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Economic Attributes of "Ensete ventricosum" Production for the Farming Communities in Wolaita and Kembata Zones of South and Central Ethiopia

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Abstract

Enset plays a vital role in providing both marketable and non-marketable goods and services for farming communities in South and Central Ethiopia. Recognizing the key attributes of enset production and leveraging scientific knowledge is essential for maximizing the resource's potential and enhancing community welfare. This study aims to identify factors that affect marginal attributes of its production and estimate value of the economic goods and services of enset production. Using a cross-sectional survey with multistage sampling techniques, the study identified several significant economic benefits associated with enset production, including food, feed, fuel, medicine, fertility enhancement, soil moisture conservation, input of construction materials, fences and household items and soil and water conservation measures. The study found that the annual value of live enset and its processed three major products Kotcho, Bulla, and fiber amounted to 41.61 million and 3.79 billion Ethiopian birr, respectively. The feed, wrapping, income and cook benefits of the commodity's estimated to be 171.9Billion Birr annually. Out of these additional attributes, feed value take the lion share (85%).The preferences of attributes varied across districts and households. The regression results revealed that marginal attributes of enset for food, feed, biodiversity, fertility, windbreak, wrapping and social cohesion is defined as a function of enset area, its source of harvest, family size, distance to market and farmer training centre characteristics of the commodity producers. The study identified key attributes of Enset production including food, feed, wrapping, biodiversity, social cohesion, land rehabilitation (fertility, moisture, windbreak, soil and water conservation) and fuel benefits that calls for immediate and long term research and development intervention. These findings underscore the critical importance of enset and emphasize the urgent need for strong policy and institutional support to ensure optimal utilization and sustainable development. The finding also illustrated that prompting Enset farming is inducing climate smart agriculture, provoking gender mainstreaming, assuring food and feed security.

Keywords: attributes; enset; fiber; food; feed; kotcho; bulla; production; products; wrapping

1. Introduction

The Enset plant, scientifically known as Ensete ventricosum, is a monocarpic perennial crop classified within the genus Enset in the family Musaceae. It is extensively cultivated by farmers in the rural areas of southern and western Ethiopia, prized for its ability to tolerate drought and its crucial role as a primary source of food. Enset serves as a versatile resource for smallholder farmers, offering sustenance, opportunities for income generation, livestock fodder, medicinal benefits, fuelwood, and

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materials for building homes. The key products obtained from Enset are Kotcho, Bulla, Corm, Enset leaves, and fiber [1,2].

Enset is an indispensable dietary element in the agricultural terrain of southern Ethiopia. Originating in this region and continuing to be cultivated, it remains a crucial component of the entire farming ecosystem [3]. Enset production is esteemed for its strategic significance in farming practices, attributed to its ability to harmoniously intercrop with major cash crops. This cultivation method is highly regarded and is closely linked to coffee cultivation and livestock rearing [4].

Enset enhance food security and generate income, presenting a range of environmental, nutritional, and socio-cultural advantages. Traditionally cultivated by indigenous communities for its edible components, its importance extends to agroforestry. When intercropped with root and tuber crops, enset provides valuable shade and contributes to soil fertility through natural fertilization with crop residues. Continuous research efforts are essential to maximize production potential [5].

Enset possesses numerous favourable characteristics as a food crop. Its corm can be harvested at any stage, and its food products exhibit extended storage capabilities, offers high yields per unit area, thrive in diverse environmental conditions, and demonstrates resilience to drought, floods, and high temperatures. Its ability to endure prolonged periods without water significantly contributes to climate change adaptation and resilience [6,7]. Following Enset, vegetables, roots, tubers, cereals, and grain crops were the top five major food items consumed across households. The proportion of production used for household consumption was 76% for enset, 72% for vegetable crops, 67% for root and tuber crops, 66% for cereals, and 62% for grain crops [8].

Local communities utilize every component of Enset crop, employing it not only for human consumption but also as fodder for livestock, contributing to climate regulation, and enriching soil quality. Enset holds significant cultural value within communities by enhancing the visual appeal of landscapes. However, its multifaceted uses face challenges owing to socioeconomic changes and a dearth of technological advancements. Decreases in Enset production can lead to the erosion of home garden farming systems, result in wind erosion, jeopardize food security and nutritional well-being, and undermine regulatory functions [9].

Expanding the scope of enset cultivation holds considerable promise in bolstering the diversification and resilience of farming systems worldwide in the face of climate change. Integrating interdisciplinary methodologies to assess both bioclimatic and socioeconomic suitability aids in identifying enset farming communities as priority targets for agricultural development initiatives [10].Enset provides various sociocultural benefits to the communities in wealth accumulation, social status, gender roles, and work patterns. Enset provides food and feed, fuel, fiber , cultural identity preservation, construction materials, ornamental use in home gardens, carbon sequestration, and soil and water conservation. Enset also plays a role in enhancing climate resilience and soil quality, meeting the water and feed requirements of livestock, and bolstering food security [11]. It complements other agricultural activities such as crop cultivation and livestock farming, ensuring a balance between food and feed security [12,13].

Households that depend on Enset can achieve a well-balanced and nutritious diet by incorporating protein-rich foods from pulses or livestock, along with green leafy vegetables that provide essential vitamins and minerals. In Enset-dependent areas, improving farm productivity and dietary diversity can be achieved through sustainable intensification and diversification of Enset cultivation [14].

Enset plays a vital role in environmental restoration efforts, enhancing soil fertility, conserving soil and water, and maintaining overall ecosystem health. This crop offers extensive nutritional, socio-cultural, medicinal, environmental, and economic benefits. Medicinally, it has been utilized for treating fractures and injuries in both humans and livestock. Furthermore, it serves as a symbol of community identity and an indicator of household wealth. Specific landraces are employed medicinally for various purposes, including treating broken bones, addressing childbirth complications, managing diarrhea, facilitating birth control, alleviating backaches, and managing heart conditions [15,16].

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Certain Enset varieties hold medicinal and spiritual significance, offer preventive care and healing properties, and protect against malevolent forces. Enset leaves serve multiple purposes, commonly utilized as wrapping material for preserving butter, cheese, chat, and harvested grains requiring a cool, moist environment. Additionally, Enset leaves are fashioned into makeshift ovens for baking special bread, with smouldering dung cakes placed atop them. The fiber extracted from enset is widely used in crafting bags, ropes, and baskets [17,18].

Enset cultivation provides numerous advantages to communities, encompassing both marketable and non-marketable values. Food, feed, biodiversity, income, fuel, medicinal, wrapping and land rehabilitation benefits of Enset production illustrates attributes of enset cultivation. Despite its recognized economic, social, and environmental benefits, the enset sector has historically received limited policy support due to a lack of up-to-date information. Addressing the challenges facing enset cultivation requires the generation updated information on its multifaceted benefits, garnering political attention, and developing supportive policies. Therefore, this study aims to delineate the crucial economic benefits of enset production, identify factors affecting the production level of enset attributes and estimate the value and preferences of attributes across districts to inform policy formulation and development interventions for sustainable farming and optimized benefits.

2. Methodology

2.1. Geographic Location of the Study Districts

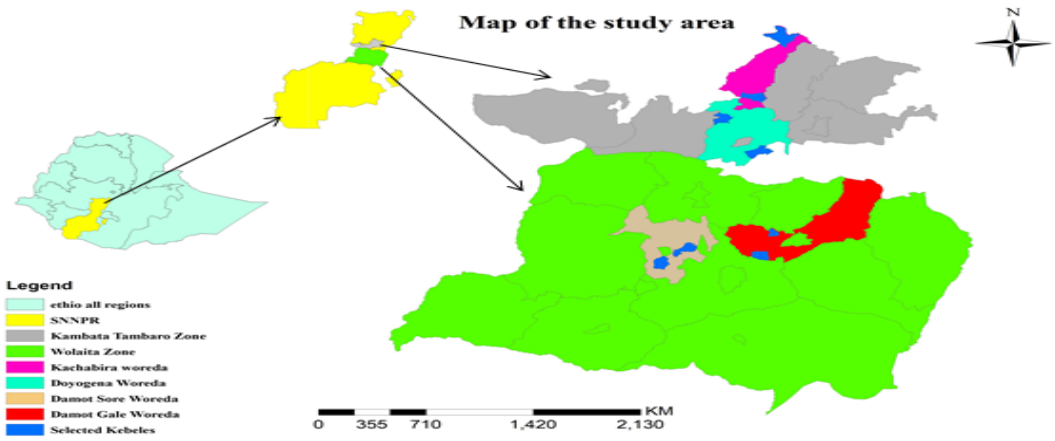

Figure 1. Map of study districts. Study Districts of Wolaita and Kembata Zones.

2.2. Description of the Study Area

As illustrated in the figure above, the study was carried out in one of the major Enset-producing regions of South and Central Ethiopia, specifically in the Wolaita and Kembata zones. In Wolaita Zone, Enset cultivation covers a total of 7,968 hectares under indigenous seed holdings. The zone is home to 295,117 Enset-cultivating farmers. A total of 1,415,020 Enset trees were harvested, yielding 212,253 quintals of Amicho, 240,553.40 quintals of Kocho, and 14,150.20 quintals of Bulla [19].

2.2.1. The Study Districts of Wolaita Zone

Damot Gale Woreda

Damot Gale District is one of the twenty administrative districts and towns in the Wolaita Zone, with a total population of 224,356 comprising 109,402 males and 114,954 females. The district is bordered by Sodo Zuria to the southwest, Boloso Sore and Damot Pulasa to the northwest, the Hadiya Zone to the north, Duguna Fango to the east, and Damot Weyde to the southeast. According to CSA

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[19], the district is home to 16,344 Enset-cultivating farmers, including 13,716 male-headed and 2,618 female-headed households.

Damot Sore Woreda

Damot Sore is an administrative district and town located in the Wolaita Zone of southeastern Ethiopia. It is bordered by Sodo Zuria to the southeast, Kindo Koiysha to the west, Boloso Bombe to the northwest, and Sore to the north. The district lies approximately 318 kilometers from Addis Ababa and is accessible via the Hosanna road. It comprises 17 rural kebeles and 3 urban kebeles, with a total population of 136,647 66,563 males and 70,084 females. Key crops grown in the area include common beans, Enset, sweet potato, maize, cassava, teff, barley, banana, and field pea. According to [20] and [19], the district has 9,776 Enset-cultivating households, including 7,332 male-headed and 2,444 female-headed households.

2.2.2. The study districts of Kembata Zone

In the Kembata Zone, Enset cultivation spans 6,778 hectares, with 112,929 natural Enset holders. These holders have an estimated landholding of 5.805 hectares. Additionally, the zone is home to 121,558 indigenous Enset seed holders. The estimated annual Enset harvest in the zone totals 1,195,069 quintals. In the 2022 fiscal year, the production of Amicho, Kotcho, and Bulla reached 262,915.18 quintals, 298,767.25 quintals, and 11,950.69 quintals, respectively [19].

Kachabira Woreda

Katcha Bira Woreda, located in the Kembata zone, is one of eight administrative districts in the area. The Woreda has a total population of 165,859, consisting of 80,837 males and 85,022 females. It is divided into 21 kebeles. Within the Woreda, 9,395 households are involved in Enset cultivation, with 8,604 headed by males and 791 by females [21].

Doyogena Woreda

Doyogena District, one of the eight administrative divisions within the Kembata Zone, has a total population of 109,251 comprising 53,379 males and 55,872 females. The district includes 14 peasant associations and is bordered by Kacha Bira to the south, Lemu Woreda in the Hadiya Zone to the west and north, and Angacha to the east. Enset cultivation plays a central role in local agriculture, with 15,660 farmers engaged 13,434 from male-headed households and 2,526 from female-headed households. Key crops grown in the area include Enset, wheat, Irish potatoes, common beans, faba beans, teff, cabbage, head cabbage, barley, field peas, beets, tomatoes, onions, carrots, and garlic [22].

2.2. Conceptual and Methodological Prospectives

Conceptual Prospecitves of Enset Production

The Dependent and Control Varibles Included in the Regesstion

The dependent varieables are attributues frquences,utilization frequcncies and its level of application in Enset farming system that clarifies importance of the commodity in different aspects. The explantory variables included in the model includes demopraphic,socioeconomic and institutional.The defined control variables listed as age,education level,Enset area coverage,distance from farmers resdistance to service centers,number of enset harvested,diseases prevalance and livestock holdings.

Conceptual prospectives of Enset production refers to attributes of its production.The attributes of Enset production defined as goods and services obtained from Enset cultivation.This attributes of Enset production includes foods,feeds,biodiversity,wrapping and land rehabilitation.

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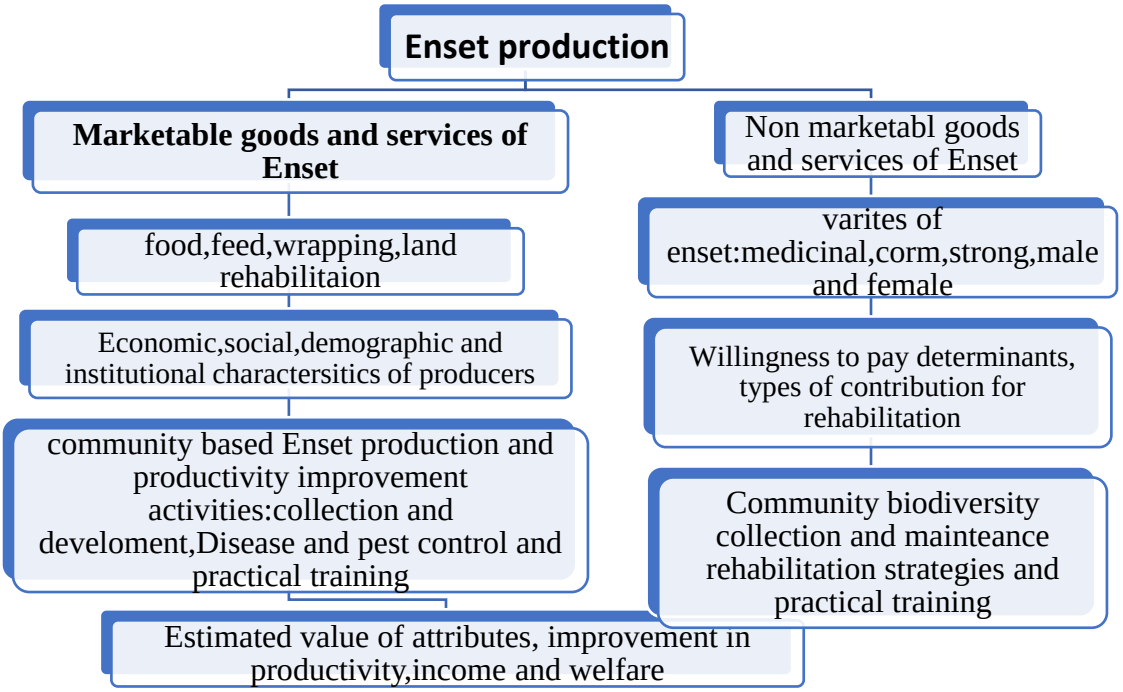

Figure 2. conceptual prospective of Enset production.

As depicted in the figure above, *Enset* production expressed by benefits of goods and services obtained from its farming. The sketched figure above points out the multiple attributes of *Enset*, its rehabilitation strategies, types of contribution, factors affecting willingness to pay for it, its strategic action for biodiversity conservation, production improvement and capacity building.

Estimation of Ordered Logit Model

The ordered logit method of estimation is by the method of maximum likelihood. In our study we ordered the utilization level of Enset attributes such as wrapping, fertility, income, gift and biodiversity. The wrapping attributes of Enset production ranked as daily, every three days and weeks basses for application in different household purposes. The attributes of fertility, income and biodiversity order is defined as high, medium and low based on frequency of utilization for their daily household demand. Although there is clear ranking among the various categories, we cannot treat them as interval scale or ratio scale variables. Thus we cannot say that the difference between daily, and every three days or weekly application frequencies of Enset products is the same. Also, the ratio between any two categories here may not be practically meaningful. Although Multinomial logit Models models can be used to estimate this ordinal-scale categories of Enset attributes, they do not take into account the ordinal nature of the dependent variable. Ordered Logit Model is preferred to Multinomial Logit Model for it estimate a single regression for each ordered category of Enset benefits; the only difference is that the intercepts differ between categories. Therefore OLM is more economical than MLM in terms of the number of parameters estimated. The ordinal logit is specifically developed to handle ordinal scale variables. Because of the mathematical complexity of the ordinal Probit model, we applied the ordinal logit model [23,24].

$$Y_i = B_1X_{1i} + B_2X_{2i} + \cdots + B_kX_{ik} + u_i = \sum_{n=1}^{k} B_nX_{in} + u_i \quad (1)$$

where Yi is unobserved, the X_s are regressors and Ui is error term.

Models fowr ordered responses estimated that use cumulative as :

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$$pr(Y_i \leq j) = \Pr\left(B_1X_{1i} + B_2X_{2i} - - - B_kX_{ki} + U_i \leq a_j\right)$$
$$= pr(u_i \leq a_j - B_1X_{1i} - B_2X_{2i} - - - B_kX_{ki}) \quad (2)$$

The commutative probabilities of ordered logit model can be written as;

$$\frac{\exp(a_j - BX)}{1 + \exp\,(a_j - BX)}$$

2.3. Methods of Data Collection and Sampling Techniques

The survey used one year cross sectional data for budget, time and other resources limitation. The basis for study and analysis was number of enset harvested in the last twelve months for different purposes. The main cause of its production is its benefits such as food, feed, biodiversity, land rehabilitation and wrapping. The study correlated its level of production and food production from its farming that is the main cause for the farming. The survey employed structured and unstructured data collection methods. A pre-test was conducted at the outset of the survey, and the final data collection proceeded after editing based on field pre-tests and feedback. The sample size was determined using [25] formula:

$$n = \frac{Z^2 * pq}{e^2} \quad (3)$$

where n is the minimum sample size, Z is the confidence level (t_{value}) of 1.96); p is the estimated proportion of population that can infer and estimate genetic, food, feed, social, economic, cultural and input related attributes of Enset, and q is $1 - p$; and e is the margin of error (i.e. the desired level of precision).

Both random and non-random sampling methods were utilized in a study conducted in the Wolaita and Kembata Zones. The selection of study zones, Woredas, and Kebeles was purposeful, considering factors such as the depletion of enset resources and their utilization for various purposes. Criteria such as farming experience, production levels, agro-ecological conditions, distance, and direction were considered during the selection.

In the Wolaita zone, Mehal Sheymba and Bolola Chawukare Kebeles in the Damot Sore district were chosen, with households randomly selected for the survey. Similarly, the Zamine Sibaye and Ade Damota peasant associations were chosen from the Damot Gale district. In the Kembata zone, Doyogena and Katcha Bira Districts were included in the study, with survey taking place in the Gomora Gewada, Wonjela, Awaye, and Hobicheka peasant associations.

The survey covered 186 household head farmers in the Wolaita Zone and 196 household head farmers in the Kembata Zone. Attributes were identified through literature review, key informant interviews, group discussions, and household surveys. The value of each major attribute was estimated by multiplying the quantity of the attribute produced by its market price. The data analysis used both descriptive and econometric approaches. The statistical software used for the analysis included Excel 2007, SPSS 20, and STATA 17. The multinomial and ordinal regression models was defined to examine factors affecting different type and level of Enset attributes in production system and it is written as:

$$y = \beta_0+\beta_1X_1+\beta_2X_2+\beta_3X_3+\beta4X4 + \beta_5X_5+\beta_6X_6+\beta_7X_7+\beta_8X_8+u \quad (4)$$

where, y is different level of Enset attributes, β_0 is intercept, from β_1X_1, β_1 is the parameter associated with zone where Enset harvested, in β_2X_2 , $\beta_2$is the parameter associated with market distance,from B_3X_3, B_3 is the parameter associated with family size, from β_4X_4 , B_4 is the parameter associated number of Enset matured, from β_5X_5 , $\beta_5$is the parameter associated availability of Enset Bacterial wilt at farmer's field, in β_6X_6, $\beta_6$is the parameter associated with Enset source for harvesting and consumption, from β_7X_7, β_7 is the parameter associated with total land owned, from β_8X_8, β_8 is the parameter associated with tropical livestock unit, in β_9X_9, β_9 is the parameter associated with yearly

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agricultural income, and u is the error term that contains factors other than independent variables included in the equation that explain Predictand [24].

3. Results and Discussions

3.1. Descriptive Result of Demographic and Socio-Economic Variables

Education Level of Respondent Farmers in Kembata Zones

In the Doyogena and Kacha Bira districts, the average number of years of schooling for household heads is approximately 4.8 years. Among respondents in Doyogena, 21.9% had no formal education, 39.47% completed grade six, 11.3% attended grades six and seven, 22.1% attended grades 9 -12, and 5.2% had education beyond high school. In Kacha Bira Woreda, 21.8% had no formal education, 35.9% completed grades one to six, 14.1% attended grades seven and eight, and 28.2% attended grades 9-12.

Education Level of Respondent Farmers in Wolaita Zone

In the farming communities of Damot Sore and Damot Gale districts, the average years of schooling is approximately 4.04 years. In Damot Sore, about 34% of residents had no formal education, 37% attended primary schools up to six grade, 19% completed grades seven and eight, 3% attended grades high schools up to twelve grade, and 7% completed high school. Similarly, in Damot Gale district, 43% had no formal education, 37% completed up to six grade, 9% completed grades seven and eight, 8% attended high school grade, and 3% completed tertiary-level education.

Age of Kembata and Wolaita Farmers

The average ages of farmers in Doyogena and Katachabira Woreda were approximately 50.41 years old. In the Damot Sore and Damot Gale districts, the average age of farmers is approximately 44.25 years.

The study result revealed (Table 1) that 55.47% of the small holder farmers belong to the active labour force and 44.53% belong to the dependant age category.

Table 1. Family size of the Farmers in Doyogena and Katacha Bira district (N=196).

Descriptive Statistics	Minimum	Maximum	Mean	Std. Deviation
Total family size	3.00	18.00	7.59	2.49
Family size aged below 5 year old	.00	9.00	1.27	.55
Family size aged between 5 to 14 years	.00	7.00	1.65	.34
Family size aged between 15 to 65 yeas	.00	11.00	4.21	1.24
Family size above 65 year old	.00	6.00	.61	0.15

Source: own survey data, 2024.

From sampled respondents (Table 2) 63% of small holder farmers are under an active labour force and 37% of households are grouped under dependant. From two consecutive tables (Tables 1 and 2),it can be concluded that the total family size of the household in the Wolaita Zone is lower than that of the Kembata Zone and the proportion of independent household farmers in Wolaita zone is higher than in the Kembata zone. The results also implied that the better Enset resource in the Kembata Zone in comparison to the Wolaita zone contributed to higher family size, longevity in life span and better food self-sufficiency.

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Table 2. Family size farmers in Wolaita Zone.

Descriptive Statistics	Minimum	Maximum	Mean	Std. Deviation
Total family size	2.00	12.00	6.41	2.18
Family size aged below 5 year old	.00	12.00	.91	.32
Family size aged between 5 to 14 year	.00	5.00	1.46	.13
Family size aged between 15 to 65 years old	.00	11.00	4.04	1.96
Family size above 65 year old	.00	7.00	.23	.15

Source: own survey data, 2024.

Major Explanatory Variables and the Variance Across Zones

The result in the Table 3 indicated that the average values for age, family size, years of schooling, total land owned, tropical livestock units, and Enset cultivation area are significantly higher among Kembata Enset producers compared to Wolaita households. Additionally, the tables show that Wolaita households have significantly better access to market points, farmers' training centres, and credit services than those in Kembata. Furthermore, the mean daily energy intake and the number of Enset harvested are notably higher in the Kembata zone than in the Wolaita zone. The classical hypothesis test confirms existence of a significant difference between the zones in terms of demographic, institutional, and socioeconomic characteristics of Enset producers.

Table 3. Classical test of hypothesis for socioeconomic and institutional variables.

Variables	Wolaita zone (N=178)		Kembata zone (N=196)		T	Combined (N=374)
	Mean (SE)	Std.dev	Mean(SE)	St.dev	t	Mean (SE)
Age (year)	44.74(1.12)	14.99	50.34(1.86)	14.86	-3.63***	47.68(0.78)
Family size (No.)	6.48(0.16)	2.18	7.51(0.18)	2,50	-4.22***	7.02(0.12)
Education (year)	4.05(0.31)	2.18	5.72(0.27)	3.78	-4.06***	4.93(0.21)
Total land (timad)	2.08(0.09)	1.19	3.05(0.16)	2.30	-5.06***	2.59(0.09)
TLU	2.18(0.03)	0.88	3.08(0.08)	1.22	-8.79***	2.62(00.0
Enset area (timad)	0.27(0.02)	0.31	0.59(0.0.04)	0.34	-6.12***	0.44(0.03)
Market distance	48.19(1.71)	22.92	80.18(4.24)	59.43	-6.74***	64.96(2.51)
FTC distance	17.04(0.9)	12.05	31.16(2.79)	18.14	-4.61***	24.44(1.57)
Road distance	18.29(1.10))	14.72	16.69(0.93)	13.04	1.12	17.45(0.72)
Credit distance	47.03(1.78)	23.82	77.96(4.06)	56.88	-6.74***	63.24(2.42)
Daily kilocalorie intake	3441.02(194.31)	1592.79	4041.56(254.63)	2563.4	-1.85**	3755.7 (162.9)
Enset Harvested yearly	11.81(0.77)	5.09	23.71(0.99)	13.88	-9.39	18.04(0.71)

Source: own survey data, 2024; Statistical significance is indicated by *** and ** at 1% and 5% respectively.

Trends of Enset Production Across Years Between Wolaita and Kembata Zone

As it illustrated in the figure below, from 2013 to 2021GC, *Enset* tress harvested shewed increased trend across districts in Wolaita and Kembata zones. The production level of *Enset* was similar for the two zones in 2014 EC and its level of divergence showed increment for the specific zones. The result implied that from previous to current years, Wolaita experienced more to harvests than that of Kembata zones.

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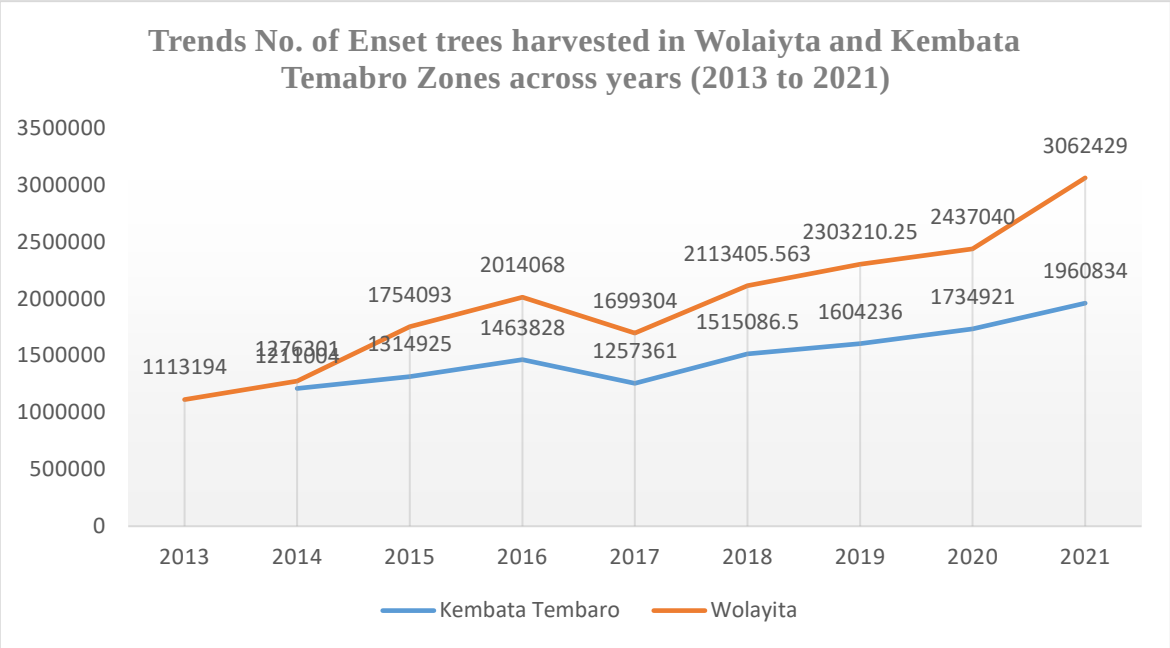

Figure 3. Number of Enset harvested across years in the study zones.

3.2. Descriptive Results of Enset Production

Level of Enset Production Across Districts

Enset production levels vary among districts owing to factors such as land ownership, sociocultural dynamics, and economic conditions. These variations can be assessed by examining the number of enset trees harvested and the extent of land coverage dedicated to enset cultivation. For instance, in the Doyogena and Katacha Bira districts, the average number of Enset trees harvested stands at 23.19+4.23. The enset production system in these districts is characterized by a distribution where 1.6% of farmers harvest no Enset,16.7% harvest 2-10 trees, 32.2% harvest 11 - 20 trees, 28% harvest 21 -30 trees, 10.7% harvest 31- 40 trees, and 10.8% harvest more than 40 trees annually.

Similarly, in the Damot Sore and Damot Gale districts, the mean number of enset trees harvested is 11.3+ 5.45. Among the sampled farmers in the Wolaita zone, 4.3% harvested no enset, 63.4% harvest 2-10 trees, 22.1% harvest 11-20 trees, and 10.21% harvest more than 20 trees. Additionally, the average land size allocated for Enset cultivation in Damot Sore and Damot Gale districts is 0.17 + 0.05 timad. In the Wolaita zone, 44.4% of farmers cover an area of 0.01 to 0.1 timad, 32.8% have land coverage ranging from 0.12 to 0.2 timad, 10% cultivate 0.2 to 0.25 timad, and 12.8% cultivate more than 0.25 timad.

3.3. The Economic Attributes of Enset Production and Its Values

The marketable aspects of enset production include various types and levels of benefits, pricing structures, and their integration into farming systems. Enset stands out as a horticultural crop with multifaceted values. Its marketable attributes are gauged by its diverse benefits, including its role as a human food source, livestock feed, building material for houses, medicinal properties, use in fences and windbreaks, contribution to biological soil and water conservation, and its traditional applications in equipment preparation. This observation aligns with the findings of [26,27] that highlighted enset's versatile uses ranging from food, wrapping and feed to house construction, medicine, income generation, fiber for house construction, cleaning rags and for making mats, sacks and ropes.

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3.3.1. Food Attributes of Enset Production and Their Values for the Community

The food benefits of Enset refer to a commodity as a food crop; however, the crop has many unaccounted benefits. Enset ranked first in proportion to household consumption from production, followed by vegetables, root crops, cereals and grain crops [28].The nutritional value of enset holds significant importance for communities, with its significance varying across districts, seasons, kebeles, agro ecological zones, and households. Enset provides consumable products such as koscho, bulla, and corm, which are utilized in various forms. Enset-based foods are central to traditional dishes Batchyra or Atakana, which are commonly consumed by all producers. These foods are often paired with maize-based dishes, such as cooked meats, dairy products, or consumed raw foods. In southern Ethiopia, festivals are incomplete without the inclusion of enset-based foods, highlighting the integral role they play in local culinary traditions. The extent of end product consumption is influenced by factors such as the type of products available, seasonal variations, Enset harvesting levels, household size, and community wealth. This output is in line with [29], which indicated that enset is known for its important role in food provision and environmental conservation.

According to the [30] report, enset production is quantified based on the number of harvested trees, processed products, and cultivated areas nationwide. From a total of 206,422,619 harvested Enset trees, the production levels of Amicho, Kotcho, and Bula were estimated at 57,189,207.53 quintals, 63,445,734.57 quintals, and 1,850,753.1 quintals, respectively. However, this value only accounts for the unprocessed enset products. Through value addition processes, the market value of Enset products is significantly enhanced, estimated at 3.75 billion Birr annually.

Own calculation for survey data,2024 and [30]. The rank of producers across regions reveals varying contributions (Table 4), with Oromiya, Sidama Region and South West ranked first, second and third for processed and unprocessed Enset products respectively, while South Ethiopia and Central Ethiopia ranked fourth and fifth. The significance of enset as a food source is reflected in social capital, land ownership, farm size, and household characteristics. Enset production has seen an increase in the number of harvested trees and yields across districts in the Wolaita and Kembata zone. While production levels remain similar between the two zones, there is noted divergence, indicating changing dynamics in enset cultivation and utilization practices [19].

Table 4. Major Enset products and its Marketable values in Ethiopia.

Producer Regions & Zones	Enset Harvested	Production In Quintals			Value Estimate of Fibre, Matured Enset, Kotcho and Bulla in Birr			
		Kotcho	Bulla	Fiber	Fiber Value	Live Enset Value	Kotcho value	Bulla value
Ethiopia	235,669,985	70,380,450.13	2,356,699.85	1572932966	3.61775e+12	41,614,071,051	1.60869e+11	11,783,499,250.00
SNNPR	73,623,923	22,087,176.90	736,239.23	491388394.4	1.13019e+12	13,000,345,219	50484881112	3,681,196,150.00
Oromiya	94,345,476	24,841,521.45	1,425,093.05	629690324.6	1.44829e+12	16,659,310,016	56780513993	7,125,465,250.00
South West	33,343,262	9,902,549	502,255	222543044.6	5.11849e+11	5,887,677,525	22634354406	2,511,273,500.00
Sidama	67,700,586	23,018,199.24	1,354,011.72	451854246.6	1.03926e+12	11,954,415,816	52612928185	6,770,058,600.00
South Eth.	21,921,610	7,054,701	423,692	146311474.6	3.36516e+11	3,870,868,138	16125000166	2,118,461,700.00
Central Eth.	16,381,902	4,801,673	169,112	109337783.1	2.51477e+11	2,892,679,073	10975231696	845,558,600.00
Gurage	8,570,865	2,571,259.50	85,708.65	57204552.81	1.3157e+11	1,513,423,888	5877153552	428,543,250.00
Hadiya	5,048,858	1,464,168.82	50,488.58	33697609.76	77504502453	891,515,886	3346665314	252,442,900.00
Kembata T.	1,195,069	298,767.25	11,950.69	7976253.006	18345381914	211,022,572	682895291	59,753,450.00
Gedio	16,086,817.00	5,308,649.61	321,736.34	107368296.3	2.46947e+11	2,840,573,634	12134033500	1,608,681,700.00
Wolaita	1,415,020	240,553.40	14,150.20	9444272.698	21721827205	249,861,020	549835311.9	70,751,000.00
Gamo	1,386,758	443,762.56	27,735.16	9255643.537	21287980136	244,870,580	1014312521	138,675,800.00
Basketo	58,966	17,689.80	589.66	393556.9702	905181031.4	10,412,082	40433752.76	2,948,300.00
Segen Peop.	1,846,995	683,388.15	36,939.90	12327404.88	28353031222	326,138,185	1562027128	184,699,500.00
Halaba	4,450	1,304.71	62.69	29700.64982	68311494.58	785,771	2982188.694	313,450.00
South Omo	1,127,054	360,657.28	22,541.08	7522300.265	17301290610	199,012,637	824357951.5	112,705,400.00
Silti	1,182,228	355,847.31	17,096.79	7890548.277	18148261038	208,755,137	813363754.9	85,483,950.00
Yem	380,432	110,325.28	3,804.32	2539118.564	5839972698	67,175,819	252171595.7	19,021,600.00

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In the districts within the Kembata zone, Enset serves as the primary dietary staple consumed throughout the year, and is enjoyed in various forms and on different occasions. It is regularly consumed as the main meal for dinners, suppers, and breakfasts, and it plays a significant role as a key ingredient in festival dishes. During major holidays, such as festivals, every household in the district prepares and consumes Enset-based dishes such as Atakana, which is a prominent traditional dish enjoyed across the region. The estimated food value Kotcho and Bulla for the Wolaita zone was 620.59 million Birr. Similarly, in the Kembata zone, the tradable value of Kotcho and Bulla was estimated to bear 74.65 million Birr.

Enset consumption occurrences preference depends on the potentiality of the study zone (Table 4), its area coverage, market distance, farmers training centre distance, Enset source and quantity harvested and family size. The outcome variable, consumption occasion of Enset production levelled as 1 for dearth period consumption, 2 for dearth period and festival consumption and 3 for whole year consumption. The regression result (Table 5) implied that if we increase the level of Enset area holding by a unit (timad), market distance (walk minute), farmers training centre distance (walk minute) and number of Enset harvested, the ordered log-odds of consuming enset for whole year increases by about 3.99, 1,1.01 and 1.07 respectively , holding all other regressors constant. As it illustrated in the Table 5 that if we increase travel by 1 unit of potential district (i.e. going from Wolaita to Kembata zone), the odds of whole year consumption vs. the combined dearth period and festival consumption are 3.95 times greater than if neither the household from less potential Woredas , ceteris paribus. For frequent consumption, small holder farmers needs to source from their own production, harvest more enset annually, dwell far away from farmers training and market centres and in the vicinity of potential production zones. The result also in line with [31] that reported the long-term practices and experiences in cultivation, utilization, and conservation of Enset landraces defined as function of their domestic and market purposes, agro-climatic differences, ethnicity factors, food cultures, and historical backgrounds. The study results supported by [32] that reported economic viability of Enset enhanced by adapting food use strategies, maximize the utilization of enset resources and promoting enset intensification in regions where it is not currently cultivated.

Table 5. Marginal effects of factors affecting consumption periods of Enset foods.

Variables	dy/dx	Std. err.	z	P>z	[95% C.I.]		X
Zone	0.3600	0.0655	5.50	0.000***	0.2316	0.488434	1.5129
Enset harvested	0.0155	0.0032	4.90	0.000***	0.0093	0.021642	17.4326
Enset area timad	0.3115	0.0894	3.49	0.000***	0.1364	0.486701	0.4286
Age	-0.0008	0.0020	-0.38	0.705	-0.0047	0.0032	47.2565
Education level	0.0075	0.0072	1.04	0.296	-0.0066	0.0215	4.9119
Market distance	0.0014	0.0007	1.94	0.052**	-0.00001	0.0027	65.5803
FTC distance	0.0031	0.0015	2.06	0.039***	0.0002	0.0059	24.5544
TLU	0.0266	0.0272	0.98	0.329	-0.0267	0.0799	2.5801
Family size	-0.0224	0.0119	-1.88	0.060**	-0.0458	0.0009	6.9845
Enset source	0.2192	0.0492	4.45	0.000***	0.1227	0.3157	0.6554
(*) dy/dx is for discrete change of dummy variable from 0 to 1							

Source: own survey data, 2024; Statistical significance is indicated by *** and ** at 1% and 5% respectively.

The regression implied that whole year Enset consumption and utilization attribute of its production can be promoted by potentiality of zone, number of Enset harvested, Enset area coverage, distance to farmers training centre and market distance. Promoting Enset food consumption is provoking organic feeding for human, livestock and environment that can be enhanced by improving service sectors access, improving economic variables of cultivators and well-functioning of institutional sectors.

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Level of Enset holder and Area coverage across regions

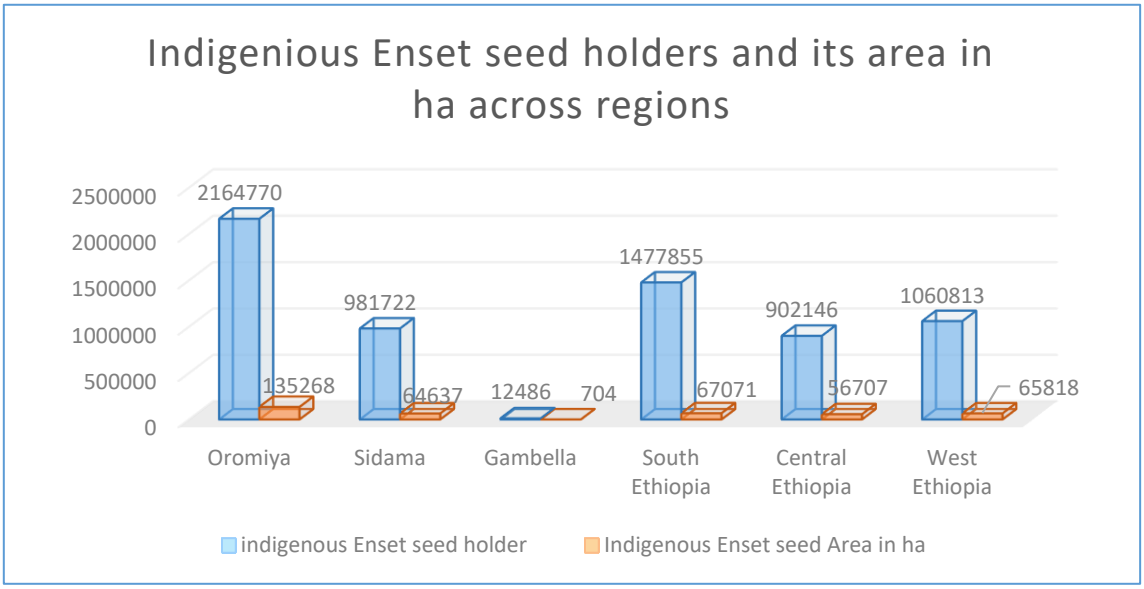

Figure 4. Indigenous Enset holders and its area across regions.

The figure above illustrates that majority of Enset cultivators and its area coverage found in Oromiya,South Ethiopia, West Ethiopia and Sidama regions. This calls for integrated and all regions inclusive action for Enset improvement and genetic conservation.

3.3.2. Feed Value of Enset Production in Study Zones

The feed benefits of the enset crop are highly appreciated and referred as feed security crops by producers used for the whole year and ranked first in the level of consumption from production. In relation to the production level, the farming season and its application as both basal and supplemental feed for large ruminants, shots and equines. Enset crops are consumed by calves and kids' for growth, bulls and heifers for maintenance, oxen in fattening and dairy cows for milk production [33]. The utilization and value of enset feed in the Kembata Zone vary depending on several factors including district, season, agroecology, and land size. Smallholder farmers with larger Enset cultivation areas typically use the crop for feed throughout the year, providing it as both basal and supplemental feed for their livestock. Conversely, households with smaller Enset cultivation areas tend to use the crop only during specific periods, such as the dry season, and primarily as basal feed. These periods of enset utilization of feed coincide with times of scarcity. In the Kembata Highlands, a higher proportion of farmers use enset as their primary feed than in the Wolaita districts. This finding is consistent with that of [4], who suggested that Enset constitutes a significant portion of livestock feed owing to its protein-rich composition.

The utilization patterns of Enset parts for livestock feed varied among the study districts, with leaves, pseudo-stems, and corms being the major parts provided to livestock. The proportion of smallholder farmers using these parts for feed in Doyogena, Katchabira, Damot Sore, and Damot Gale was 90%, 69.62%, 33%, and 67%, respectively. Specifically, in Doyogena, 90% of farmers use all parts of the Enset plant for feed, 8% use only leaves, and 3% use only leaves and pseudo-stems.

The estimated value of Enset feed in Wolaita amounts to 5259.47 Birr annually per household, calculated based on the average number of months Enset is used as feed and the daily feed cost for one production period. In the Kembata zone, the feed value of Enset is estimated at 29,190 Birr annually, calculated as the product of daily feed costs and number of feeding days per year.

Supporting Enset producing is inducing climate smart agriculture, improving productivity of agriculture and assuring feed security of livestock sector that explained by demographic, social and economic variables of Enset producers. This endogenous variable, attributes of Enset for feeding

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levelled as feeding at the dearth period only, feeding at dearth plus supplement occasions for half of the year and feeding the whole year. The parameter estimate of the regression result (Table 6) implies that the feeding benefits of enset are defined as functions of zone, age, number of enset harvested, Enset area coverage, tropical livestock units and family size. The results indicated promoting factors for whole year consumption of Enset feeds and its attributes listed as enset area coverage, age, enset trees harvested, tropical livestock unit and potential of the zone. The result illustrates that marginal difference in consuming Enset for whole year or on certain occasions manifested by zone, Enset area and harvest and livestock holding.

Table 6. Marginal effects of factors affecting consumption occasions of Enset feeds.

Variables	dy/dx	Std. err.	Z	P>z	[95%	C.I.]	X
zone	0.3984	0.0639	6.23	0.000***	0.27312	.523594	1.51295
age	0.0014	0.0008	1.64	0.101	-0.000264	.002973	47.2565
Education level	-0.0020	0.0033	-0.61	0.540	-0.00854	.004471	4.91192
Market distance	-0.00002	0.0002	-0.08	0.937	-0.000435	.000401	65.5803
FTC distance	-0.0003	0.0003	-1.09	0.277	-0.000902	.000258	24.5544
Enset harvested	0.0033	0.0012	2.80	0.005*	0.001005	.005689	17.4326
Enset area	0.0628	0.0289	2.16	0.030**	0.005934	.119585	.428601
TLU	0.0203	0.0109	1.84	0.066*	-0.001304	.041794	2.58013
Family size	0.0096	0.0049	1.97	0.048*	0.00007	.019137	6.98446

Source: own survey, 2024 and *** for $p < 0.001$), ** for $p < 0.05$ and * for $p < 0.01$.

3.3.3. Fibre Attributes of Enset Production and Its Value in Ethiopia

Fibers constitute a significant portion of enset-derived products obtained by harvesting and processing the plant. It serves as the primary material for crafting ropes used in tethering livestock, manufacturing sacks for storing grains, and constructing traditional houses. Fiber yield typically ranges from 475 quintals in fresh weight to 0.16 tons per hectare, as noted by [20,34,35].

In the year 2022, from a total of 235,669,985 harvested Enset trees, an estimated 1.5 billion quintals of fiber were produced. The market value of this fiber was approximated to be 3.62 billion birr, constituting 95% of the total marketable products derived from Enset. The distribution of the fiber's marketable value across regions is as follows: 39.9% from the Oromiya Region, 28.99% from Sidama Region, 9.4% from South Ethiopia, and 6.95% from the Central Ethiopia Region.

3.3.4. Soil and Water Conservation Benefits of Enset Production and Its Values

The soil and water conservation attribute of enset production is one of the most important additional services obtained from farming and is called a biological natural resource rehabilitation benefit. According to the survey, the enset plant was employed for soil and water conservation efforts within the district. As a natural method for conserving soil and water, this crop aids smallholder farmers in preserving their fertile lands, thus preventing erosion and runoff-induced loss. When cultivated in farmyards, crops intercepts runoff and diminish erosion originating from residential structures. The value of Enset as a natural soi l and water conservation tool was calculated by multiplying the daily wage rate, the time required for planting, and cost of equivalent plants needed for the district. This assessment yielded an annual valuation of 436.62 Birr for Wolaita and 1118 Birr for Kembata. The value of enset varies across districts depending on factors such as Enset area coverage, daily wage rates, and the accessibility of natural soil and water conservation plants [28].

3.3.5. Wind Break Attribute of Enset Production

The Predictand variable, wind break attribute of Enset farming is one of the key benefits of production and is referred to as natural resource rehabilitation for controlling winds and related damage. This attribute defined as 1, 2 and 3 figures high, medium and low. The wind break benefit

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is used by producers through in homestead plantations. The specific wind break attributes of enset production (Table 7) are explained by producer districts, extent of contribution in Ethiopian Birr for rehabilitation, market distance and source of the commodity for consumption.

Table 7. Factors affecting orders of wind break attributes of Enset production.

Wind break attribute	Odds ratio	Std. err.	Z	P>z	[95% conf.	interval]
Total contribution	1.00	0.000	2.85	0.00***	1.0002	1.0008
zone	0.10	0.033	-6.99	0.00***	0.0529	0.1917
age	1.00	0.009	0.06	0.95	0.9826	1.0189
Education level	1.01	0.031	0.46	0.64	0.9541	1.0789
Market distance	0.99	0.003	-3.38	0.00***	0.9860	0.9963
Enset harvested	1.01	0.010	0.96	0.34	0.9899	1.03005
Enset source	2.11	0.577	2.73	0.01**	1.2339	3.6078
Land owned	0.97	0.068	-0.39	0.69	0.8487	1.1159
TLU	0.83	0.097	-1.58	0.12	0.6622	1.0455
Family size	0.98	0.050	-0.35	0.72	0.8879	1.0859
/cut1	-5.01	0.716		-6.42	-3.6107	
/cut2	-0.91	0.631		-2.15	.3286	

Source: own survey,2024 and *** for $p < 0.001$), ** for $p < 0.05$ and * for $p < 0.01$.

The result in the table above showed that Enset provokes homestead attractiveness and environmental regulation of the communities that influenced by the district capability of producing the commodity, service sector and economic viability of producers.

3.3.6. Fuel Attributes of Enset Production and Its Values

The survey findings revealed that dried Enset leaves applied in various purposes such as fuel for fires, material for house construction, and fodder during dry periods. According to a survey, the extent of its utilization is influenced by factors such as the economic condition of the community, availability of alternative firewood and forage options, and prevailing weather conditions. The monetary worth of dried Enset leaves utilized for fuel and fodder in the Wolaita and Kembata zones is estimated at 683.81 and 184.01Ethiopian Birr, respectively. This suggests that the farming community in the Wolaita zone utilizes dried enset leaves to a greater degree than that in the Kembata zone.

3.3.7. Wrapping Attributes of Enset Production and Its Values

The wrapping advantages of the Enset plant constitute a significant feature that enables its diverse applications, and its use is influenced by factors such as varietal types, seasonal conditions, cultural practices in fencing, socioeconomic status, age, and durability. These wrapping benefits are manifest in various applications including traditional house construction, fencing, cooking, preparation of traditional football, crafting hives and livestock tethering ropes, as well as bundling items for storage and transportation. Preferences for Enset varieties regarding wrapping qualities differ based on their strength and longevity. The utilization levels of enset for wrapping purposes vary across districts and zones, influenced by factors such as Enset resource accessibility, land coverage, and growth stages.

Enset varieties preferred for their wrapping attributes, particularly for fence and house construction, include male varieties such as Sisqela, Digomerza, Gishra, Dirbo, Sorpa, Wolanche, Bishato, Unjame, Tassa, and Kesito, known for their strength in the Kembata Zone. Similarly, strong enset varieties in the Wolaita zone prized for their wrapping benefits encompass Halea, Maziya, Godariya, Badadiya, Feleqiya, Kembata, Tuzuma, Mochyiya, Daluliya, Islama, Ankkogena, Alagena, Arigama, Dokozuwa, Sheleqymiya, and Wandadiya.

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In the Wolaita Zone, the purpose of enset utilization for wrapping varies across peasant associations, influenced by factors such as the availability of enset leaves, household financial capacities, seasonal variations, and geographical considerations. The estimated market value of Enset used for wrapping in this zone is 217.49 Birr per household, calculated based on the quantity of dried Enset leaves utilized and their market price.

Conversely, in the Kembata Zone, almost all farmers utilize enset leaves for wrapping. The market value of dried Enset leaves employed for wrapping at the household level is calculated at 527.67 Birr. Additionally, Enset farming households produce various household items from dried leaves, including Jiba and traditional bee hives. The estimated market value of Jiba in this zone is 948 Birr annually per household, with an average holding of number of this product owned is 5.23±1.3. Moreover, dried Enset leaves are utilized as bedding material, with a market value estimated at 176.26 Birr per household annually.

Furthermore, in both zones, Enset leaves are utilized for house construction, aiding in the storage of crop residues and harvested crops, with an estimated annual value of 611.92 Birr per household. Additionally, Enset leaves are used for shading sown seeds of various crops, with an average of 16.63 leaves per year, resulting in a market value of 89.26 Birr.

In the Kembata Zone, the wrapping benefits of Enset are predominantly expressed in fencing, grass and firewood holding, holding harvested crops and residue, and house construction. Utilization levels of enset leaves for wrapping purposes vary across districts, influenced by enset farming levels, cereal crop farming, and topographical features.

The survey results also indicate variations in the utilization levels of enset leaves for cooking across districts. For instance, in Doyogena Woreda, over 51% of communities cook using Enset leaves daily, whereas in Kataca Bira, the usage ranges from daily to monthly frequencies. Overall, more than 46% of the communities reported practicing cooking food using Enset leaves daily. The estimated market value of Enset for cooking in Wolaita and Kembata districts is 312.60 and 1471.39 Birr, respectively.

The response variable of the regression, wrapping attribute of Enset is one of the major benefits practiced by almost all farmers who participated in production or not in the study district. The wrapping attributes level of Enset defined as daily, every three days and weekly for utilization frequency across households. The wrapping attribute of Enset was revealed in food cooking, cover for dairy products, cereal crop products, seizing grasses, wood and house construction. The wrapping attribute utilization of Enset was promoted (Table 8) by family size, potential of the zone, owned land size and multiple sources of the product. The result implied that Enset supports industrial sector and its input function the sector is explained by labour availability, potentiality of the district, economic status of producers and potentiality of the sector.

Table 8. Enset production and Factors affecting level of wrapping attribute.

Ordered Probit regression	**Number of obs =**		**386**			
	Wald chi2[10]		=		77.10	
Log likelihood = -325.14			Prob > chi2 =		0.00	
Wrapping attribute level	Coef.	Std. Err	. z	P>z	[95% Conf. Interval]	
Family size	0.07	0.027	-2.58	0.01**	-0.12	-0.07
Zone	0.66	0.16	-4.24	0.00***	-0.97	-0.36
Age	0.002	0.005	0.39	0.69	-0.008	0.012
Education level	0.004	0.02	0.20	0.84	-0.03	0.04
Market distance	0.002	0.001	-1.37	0.17	-0.005	0.0008
FTC distance	0.001	0.002	0.48	0.63	-0.004	0.006
Enset harvested	0.004	0.006	-0.65	0.51	-0.02	0.007
Enset source	0.26	0.14	1.77	0.08*	-0.03	0.54
Land owned	0.107	0.04	-2.73	0.006***	-0.18	-0.03
TLU	0.08	0.06	-1.34	0.179	-0.21	0.04

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cut1	3.36	0.37	-4.09	-2.63
cut2	1.75	0.34	-2.43	-1.08

Source: own survey,2024 and *** for $p < 0.001$), ** for $p < 0.05$ and * for $p < 0.01$.

3.3.8. Medicinal Attributes of Enset Production and Its Value Estimates

Enset is one of the major medicinal plants among the communities. Its medicinal value has been applied to both humans and animals. The mean number of *Enset* used for medicine annually was 2.9. The market price of Enset used for medicine annually is 193.24 Birr for *Wolaita* Zone and 376.19 Birr for Kembata District. The result supported by [10] that implied Enset plays a significant role in the wealth distribution and social cohesion within farming communities. Additionally, it serves medicinal purposes and exhibits resilience to environmental stressors such as frost, pests, and pathogens, and therefore warrants robust policy backing. This is also supported by result of [36], who reported that some Enset varieties were applied to treat bone problems and fed to a mother who gave birth for strengthening and fast recovery.

The major medicinal varieties of Doyogena include *Quiyna, Gishra, Sebere, Abatamerza, Oniy, Tassa, Cherqwa, Sheleqa,Sisqela, Leqaqa, and Ginbwa*. The farmers in this district confirmed that their level of utilization varies for varieties. From the varieties listed, 47% of respondents used *Qeqyile, Gishra, and Qoiyna* as medicinal plants, and the remaining proportion used other varieties. The major medicinal Enset varieties of Katchabira district include *Quiyna, Qeqyle, Gishra, Cherquwa, Tebere, Dirbo, Tasso, Sebera, and Sisqela*. The utilization frequency of certain varieties by farmers was higher than that of others. Of the listed medicinal varieties in the district, 85% of the respondents used *Qeqyle, Quiyna, and Gishara.* The major medicinal varieties of Damot Gale district of the *Wolaita* Zone include *Qabariya, Felwua, Agina, Gefetanuwa, Arikiya, Sutiya, Esilama,Wanadiya, Ankwa, Kataniya, Neqaqa, Sirariya, Shalaqumiya, Lochyngiya, Anikogena, Buluwa, Wanadiya, Arigama,* and *Feleqiya.* The major medicinal varieties listed in the Damot Sore Woreda of the *Wolaita* zone include *Arkiya, Gefetanawua, Naqaqa, Wanadiya, Kataniya, Ankwa, Suitiya, and Lochyngiya.*

3.3.9. Fertility Attributes of Enset Production and Its Value

Enset is recognized as one of the foremost crops contributing to enhanced soil fertility through decomposition, providing soil shading, and enriching it with retained water. The result is in line with [11] that realized enset's contributions in soil health maintenance. Smallholder farmers implement crop rotation strategies, utilizing Enset land for the cultivation of crops such as maize, potato, taro, and yam in succession. Typically, enset land yields are produced without the need for fertilizers for over two years on average in the district. The monetary value attributed to the fertility benefits of Enset amounts to 372.94 Birr annually in the Kembata zone and 158.56 Birr in the Wolaita zone. In particular, the significance of Enset's contribution to soil fertility enhancement was notably high in Doyogena and Kachabira. In the Kembata zone, Enset land can sustain production without fertilizer for approximately 1.99 years, while in the Wolaita zone, this duration averages approximately 1.84 years. Additionally, smallholder farmers emphasize the role of Enset in improving soil moisture levels in various parts of the plant. This result is in line with [24] who reported that enset intercropping improves soil fertility by decaying its body parts during the growth of crops grown within the vicinity of the commodity for the addition of nutrients and providing shading to the other crops.

The explained variable of fertility attribute defined as high, medium or low for application of Enset leaves for fertility of their whole land, half of their land and or home stead only. The regression results (Table 9) indicated the likelihood of small holder farmers of cultivating of more fertility attribute explained by holding of tropical livestock unit and vicinity to market points. From the included explanatory variable, the number of livestock owned is known as promoting factor for fertility attributes, while market distance is the reverse factor.

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Table 9. Determinants fertility attribute of Enset production.

Ordered Probit regression		**Number of obs**		**=**	**386**	
Wald chi2[9]		=		28.80		
Log likelihood = -323.91893		Prob > chi2 =		0.0007		
Fertility attribute	Coef.	Std. Err.	Z	P>z	[95% Conf.	Interval]
zone	0.02	0.16	0.13	0.9	-0.29	0.34
Family size	-0.05	0.03	-1.56	0.12	-0.1009	0.01
TLU	-0.25	0.07	-3.68	0.00***	-0.39	-0.12
Land owned	0.02	0.04	0.51	0.6	-0.06	0.11
Enset harvested	0.002	0.006	0.42	0.67	-0.008	0.01
Mkt distance	0.003	0.001	2.40	0.02**	0.0006	0.006
Edu level	-0.008	0.018	-0.47	0.64	-0.043	0.03
age	0.004	0.005	0.76	0.45	-0.006	0.01
Enset area	-0.09	0.14	-0.63	0.53	-0.37	0.19
cut1	-1.63	0.36			-2.33	-0.93
cut2	-0.93	0.35			-1.62	-0.24

Source: own survey,2024 and *** for $p < 0.001$), ** for $p < 0.05$ and * for $p < 0.01$.

The table above illustrates that Enset production helps to reduce production costs of farming and enhance organic farming that explained by livestock holding and proximity to service sectors.

3.3.10. Income Benefits of Enset Production and Its Values

The revenue generated from enset farming varies significantly between districts and households. In the Kembata zone, the average annual income from enset products is estimated at 910.44 Birr, whereas in the Wolaita Zone, it amounts to 39.45 Birr. In the Wolaita zone, farmers predominantly derive income from the sale of fiber, whereas in the Kembata zone, revenue sources include the sale of kotcho, bulla, and fiber. Owing to differences in production potential and product types, there is a notable disparity in income levels among smallholder farmers in the two study districts. The result is in line with [37] that implied household income directly linked with Enset cultivation.

The study result showed that the income attribute of Enset explained by the study zone, market distance, farming training centre distance, number of Enset harvested and area coverage. The small holder farmers that earn higher level income are those that dwell in potential zone, held more of Enset, live away from market centres and in vicinity to farmers training centre and harvest more number of Enset. The study points out that the availability of opportunity to earn higher income associated with production promotion and extension service. The result is in line with [23], who reported that the farmers in the highlands of Southern and South Eastern Ethiopia depend upon enset for income and other multiple benefits.

The outcome variable is income attribute level of Enset that grouped as high, medium and low for more than thousand birr, between nine hundred ninety nine Birr to five hundred Birr and less or equal to four hundred ninety nine Birr income contribution of the households, respectively. The income attribute level of enset producers (Table 10) is directly related to the potentiality of districts, market distance, number of the commodities harvested annually and multiple source of enset for consumption such as market and own production. The result also showed a trend of negative association between incomes attribute level and farmers training centres distance. The finding indicated that marginal gain of Enset income can be influenced by agroecology, improved service sector and promoting market oriented production.

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Table 10. Marginal effects of determinants of income earned from Enset production.

variable	dy/dx	Std. err.	Z	P>z	[95% C.I.]		X
Zone	0.1250411	0.02591	4.83	0.000***	0.074	0.176	1.513
Age	0.0000168	0.00072	0.02	0.981	-0.001	0.001	47.257
Education level	0.0041668	0.00272	1.53	0.126	-0.001	0.009	4.912
Market distance	0.0004882	0.00023	2.12	0.034**	0.000	0.001	65.580
FTC distance	-0.0015749	0.00059	-2.67	0.008**	-0.003	0.000	24.554
TLU	0.0024474	0.0092	0.27	0.790	-0.016	0.020	2.580
Family size	-0.003759	0.0043	-0.87	0.382	-0.012	0.005	6.984
Enset harvested	0.0048258	0.00102	4.75	0.000***	0.003	0.007	17.433
Enset source	0.0769892	0.02475	3.11	0.002**	0.028	0.126	0.429

Source: own survey,2024 and *** for $p < 0.001$), ** for $p < 0.05$ and * for $p < 0.01$.

3.3.11. Social Benefits of Enset and Its Value in Study Zones

The societal significance of enset cultivation underscores its importance within communities, its cultural function, and its integral role in traditions, livelihoods, and food systems. The result also supported by [10] that reported that Enset plays a significant role in socializing the community in various ways. Research indicates that during religious festivities, Enset-based foods hold paramount value for traditional meal preparations, either on their own or in combination with other ingredients. A prevalent traditional dish during the Meskel festival, known as Bachyra in Wolaita and Atakana in Kembata districts, exemplifies this significance. This special dish comprises a blend of kotcho, bulla, milk, butter, and spices. Enset derived foods are commonly paired with raw and cooked meat, cheese, and milk. Furthermore, Enset products such as Kotcho, bulla, and corm are often shared as gifts with neighbouring communities, particularly benefiting relatives and economically disadvantaged groups. This practice of freely giving Enset products fosters social cohesion within districts and strengthens inter-community ties. The estimated annual value of the enset products given freely per household in the Kembata zone is 437.92 Birr.

This finding aligns with the observations of [38], who highlight enset cultivation as a cultural emblem for Kembata communities, symbolizing their identity. The significance of Enset as social capital, a source of communal support, and a catalyst for community collaboration is invaluable. It holds potential for furthering cooperation in development initiatives, including genetic conservation efforts, the enhancement of Enset-based commodities, and the overall welfare of communities.

In the Wolaita zone, smallholder farmers traditionally offer enset products to other households, with the provision being contingent upon factors such as the availability of enset products, the season, the economic status of the household, and specific occasions. Enset seedlings and corms are shared during planting seasons, dry and green enset leaves are provided year-round, and Enset Kotcho is distributed during periods of scarcity. The primary Enset products shared with other households included Kotcho, seedlings, corms, green, and dried leaves. The estimated annual market value of freely given enset products in the Wolaita zone amounts to 183.53 Birr.

The free provision of Enset products is known as the major benefit of Enset production, which is highly important for social ties and community development. The gift attribute that represents dependant variable of the model of Enset levelled as zero for no provision, one for up to 400Birr valued provision and three for 401Birr and above gifts. The ordered regression results (Table 11) predicted that the rank for social attribute level of Enset provision defined as function of potentiality of the districts, tropical livestock unit, and number of enset harvested, market distance and age of small holder farmer. The result implied that certain variables such as tropical livestock units, more enset harvesting and market distance to the residence of the respondent showed a promoting effect on free provision of enset for their surrounding communities. The findings revealed that Enset production helps to develop social capital that by its own can be enhanced by economic viability of producers and infrastructural improvement.

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Table 11. Determinants of free provision of Enset products as social benefits .

Ordered Probit regression		**Number of Observation =**			**386**	
		Wald	chi2[11]	= 181.68		
Log likelihood = -277.85		Prob	> chi2	= 0.00		
Gift attribute level	Coef.	Std. Err.	Z	P>z	[95% Conf. Interval]	
zone	0.98	0.17	5.89	0.00***	0.65	1.31
Family size	0.01	0.03	0.46	0.65	-0.05	0.07
TLU	0.31	0.07	4.42	0.00***	0.17	0.45
Land owned	0.006	0.05	0.14	0.89	-0.09	0.09
Enset source	0.15	0.16	0.90	0.37	-0.17	0.47
Enset harvested	0.03	0.007	4.70	0.00***	0.02	0.04
FTC distance	-0.003	0.002	-1.51	0.13	-0.008	0.001
Market distance	0.003	0.002	2.12	0.03**	0.0002	0.006
Education level	0.007	0.02	0.36	0.72	-0.03	0.045
age	-0.01	0.005	-2.39	0.02**	-0.02	-0.002
Enset area	0.10	0.14	0.73	0.46	-0.17	0.38
cut1	2.65	0.38			1.89	3.40

Source: own survey,2024 and *** for $p < 0.001$), ** for $p < 0.05$ and * for $p < 0.01$.

3.3.12. Rainwater Collection Benefits of Enset Farming and Its Values

The degree to which enset leaves are utilized for rainwater collection is influenced by housing design and seasonal variations. A notable contrast exists between the study districts regarding the extent of enset leaf utilization for this purpose. Approximately 25% of farming communities in Doyogena and 47% in Katcha Bira districts have historically applied Enset leaves for rainwater collection. On average, the quantity of water collected using Enset leaves amounts to 838.55 litters, valued at 74.85 Birr for households in the Kembata zone. In contrast, in the Wolaita Zone, the annual market value of rainwater collected using Enset leaves totals 32.94 Birr, with an average water collection of 588.18 litters per household annually for Wolaita districts. The proportion of households utilizing Enset leaves for rainwater collection stood at 48.97% in Damot Sore and 43.75% in Damot Gale districts.

3.3.13. Biodiversity Benefits of Enset Production and Its Value

Enset biodiversity refers to refers to the diversity of varieties cultivated among smallholder farmers and across districts. The assortment of enset varieties and their prevalence across zones and districts varies according to factors such as farming practices, Enset cultivation area, cultural preferences, and dietary habits. In the Wolaita zone, farmers' preferences for specific Enset varieties are influenced by various factors including the suitability of corm for consumption, the strength of leaves for medicinal purposes, leaf colour, fodder quality, and societal norms. Corm varieties are particularly favoured by smallholder farmers for their consumption of milk products, constitute significant cultural dishes in the region. The finding is in line with [3,23] that implied the knowledge system, socio-cultural characteristics, and communal practices related to enset cultivation greatly contribute to preserving enset diversity in Wolaita, South Ethiopia [3,39].

Enset varieties are categorized into female and male varieties, as well as corm, kotcho, bulla, and fiber varieties, each serving distinct purposes such as medicinal, fodder, fence and dietary uses in both Wolaita and Kembata regions. A single enset variety may offer multiple benefits and can be further classified as male or female. Male Enset varieties are noted for their high kotcho yield, large size, and resistance to diseases, pests and rain shortages. Bulla varieties are also known as kotcho varieties. Female Enset varieties, on the other hand, are characterized as sweet, soft, small, and among the most exhaustively used varieties. Male Enset varieties are preferred for purposes such as fencing, housing, windbreaks, and fodder. It is recommended to cultivate a combination of male and female

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Enset varieties to optimize Kotcho production, a finding supported by previous research such as that of [40], who reported the existence of over fifty-five Enset clones with various utilization purposes.

The major kotcho varieties identified were Halea, Esilama, Ankogena, Gefetanwua, Neqaqa, Wanadiya, Arkiya, Shelequmiya, Mochiya, Tuzuma, Adinano, Kataniya, Qebariya, Lembwua, Gena, Arigema, Fellwua, Badadiya, Sirariya, Dokozwua, Chychya, and Adinona. The fiber enset varieties listed in Wolaita include Halea, Shalaqumaiya, Gefetenawu, Esilama, Godoriya, Kataniya, Felwua, Mochiya, Maziya, Tuzuma, Wanadiya, Arigama, Badadiya, Alagena, Feleqiya, and Sirara.The reported corm varieties included Neqaqa, Shalaqumiya, Agina, Qabariya, Katanya, Gupanaiya, Arkiya, Queiyns, Gidarete, Felwua Quiyna, Suiytiya, Chychiya, Gefetnawua, Neqaqa, Shalaqumiya, Arkiya, Qabariya, Bullwua, Kataniya, Silqanatiya, and Ginwa.The bulla varieties identified include Halea, Gefetanwua, Esilama, Ankogena, Shalaqumiya, Neqaqa, Wanadiya, and Arkiya. This finding is consistent with the observations of [41], who noted variations in the responses of cultivars to different nematodes and the availability of resistant and susceptible Enset varieties.

The biodiversity attribute of Enset is expressed as a variation of varieties for benefits of food, feed, medicine, fertility, and wrapping. Enset is also described as male and female, hard and strong, big and small varieties. Biodiversity level is levelled high for more than ten varieties, medium for five to ten and low for less or equal to four types per individual producer households. The dependant variable, level of biodiversity attribute (Table 12) is defined as a function of zone, enset area, Tropical Livestock Unit, father enset area, educational, farmers training centre distance and enset harvested. There is greater likelihood to have higher biodiversity level of Enset for the small holder farmer that dwell around Wolaita than Kembata zone, own more Enset area on fathers land and educated more. The results also indicated that there is less likelihood of having higher biodiversity that own more own Enset land area, harvests more Enset and live in vicinity to farmers training centre. The results point out community and family based intervention and education promotion can help the conservation of biodiversity for optimal utilization and improved production. This result is in line with [42],who reported that enset richness and diversity in production regions demands conservation for enhanced food security of farmers at household. The finding also supported by [30] who implied that Enset producers held 15-56 Enset varieties to meet with their diversified demands of nutritional, fiber, fermentative quality, yield and disease and drought resistance. The research findings points out that marginal gain of Enset biodiversity can be improved by training, infrastructural improvement and social capital development.

Table 12. Marginal effects of factors affecting level of Enset biodiversity.

Variables	dy/dx	Std. err.	Z	P>z	[95% C.I.]	X
Zone	-0.0145984	0.008	-1.82	0.068*	-0.030281 0.001085	1.52381
Enset area	-0.0240554	0.00694	-3.47	0.001**	-0.037651 -0.01046	0.712235
TLU	-0.0034896	0.00217	-1.61	0.108	-0.007746 0.000766	2.7977
Father Enset area	0.0051296	0.00279	1.84	0.066*	-0.000332 0.010591	1.40828
Age	0.0000922	0.00011	0.82	0.411	-0.000128 0.000312	47.3228
Education level	0.0009142	0.00053	1.72	0.085*	-0.000126 0.001955	4.96032
Market distance	0.0000337	0.00005	0.73	0.464	-0.000057 0.000124	65.7513
FTC distance	-0.0002812	0.00017	-1.70	0.088*	-0.000605 0.000042	24.7963
Family size	0.0009385	0.00074	1.27	0.205	-0.000512 0.002389	7.00794
Enset harvested	-0.0003654	0.00021	-1.73	0.084*	-0.00078 0.00005	17.5423

Source: own survey,2024 and *** for $p < 0.001$), ** for $p < 0.05$ and * for $p < 0.01$.

4. Conclusions and policy Recommendation

Enset, a climate-smart, adaptable, eco-friendly, productive, and versatile crop, serves as a cornerstone of livelihoods and economic sustenance for a quarter of Ethiopia's population. The marketable worth of three primary enset outputs, Kotcho, Bulla, and fiber, indicated a significant contribution to the economy of the commodity for communities in the producer region and

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nationwide. These economic benefits include food, fodder, biodiversity, wrapping, land rehabilitation, social cohesion, ornamental and medicinal values. Preferences for enset benefits varied across districts and producer households. The first, second, third and fourth ranked attributes of Enset were food, feed, biodiversity, wrapping and land rehabilitation. The study summarized these benefits of Enset cultivation in to attributes of food, feed, biodiversity, land rehabilitation and wrapping. Medicinal and income attribute merged into food attributes for the commodity consumed for health cases and marketable portion is consumable part of the commodity. Wrapping attribute comprised inputs benefits of Enset for house construction, fence, holding harvested crops and dairy products, fuel, fiber and goods preparation. Land rehabilitation services expressed in soil fertility, moisture conservation, soil and water conservation, windbreak and ornamental benefits. The multi-functional nature of Enset farming directs all stakeholder cooperation and strong policy support for improving Enset cultivation. Its improvement also refers to improving productivity of various sectors, sector to sector linkage and knowledge sharing of stakeholders and welfare improvement of small holder farmers.

The nutritional value of Enset products is contingent on the harvesting methods and other food ingredients utilized in the process. Bulla, in particular, is noted for its nutritional richness and historical use as a staple food, particularly among soldiers. Its long shelf life and direct conversion into nourishment make it a convenient and practical food source, particularly for vulnerable groups such as elderly and young children. As a major food crop, enset serves as a significant source of food for communities, providing sustenance in various forms throughout the year. The feed attribute of the commodity is manifested in its consumption for livestock as both supplement and basal purposes, enset that is highly rated. This suggests that enset plays a crucial role in providing feed for livestock, contributing to the availability, access, utilization, and stability of feed in livestock farming systems. Enset production also provides wrapping benefits, which include its use in house construction, fencing, and holding harvested grains and dairy products. Enset generates income through products such as Bulla, Kotcho, and fibers. The findings underscore the multifaceted benefits of enset for both communities and the nation, emphasizing the need for comprehensive policy and research interventions to optimize its utilization and ensure sustainability. Integrated research and development initiatives, community-driven promotion efforts, and practical demonstrations can further enhance the utilization and sustainable management of the Enset crop. The multiple attributes of enset production are explained by the socioeconomic, demographic and institutional features of small holder farmers. enset is a versatile and valuable crop that provides a range of benefits beyond its role as a food source, including livestock feed, construction materials, culinary ingredients, and income generation. The Enset consumption occasions directly linked with zone, Enset harvested, Enset area, market distance, famers training centre distance and its source. Feed and wrapping attributes of Enset production is expressed in zone, family size, Enset area, TLU, family size, Enset harvested and source of Enset. Immediate action designed for sustainable use this precious resource is promotion of Enset food, biodiversity and feed consumption among Enset producers, on producer and none producer regions and in pastoral and agricultural system of the country.

Promoting and identifying key economic attributes of Enset production lays excellent foundation of Enset rehabilitation. These precious Enset resources with its ample benefits for the community and country economy needs community based and multiple stakeholder's action for optimization. The community based strategic actions designed for research and development intervention comprised collection, maintenance and development varieties, bacterial wilting and pest control and practical training. The stakeholders that can play constructive function in development of Enset farming include universities, small holder farmers, pastoralists, international, federal and regional research institutes, ministry of agriculture, urban, water, health, youths and women and environments.

The implication of policy direction points out inclusion of Enset attributes in every green legacy, shot run and long run agriculture, environmental rehabilitation food and feed improvement program and welfare improvement strategies of the communities. Promoting food attributes is supporting

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food and nutrition security, eradicating poverty and reducing food costs, accessing organic system for agriculture and developing climate smart agriculture. Enabling consumption Enset feeds is gender mainstreaming, adding feed security for livestock sector, improving productivity and opening door for consumption of organic dairy and beef products and getting path to international market through these outputs. Developing opportunities for application Enset leaves and by-products for fertility is creating healthy environment for next generation and current farming system and reducing costs of farming. The limitation of the study was just carrying out only one year cross sectional survey data on only selected districts and peasant association that further needs panel and longitudinal study for dynamism of production, evaluation of its impact and synthesis more soundly findings.

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