Morphological and use-value related management of enset (*Ensete ventricosum* (Welw.) Cheesman) diversity and distribution in SNNPRS, Ethiopia.

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1. INTRODUCTION

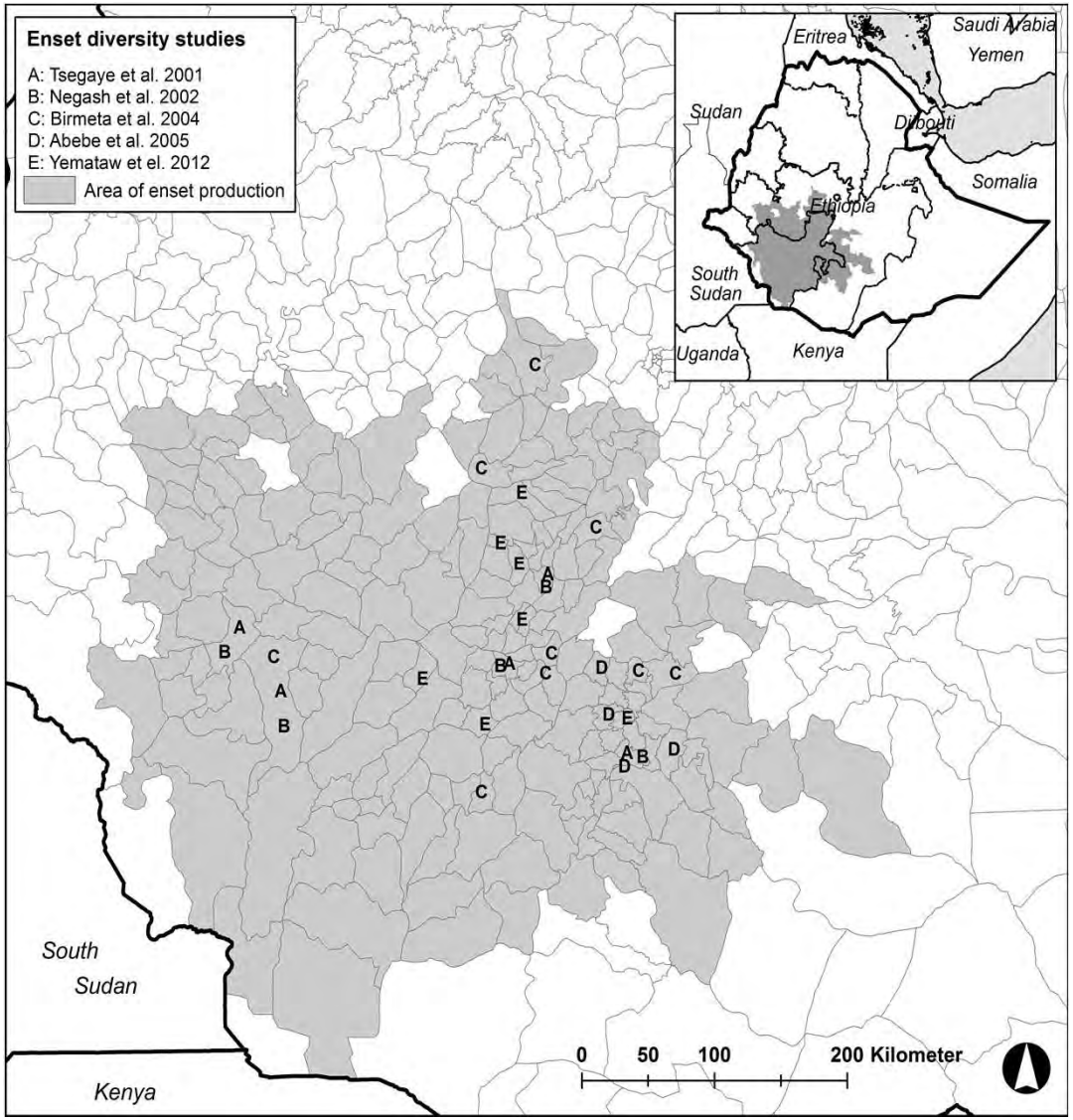
❖ 1.1. TAXONOMY OF ENSET

- ❖ It is a perennial monocarpic crop.
- ❖ Order Schistaminae and family Musaceae along with bananas.
- ❖ It is a diploid (2n= 18),

- ❖ Previously considered as member of the **genus Musa**,
  - ❖ However, **pseudostem morphology and chromosome number**

- ❖ Then giving the genus name Ensete
- ❖ **(*Ensete ventricosum* (Welw.) Cheesman)**

1.2. IMPORTANCE



Area of enset production of Ethiopia, diversity study areas.

- It is a staple & co-staple food crop for over 15 million people
- It provides year-round food, fiber, animal feed and medicine
- Gives higher yield per unit area (25 t ha^{-1} yr^{-1})

1.2. IMPORTANCE

- In Ethiopia enset is cultivated **mainly for food.**
- The edible parts of the plant are formed by the **pseudostem and the underground corm**
- The major foods are **kocho**, **bulla & Amicho**

kocho

bulla

- **Amicho**

1.2. IMPORTANCE

Fiber:

- Enset yields good quality fiber. It is the by-product of enset,
- Its strength was found to be equivalent to important fiber crop ***Musa textiles/Abaca*.**

- It is also a source of **starch for domestic and industrial uses**.
  - Its starch is used the manufacturing of **paper, adhesives,**

1.2. IMPORTANCE

❖ ***Local medication**:*

- ➢bone fracture,
- ➢diarrhea,
- ➢in discharging placenta, for both human being and animals.

❖ **As a result Enset Producing farmers declare that**, —

- ➢ Enset is our food, our clothes, our beds, our houses, our cattle feed, and our plates.

1.3. ENSET Diversity & Distribution

- Farmers characterize and select enset clones based on
  - **morphological, agronomic traits and use value** from different enset growing areas of Ethiopia (Tsegaye, 2002)
- Different authors reported that **numerous enset clones** were identified in each region (Negash, 2001).

1.4. PRODUCTION LIMITING FACTORS

- Enset support **dense human populations and potential industrial application**
  - however attracted **less research and support** than its capacity.

- Now a day the **stocks of the crop are declining.**
  - various diseases, notably enset bacterial wilt (EBW)

    Causes loss up to 70 – 100%

- There is a need to increase understanding of this potentially important crop before more of the **agro-biodiversity is lost.**

2. OBJECTIVE

❖ Therefore, the present study was conducted

- ✓ To assess and document the skills with which farmers recognize, classify, select and manage enset diversity in major enset production areas in southern Ethiopia.

3. MATERIALS AND METHODS

Description of the research area

- The SNNPRS has a total area of 117,506 km^2 with altitudes ranging from 378 to 4,207 masl (Abebe 2005).
- 7 district were selected to carry out the present study.
- Based on enset diversity, two PA (=14 PA) were selected in each district.
- From each PA 20 (280 HH) households were selected randomly.

Materials and methods cont……

DATA COLLECTION AND ANALYSIS

- For Data collection a structured questionnaire, through individual interviews was carried out

- **There are two separate parts**
  - **A. Morphological and use value based characterization**
  - **B. Diversity and Distribution**

A. Morphological and use value based characterization

- The farmers' classifications of enset were assessed during the survey by asking respondents:
  - to describe a clone's distinguishing features,
  - selection criteria and attributes that are important in their decision to maintain it.

Materials and methods cont……

- Two enset plants per clone were characterized for three qualitative traits and eight agronomic and use-related parameters Mention the traits
- A total of **165 enset clones** were included in this study.
- Frequency distributions and the number of phenotypic classes distinguished by farmers were used to calculate the Shannon-Weaver diversity index (*H*') for each character (Hennink and Zeven 1991).
- The index is defined as:

$$H = \frac{-\sum p_i \ln p_i}{\ln n}$$

B. ENSET DIVERSITY AND DISTRIBUTION

- As a measure of diversity that takes into account the proportional abundance of clones (richness and evenness).
  - **Simpson's Index of Diversity (1-D) = 1-$\sum$ $(n/N)^2$ and,**
  - **Shannon and Weaver (1949) diversity indices**
  - ***H' = - Σ pi ln pi* (Magurran, 1988)**
  - **E = H'/lnS,** where S refers to the number of clones described in each district.
  - **Sorenson's similarity coefficient (Cs) (Sorenson, 1948).**

$$Cs = \frac{2J}{a+b}$$

4. RESULTS AND DISCUSSION

A. MORPHOLOGICAL AND USE VALUE BASED CHARACTERIZATION

- Farmers in the study area use a combination of **similar criteria to classify enset clones**.
- Farmers use these criteria as a **tool for clonal identification and characterization.**

Table 1. Farmers' criteria for classification of enset clones

Trait	Trait
Plant vigor	Medicinal value
Maturity	Disease response
Kocho yield	Petiole color
Bulla quality	Midrib color
Corm use	Leaf color
Fiber quality	Drought tolerance

- Polymorphism was observed for all the trait, with H′ values ranging from **0.154** for bulla quality to **0.827** for midrib color (Table 1).

Results and discussion cont.……

Table 2. Mean value of enset clones that are identified by farmers as being Xanthomonas wilt tolerant.	
Clone name	**FSQKB (ton ha^{-1} yr^{-1})**
Abatmerza	8.29
Agina	4.75
Alenticho	10.57
Bedadia	8.66
Bota-meziya	5.21
Buzzare	9.68
Dirbo	14.8
Hawe	13.6
Jegeda	5.61
Kekere	6.57
Kucharkia	5.16
Mariya	9.27
Mesmesa	10.79
Mean	**8.689**

- **13 clones** were identified by farmers as **tolerant to enset bacterial wilt**
- Low *kocho* yield as compared with other enset clones evaluated for Kocho yield.

Results and discussion cont……..

Table 3. Mean value of agronomic traits of enset clones that are used for medicinal purposes by enset farmers.	
Clone name	**FSQKB (ton ha^{-1} yr^{-1})**
Adinona	2.70
Aeluwa	7.80
Argema	8.16
Astara	8.38
Bedadia	4.55
Chamia	11.05
Gishera	14.39
Guarye	12.38
Hargamo	4.96
Jegeda	5.61
Kekere	6.57
Ored	9.60
Senkutie	10.79
Tuzuma	13.27
Mean	8.60

- Farmers also listed **14 other enset clones for medicinal purposes.**
- These enset clones have low *kocho* yield (8.6 t ha^{-1} yr^{-1}).
- Nevertheless the squeezed *kocho* yield of 4 clones were found to be greater than the mean yield.

Results and discussion cont……..

- In addition farmers recognize two major categories of Enset clones: '**male' and 'female' Enset.**
- the designation as 'male' or 'female' is not linked to their **reproductive biology.**
- Men prefer **male enset** clones whereas female farmers prefer **female enset clones**

Table 4. Characteristics of 'male' and 'female' Enset clones in Wolaita, GamoGoffa and Dawro Zones of Southern Ethiopia.

Characteristics	**Category**	
	Male Enset	**Female Enset**
Plant vigor	Vigorous	Less vigorous
Disease reaction	Tolerant	Susceptible
kocho quality	Less quality	More quality
Maturity	Late maturing	Early maturing
Amicho palatability	Non edible	Edible and tasty
fiber quality	High strength	Low strength

B. DIVERSITY AND DISTRIBUTION

I. ENSET CLONE RICHNESS/DISTRICT

Table 5. Enset clone diversity in the seven districts, Southern Ethiopia, Expressed as richness (No. of clone/district & No. of unique clones

Districts	Richness (%)	No. of unique landrace
Sidama	**30 (10.8*)**	24
Wolaita	39 (14.02)	22
GamoGoffa	34 (12.23)	23
Kembata	**43 (15.5)**	24
Hadiya	**59 (21.2)**	33
Dawro	42 (15.1)	29
Gurage	31 (11.15)	23
Mean± SE	39.7 ± 3.75	

Results and discussion cont.……

II. ENSET CLONE RICHNESS/ FARM

Table 6. Variation in the number of enset clones planted per farm & clone richness (No. of clone/farm, Mean richness /farm in the seven zones

No. of Enset clones per farm	Number of farms								Mean number (%) of farms
	S*	W	GG	K	H	D	G	Total	
≤ 5 clones	6	2	9	1	2	3	6	27	4.1(10.3)
6-10 clones	19	22	24	**39**	31	26	23	184	26.3 (65.8)
11-15 clones	12	14	6	0	2	11	9	54	7.7 (19.3)
≥15 clones	3	2	1	0	5	0	2	10	1.9 (4.8)
Min richness/farm	3	4	3	4	**2**	3	2		
Max richness/farm	18	19	17	10	**26**	15	24		
Mean richness/farm	**9.47**	**7.53**	**8.98**	**10.25**	**7.95**	**9.48**	**8.95**		8.94 ± 0.94

*S = Sidama, W = Wolaita, GG = Gamo Gofa, K = Kembata, H = Hadiya, D = Dawro, G = Gurage

III. DIVERSITY / HETEROGENEITY INDICES

Table 6. Enset clone diversity in the seven districts, Southern Ethiopia, Expressed as Simpson(1-D) and Shannon (H') diversity indices, and Evenness

Districts	1-D	H'	Evenness (E)
Sidama(S)	**0.971**	**3.577**	**0.97**
Wolaita	**0.977**	**3.671**	**0.995**
GamoGoffa	0.972	3.586	0.972
Kembata	0.975	3.636	0.986
Hadiya	0.974	3.606	0.977
Dawro	0.974	3.606	0.978
Gurage	0.975	3.631	0.984
Mean± Standard error			

- Both richness and diversity indices indicates the presence of high diversity in these 7 districts.

C. CLONES SHARED BETWEEN PAIRS OF ZONES AND SORNESON'S SIMILARITY INDICES

Table 7. Number of shared clones (above diagonal) and S (below diagonal) between pairs of zones.

Zones	Sidama	Wolaita	Gamo Gofa	Kembata	Hadiya	Dawro	Gurage
Sidama	--	3	1	2	2	3	1
Wolaita	*0.06	--	**11**	1	4	**11**	1
Gamo Gofa	0.06	0.27	--	0	1	6	0
Kembata	0.03	0.02	0.026	--	**17**	0	2
Hadiya	0.07	0.08	0.02	0.35	--	2	8
Dawro	0.06	0.3	0.16	0	0.04	--	0
Gurage	0.03	0.03	0	0.05	0.18	0	--

*=Sorenson's similarity index

- Strong **cultural and linguistic similarities** exist between the above districts.

D. DISTRIBUTION AND ABUNDANCE OF CLONES ACROSS THE DISTRICTS

Table 8. Distribution of enset clones across the seven districts.	
Number of zones	Number of enset clones (%)
One	178 (81.65)
Two	29 (13.3)
Three	8 (3.7)
Four	2 (0.9)
Five	1 (0.46)
Six	0
Seven	0
Total	**218**

- The distribution of clone is characterized by **high level of endemism** which has **implications for the conservation of Enset diversity.**

CONCLUSION & RECOMMENDATION

- Knowledge of farmers' practices is currently used to confirm agronomic innovations introduced in areas under consideration and the setting up a network of "collections" managed by farmers .

- This study has been carried out in only seven districts. Other areas have peculiarities of their own, remain to be investigated.

Conclusion & recommendation cont.….

- The unequal distribution and abundance of clones reflect their relative importance to farmers and provide strong evidence for selection.

- Highland regions have a high concentration of diverse and unique enset landraces and should be given priority in efforts aimed at collection and *in situ* germplasm conservation.

VIEW POINTS

- Spread of modern agricultural techniques for enset cultivation in Ethiopia might lead to disappearance of some of the mechanisms generating diversity in traditional agro-ecosystems.

  - On-farm conservation and utilization of enset diversity should take into account:

1. Facilitate **policy and institutional framework** supporting on farm and in-situ conservation and utilization of agro-biodiversity and wild crop relatives.

   - **Formulation of local level by-laws**
   - Adopt a **participatory monitoring and evaluation system.**

View points cont…….

2. Establish entrepreneurship, strong and fair partnerships between producers, dealers, consumers and other stakeholders in the production to consumption chain, and through a participatory integrated learning approach by all partners.

   - ❖ Markets provide incentive for farmer uptake of agro-biodiversity friendly practices. As the crop becomes more valuable in the market, the unit cost of maintaining its traditional varieties on-farm increases.

3. Establish *in situ* gene banks and on-farm conservation sites to enhance and ensure long term availability and conservation of the genetic diversity and its wild relative.

ENJOY WITH ENSET PRODUCTS