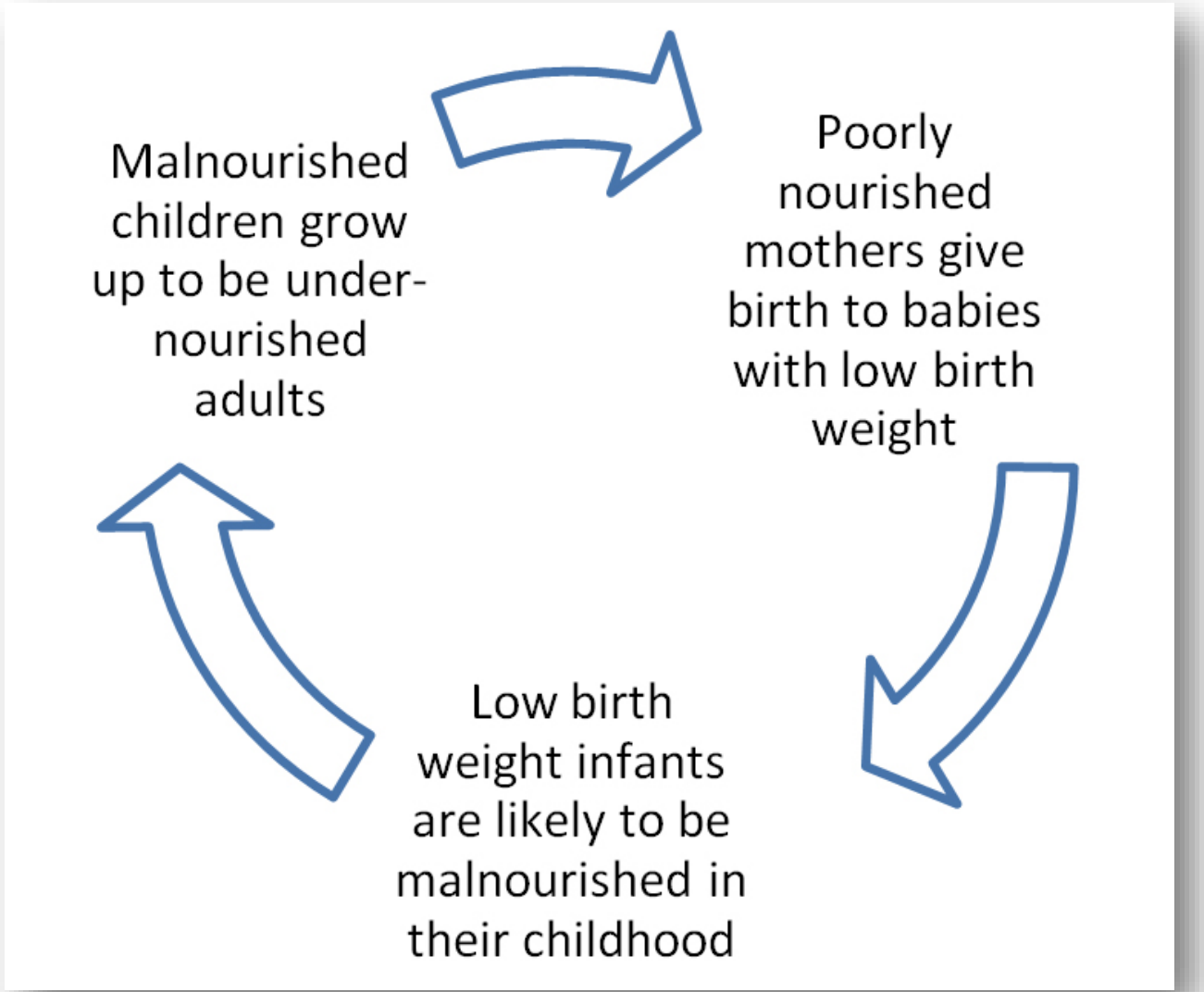
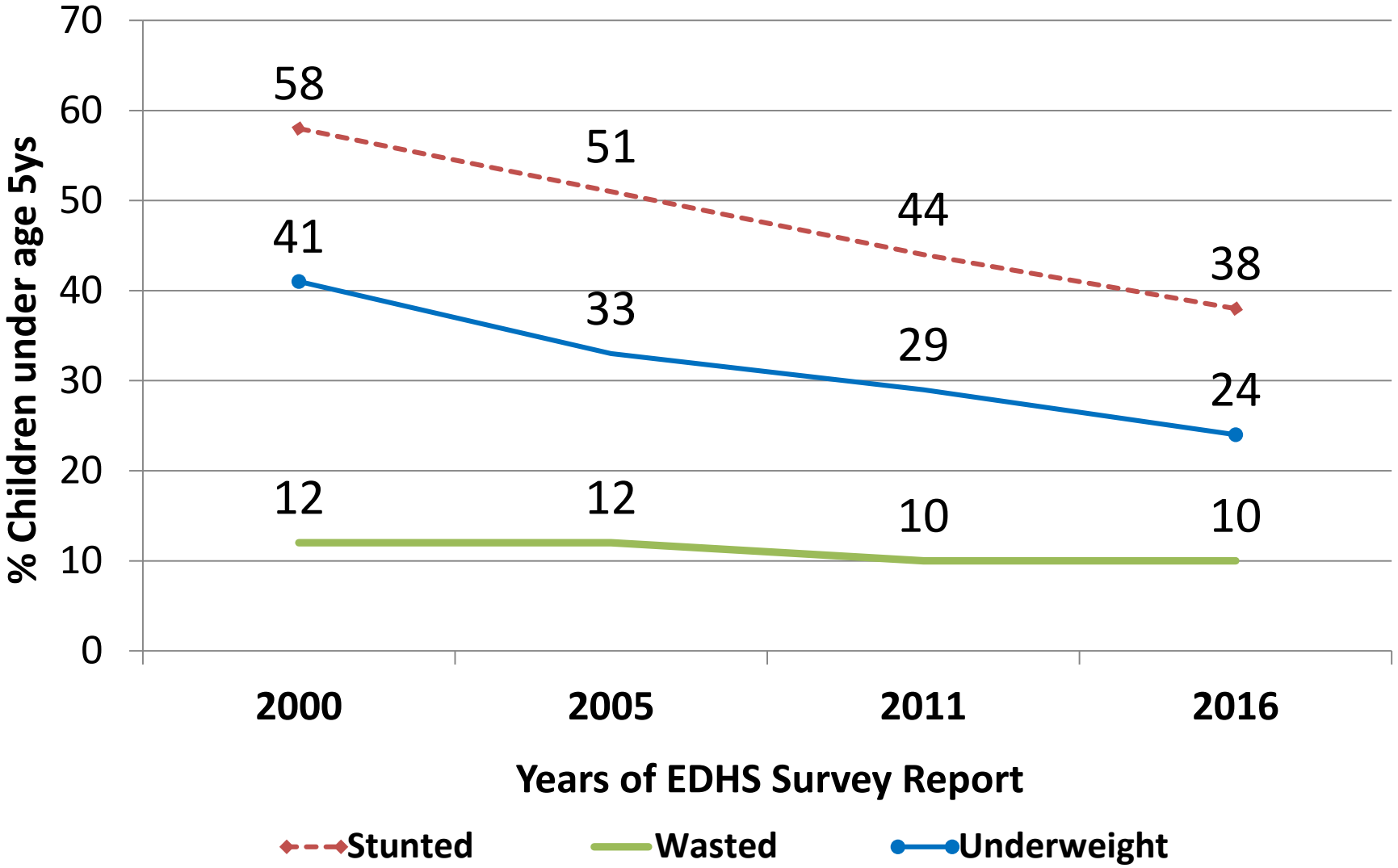
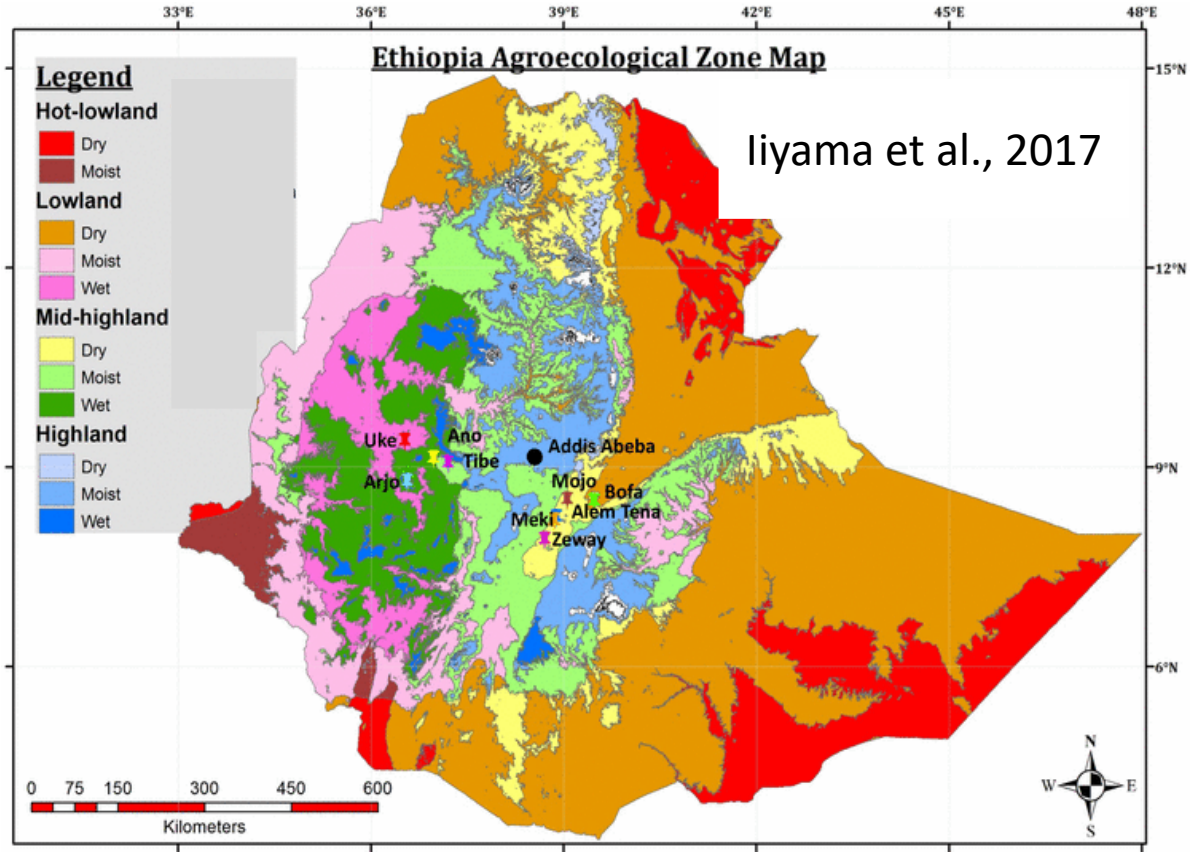

Malnourished children grow up to be under-nourished adults
Poorly nourished mothers give birth to babies with low birth weight
Low birth weight infants are likely to be malnourished in their childhood

Trends of malnutrition indices in children under 5 years of age in Ethiopia



Problem and research gap

- Agroecological zone is a spatial classification of the landscape into area units with similar agricultural and ecological characteristics.
- Determines the distribution of crops and length of growing season (Hurni, 1998)
- Ethiopia is a very diverse country in terms of agroecological zones
  - Higher diversity among and within regions
- However, dietary patterns and gaps have not yet been studied according to this heterogeneity (Gebru *et al*., 2018).

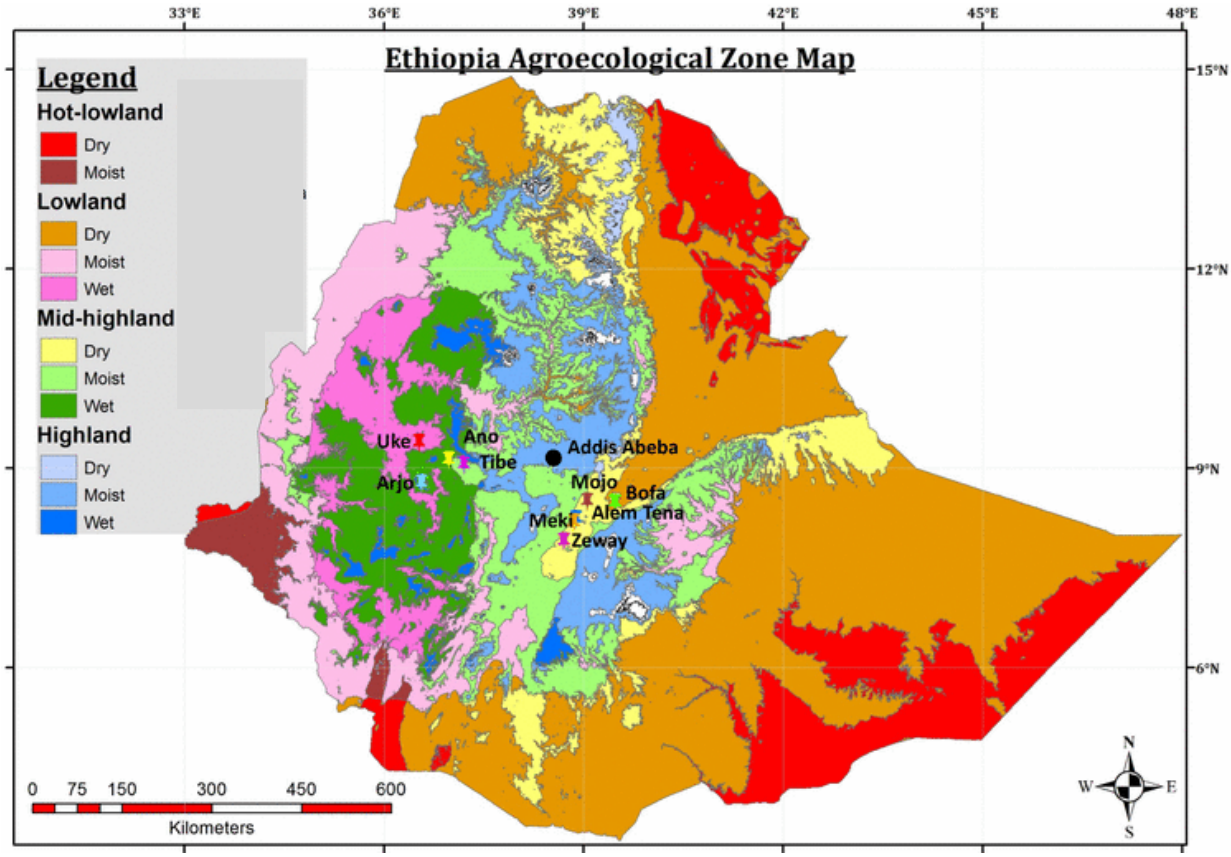


Iiyama et al., 2017

Research gap objective-3:

Few agroecology-based studies reported:

- Variation in household food insecurity status over different AEZs.
- However, findings are inconsistent and having methodologic flaws:
  - ➢ Food systems typology-mix/ rural-urban mix,
  - ➢ Under representation of sample size,
  - ➢ Assessed with a single dimension of food security (access) at HH level
- Assessing with other food security indicators and using direct nutrition outcome indicators (Anthropometry & biochemical) are significantly required.



Research gap specific objective-1

- Having enough food to eat doesn’t imply adequate nutrition.
- Improving nutrition requires diverse diet besides better access.
- This implies that the surrounding food environment need to provide diverse food.
- However, production diversity and dietary diversity linkages are context-specific and study reports are mixed.
- Highlights the need for further studies to better understand how agriculture and food system can be made more nutrition sensitive in a particular context.

Research gap specific objective-1 Cont'd

- Village level food production governs the household food choice in rural areas.
- In most studies production information is found based on household survey or farmer level recall.
- In such quantitative estimation, errors reported in production information by farmers (Abay *et al*., 2018).
- Moreover, production estimates in heterogeneous smallholder farming systems often rely on labour-intensive surveys (Lambert *et al*., 2018).

- With this regard, recent developments in (very) high-resolution remote sensing data come up with new opportunities to work in heterogeneous smallholder.
- However, only few studies have assessed in challenging tropical area with cloud cover.

Research gap objective-2:

- To achieve a healthy food system:
  - Measuring food supply diversity
  - Evaluating nutrients provided by major food crops
- Nutrient content vary
  - Between varieties of the same crop & among crops
  - Natural difference (genetic), soil, nutrient expression or fortification
- Nutrient deficiency
  - Low dietary intake
  - Low bioavailability mineral micro-nutrients from plant-based staples
  - Anti-nutrients

Research gap objective-2:

- In rural Ethiopia, people consume large portion of foods produced locally (Sibhatu & Qaim, 2017)
- In such conditions, the nutrient status of people is markedly affected by the concentration of essential nutrients available in major crops.
- Appropriate dietary recommendations are derived from context-specific nutrient composition.
- Food composition (FC) data lacking updated may lead to wrong research and policy decision
- Ethiopian FC data updated 20 years ago; however, improved varieties have continually been introduced
- Data gap?