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RESEARCH ARTICLE

DIVERSITY, INDIGENOUS KNOWLEDGE AND MANAGEMENT OF ENSET DIVERSITY ON-FARM: EVIDENCE *FROM KEMBATATEMBAROZONE, ANGACHAWOREDA*, ETHIOPIA

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ABSTRACT

Enset, *Enseteventricosum*, is a crop that contributes to food security for more than 20 % of Ethiopia's population. The objective of the present study was to understand farmers' knowledge to enset diversity management and their response to EXW. A total of 80 farm households were surveyed using individual household interviews. Sixty-five cultivar names were recorded for the study area. The number of cultivars cultivated on individual farms ranged from 4 to 10 (with mean of 9.3). Farmers primarily prefer cultivars with good kocho and bulla yield and quality and 10 enset cultivars having merits of it were encountered on above 50% of the farms visited. Farmers as tolerant to enset bacterial wilt identified seven cultivars. Farmers identified various enset production constraints in their locality. 30% of farmers reported the existence of EXW in their fields. Most farmers' understanding of how disease is caused had no basis in scientific fact, citing birds, insects, wind and highly fermented dung during wet season as the causal agents of the bacteria, while nearly 25% said they did not know. An understanding of cultivar distribution and selection criteria will assist future germplasm conservation to ensure continued food security. Therefore, in order to maintain enset genetic diversity and to reduce the likelihood of incursion of EXW in enset crops, a systematic operational approach to the management of EXW should be adopted.

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INTRODUCTION

Enset is an important staple crop for about 15 million people living in the densely populated regions of South and Southwestern Ethiopia; the crop grown in mixed subsistence farming systems (Zippel 2002). Ensetalso utilized for livestock feed, fuel wood, construction materials, containers, and to shade other crops (Shigeta 1991). The major food types obtained from enset are *kocho*, *bulla* and *amicho*. *Kocho* is fermented starch obtained from decorticated (scraped) leaf sheaths and grated corms. *Bulla* is a liquid which is obtained when leaf sheaths and corms are pulverized, the liquid containing starch is squeezed out from scraped leaf sheathes and grated corm and the resultant starch allowed to concentrate into white powder. *Amicho* is boiled enset corm pieces that are prepared and consumed in a similar manner to other root and tuber crops (Brandt *et al.* 1997). Agro-biodiversity in Ethiopia strongly linked with local communities who are always embedded by their local ecosystems, modifying them and being modified by them (IBCR 2001). Numerous practices of enhancing biodiversity are tied to the rich cultural diversities and local knowledge of Ethiopia (TessemaTanto and Girma Balcha 2003). The diverse farming system of the country is traditional and based on small-scale production, which is managed with simple production technology. In this production system, the components of agro-biodiversity offer diverse services and benefits that vary according to farming systems. The services provide a range of options with multiple uses, particularly in food and in meeting local changing environmental and socio-economic needs (IBCR 2001). Like in many other developing countries farmers in Ethiopia, maintain a number of landraces of crops on their small plot of land because no single variety can satisfy their basic needs. It is also stated in IPGRI (1999) that the local varieties fit easily into traditional farming system, and this will enable farmers maximize returns using low levels of technology and limited resources. Tsegaye (2002) reported that numerous enset cultivars were identified in each region and the variations in the number of cultivars were attributed to a combination of socio-cultural and agro-ecological factors. Furthermore, Birmeta (2004) reported that the observed genetic diversity in cultivated enset in a particular area appears to be related to the extent of enset cultivation and the culture and distribution pattern of the different ethnic groups. A number of researchers have reported that the communities that cultivate and use the crop in Ethiopia recognize and maintain a considerable assemblage of enset

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varieties (Yemataw *et al.,* 2014(b); Tesfaye and Ludders 2003; Tsegaye and Struik 2002; Shigeta 1996). The different varieties are individually identified and given separate names by farmers. Despite this, the current agricultural policies largely focus on national or regional important crops without due consideration of indigenous crop production. Major agricultural development programs are biased towards the cultivation of high yielding commercial crops. However, this does not seem realistic, especially to subsistence farmers in developing countries like Ethiopia, who prefer to increase their option by diversifying their small plots of land rather than homogenizing them with high external inputs and varieties. Indigenous knowledge is used to sustain the community and its culture. Placing value on such knowledge could strengthen cultural identity and the enhanced use of such knowledge to achieve social and development goals, such as sustainable agriculture, affordable and appropriate public health, and conservation of biodiversity. Jabulani (2007) averred that Indigenous knowledge is an essential resource for any human development process. Enset in KembataTembaro zone Angachaworeda is one of the major sources of food and contributes significantly to household food security. Since the last few decades, however, farmers declared that the production of the crop has been declining. Introduction of new species of cereal crops, recurrent droughts, land scarcity, long maturation period coupled with disease and pest are the major factors that have contributed to the decline. The local knowledge of the woreda on the use and management of enset has not been studied exhaustively and also not well documented. The objective of the present study was to obtain an understanding of cultivar diversity, distribution and to exploit farmers' indigenous knowledge on enset cultivar diversity management through the use of farmer interviews.

MATERIALS AND METHODS

Description of ethno botany study site

The present ethno botanical study was conducted in the KembataTembaro administrative zone of Southern Nation and Nationalities People Region. Angacha is one of the woredas of the zone where this study was carried out. The selection was based on the interest of the donor organization. It is one of the districts of Kembata-Tembaro zone where enset is still grown widely. The study area is believed to have ample genetic diversity and local knowledge on the use and management of enset.

Sampling and Data collection

Discussions were made with experts working in agriculture and rural development offices to select the representative study sites within the district. For this purpose the smallest administrative unit in the district Kebele Administrative (KA) was used. Eventually, following the discussion and based on the available secondary data, ten KA were selected for interviews. Preliminary field visit was made prior to the actual field work in the selected KA in order to familiarize with the area and development agents working there. During the survey leaders of the peasant associations and development agents working in each peasant associations assisted us in producing the list of farmers growing enset. From the list informants were selected randomly, and this random sampling permitted all wealth categories to be represented. Eight households were randomly selected from each KA, giving a total of 80 households across the woreda. Interviews were conducted with the head of the household or the person responsible for maintenance of the enset plantation. Before starting the interview session, time was devoted to introducing the subject and the purpose of the study. The households were interviewed using a semi-structured questionnaire at KA level. The questionnaire covered different topics such as information about the study area, landholdings, crops commonly grown and specific information on the use and management of enset. The detailed information

RESULTS AND DISCUSSION

Importance of Enset in the Farming System

In Angacha, enset, wheat, Field pea, Potato, Barley, Faba bean, Common bean, Maize, Teff and vegetables and fruits were cited as the most cultivated crops. For 80.98% of the surveyed farmers (32.28% as principal and 48.70% of response as major), enset was the main cultivated crop in terms of allocated area (Table 1). The number of crop species grown in a farm is an important indicator of diversity. The main staple food enset is primarily an energy producing food. Nutritionally, the composition of crops widely produced and consumed in these farming systems is largely dominated by energy producing food crops. Enset and cereal crops cover nearly half of the crop fields are predominantly energy producing crops. Enset is the staple food and Wheat is the major cash earner in the areas, and thus they are produced in large quantities. Abebe (2005) reported the occurrences of 78 cultivated crops are grown with an average of 16 crops per farm in the home gardens of Sidama zone. Out of the total number of 78 crop species, 84% were food crops and spices. The multistory configuration and high species diversity of home gardens is believed to avoid the environmental deterioration commonly associated with mono cultural production systems (Fernandes and Nair, 1986). Table 1. Common food crops and area of production.

Table 1. Common food crops and area of production

Crops	Mean farm area coverage (%)
Enset	27
Wheat	19
Field pea	17
Potato	9
Barley	8
Faba bean	8
Common bean	4
Maize	4
Teff	4

Enset Cultivar Richness and Diversity

A total number of 65 cultivar names were recorded for the study area (Table 2). The number of cultivars cultivated on individual farms ranged from 4 to 10 (with mean of 9.3) (Table 3). Majority of the farms surveyed (73.5%) constitute 6-10 enset clones per farm (Table 3). The woredaenset farming system is rich in cultivar diversity. For instant, in previous studies, comparable results were reported by Yemataw*et al.* (2014(b)), who described 43 different enset cultivars Doyogenaworeda, KembataTembaro zone.

Farmers' selection criteria as a means for genetic diversity maintenance

Farmers in the study area use a combination of similar criteria to name enset clones (Table 4).

Table 2. Name of enset clones based on farmers naming in AngachaWoreda

No.	Clone name	No.	Clone name	No.	Clone name
1	Siskela	23	Desho	45	Qerqwa
2	Wachiso	24	Fechase	46	Wolegella
3	Sorpe	25	Woea	47	Godorote
4	Gishra	26	Qoyna	48	Wojo Siskela
5	Unjamo	27	Mariye	49	Gambala Sisqela
6	Etine	28	Agena	50	Awanada
7	Shleqeta	29	Usqureze	51	Astara
8	Dirbo	30	Qeqile	52	Guarye
9	Merza	31	Moche	53	Agade
10	Ginbo	32	Wollanche	54	Qinware
11	Mesmesa	33	Hargema	55	Dangicho
12	Dereqeta	34	Abatmerza	56	Eniwara
13	Mendeluqa	35	Kesse	57	Henwa
14	Torore	36	Kerbo	58	Degomerza
15	Tessa	37	Sonadiya	59	Lukanda
16	Weshemeda	38	Qrqare	60	Derga
17	Leqaqa	39	Cherqwa	61	Felegede
18	Dego	40	Fechache	62	Gunze
19	Tebere	41	Menera	63	Keshela Dirbo
20	Sabara	42	Shelequme	64	Lenbo
21	Hella	43	Wongorote	65	Zobira
22	Bokako	44	Oniya		

Table 3. Enset clone diversity in the woreda, Expressed as richness

Number of clones per Farm	Number of farms (N=80)
≤ 5 clones	11
6-10 clones	59
11-15 clones	10
≥15 clones	0
Total (Richness)	65
Mean Richness/Farm	9.3
Minimum Richness/Farm	4
Maximum Richness/Farm	10

Table 4. Farmers' criteria for classification of enset clones

No.	Trait
1	Plant vigor
2	Maturity (cycle duration)
3	Kocho yield
4	Bulla quality
5	Corm use
6	Fiber quality
7	Medicinal value
8	Disease response
9	Petiole color
10	Midrib color
11	Leaf color (upper surface)
12	Drought tolerance
13	Culinary quality

Table 5. Name of the most abundant and well distributed enset clones in Angachaworeda

No.	Name of clone	No. of surveyed farm/district (N=80)
1	Gishera	45
2	Leqaqa	45
3	Sisqela	60
4	Gimbo	45
5	Astara	42
6	Dirbo	46
7	Etene	48
8	Merza	46
9	Sheleqe	45
10	Unjame	46

Table 6. List of enset clones identified by farmers as being *Xanthomonas* wilt tolerant and used for medicinal purposes

Xanthomonas wilt tolerant clones		Clones used for medicinal purposes	
No.	Clone name	No.	Clone name
1	Abatmerza	1	Astara
2	Dirbo	2	Bedadia
3	Hawe	3	Chamia
4	Jegeda	4	Gishera
5	Kekere	5	Guarye
6	Mariya	6	Hargamo
7	Mesmesa	7	Ored

Table 7. Trend of enset production in Angacha Wereda

Variables		Percent of respondents (%)
Trends of enset production in the last 15 years	Increasing	7.6
	No change	10.3
	Decreasing	82.1
Reason for changes in trends of enset production	Frequent drought and climate change	61.0
	Occurrence of disease and pest	5.6
	Proper management	22.2
	Low productivity due to EXW	5.6
	Shortage of pure seedlings	2.8
	Increased use for meal and feed	2.8
Reasons for loss of enset landraces in the last years	Disease and pest	28.6
	Drought	14.3
	Poor management	57.1

Table 8. Farmers' perceptions on EXW symptom, causal agent and mechanism of transmission in Angachaworeda

Variable	Category	Proportion of respondents (%)
Identify EXW infected enset	Yes (%)	100
	No (%)	0
How do you identify if it is EXW or not? (%)	Yellowish leaf	60
	Start in florescence and goes to other parts	11.25
	Wilting and yellowish leaves	28.75
Cause of EXW (%)	Wind	40
	Highly fermented dung during wet season	21.25
	Insects	11.25
	Birds	2.5
	Unknown	25
Mechanism of EXW disease transmission from external source to farmer field and infected plant to healthy plant	Farm tools, cattle dung	62.5
	Air	23.75
	Birds	5
	Unknown	8.75

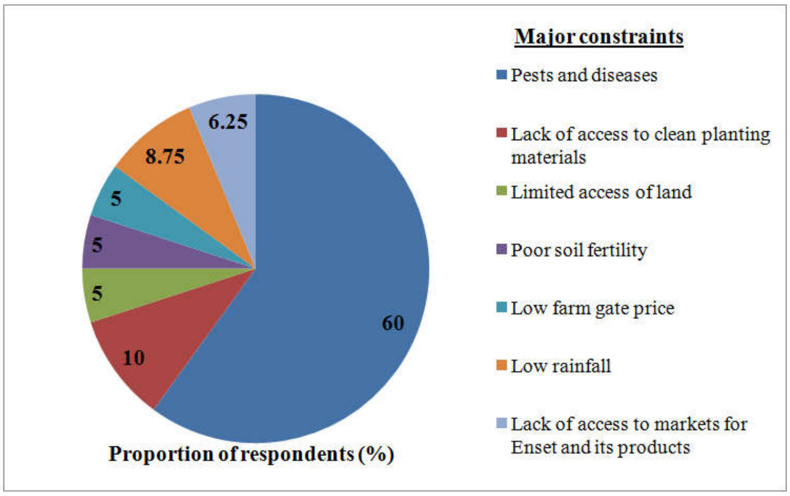

Figure 1. Major constraints of enset production in AngachaWoreda

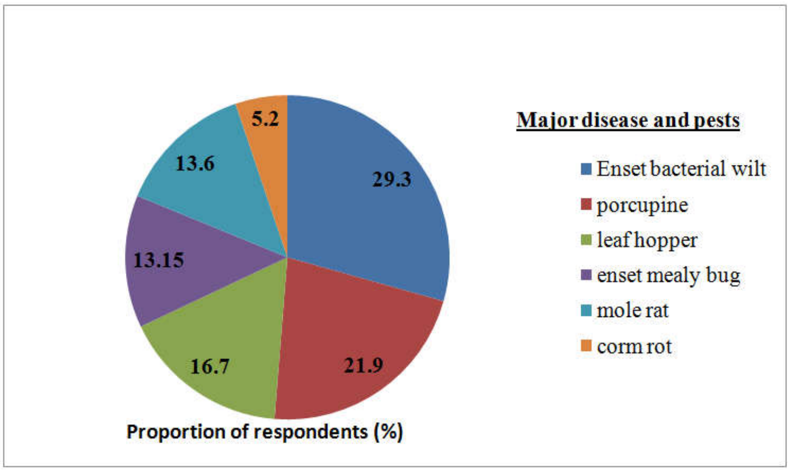

Figure 2. Major disease and pest of enset production in AngachaWoreda

Thirteen traits are the major criteria for classification of enset clones in the woreda. Farmers use these criteria as a tool for clonal identification, description and maintenance of diversity. Yemataw *et al.* 2014(a) reported that farmers maintain and enrich the diversity of enset, and select or describe clones for various uses. Moreover comparable uses of enset clones and their selection criteria were described by a number of authors for many enset growing ethnic groups of Ethiopia (Haile *et al.,* 1996; Negash and Niehof 2004; Abebe, 2005). Enset producing farmers use diversity to meet complex goals in the region. They generally grow several cultivars on their farms, planting these mixed together on their plots. Based on their use value large differences were evident between cultivars abundance and distribution. Farmers primarily prefer cultivars with good kocho and bulla yield and quality. For example, ten enset cultivars having merits of high and quality *Kocho* and *bulla* yield were encountered on above 50% of the farms visited (Table 5). The abundance of cultivars in the woreda is generally uneven because some cultivars, particularly those having merits of better kocho yield and quality have got a wider distribution within and between the sites. High cultivar diversity in a woreda may indicate extended periods of enset cultivation and a more subsistence form of production. In some cases, poorly producing cultivars continue to be maintained for special traditional or religious uses. For instance, seven cultivars were identified by farmers as tolerant to enset bacterial wilt (Table 6) and validation of farmers' findings with going on. Farmers also listed seven other enset cultivars that have been used for medicinal purposes (Table 6). Yemataw*et al.,* 2014(a) stated that farmers maintained cultivars that have been used for medicinal purposes even if they have got lower kocho yield. Similar results have been found in the case of banana in Uganda (Gold *et al.,* 2001) and rice in Asia (Witcombe *et al.,* 1996). Farmers noted that the trend of enset production and productivity in the region shows a decreasing trend. Farmers claimed that the spread of Enset*Xanthmonas* wilt could affect the total number of cultivars at district level, moreover; the average number of cultivars at farm level was also the lowest. Yemataw *et al.* (2014(b)) found out that farmers verbally reported more than 100 enset cultivars grown in each locality a few years back, however, most of the cultivars were lost due to disease and wild animals such as mole rat, porcupine and wild pigs. Likewise, Tesfaye (2002) also found out that in Sidama, farmers reported names of 20 enset cultivars which were not encountered in any of the farms that were visited. Some enset landraces might have been totally lost from farmers' fields. Table 5.Name of the most abundant and well distributed enset clones in Angachaworeda

Farmers' perception on enset production trend

Trend of enset production in the last 15 years in the wereda is meaningfully different. About 82.1% of the farmers respectively reported decreasing trend. Most farmers 61.10% farmers believe cause is frequent drought and climate change.

The effect of EXW disease is not only explained by decreasing in production trend of enset but also has an effect in decreasing landrace type. As reported by most farmers in the study areas there is loss of enset landrace which is mainly caused by disease and pest. For example, 28.6% of farmers believe disease and pest are the main cause for loss of enset landrace (Table 7). The result showed that in recent year's production of enset showed a decreasing trend. Major reasons could be due to outbreak of enset EXW disease and frequent drought which have led to low production. Ashagari (1985) pointed out that, once the disease affects the whole systems; it causes a maximum yield loss. Studies on bacterial wilt disease assessment in southern region also resulted losses of up to 100% under severe damage (Shank and Chernet, 1996). However, CSA (2011) reported that 3,020,143 km^2 of land is covered by enset crop and about 6.9 million quintals of enset yields were produced in 2010/11 production season. In order to alleviate this EXW problem farmers introduced new landraces to their farm as a coping mechanism for the management of the disease. For example, (Rao and Hodgkin, 2002) indicated genetic diversity could be seen as a defense against problems caused by genetic vulnerability.

Understanding Farmers' Response to EXW

Farmers identified various enset production constraints in their locality (Fig. 1). EXW is the most important constraint on enset production. Nearly 30% of farmers reported the existence of EXW in their fields (Fig. 2) and almost 90% reported a wilting and yellowish leaf or yellowish leaf as the symptoms of disease, while the remainder stated that it can be first noticed in the flag leaf and infolorecense of the plant, and moves towards the pseudo-stem (Table 8). Most respondents (50-60%) correctly identified the principal means of EXW disease transmission, from an external source to the farmers' fields, from infected to healthy plants via contaminated tools and insects, even if a minority erroneously identified animal dung, and wind transmission (Table 8). However, most farmers' understanding of how disease is caused had no basis in scientific fact, citing birds, insects, wind and highly fermented dung during wet season as the causal agents of the bacteria, while nearly 25% said they did not know. Most of the farmers are aware of the existence of EXW disease, and that the use of contaminated tools is a major route of transmission. Whether or not they possess the knowledge of disinfection practices is unclear. But they are not taking any preventative or disease control measures. They have not taken any steps to change their cultural practices (fertilization, plant population management practices and inter-cropping); nor have they taken any sanitary enhancement measures, all of which would reduce the likely of contamination and transmission of EXW. In Angachaworeda, EXW has had the greatest impact on enset production. Severe declines in cultivation, changes in cropping and dietary patterns, genetic erosion and catastrophic impacts on livelihoods have all accompanied the arrival of EXW in enset growing areas. For instance, Rao and Hodgkin (2002) indicated genetic diversity can be seen as a defense against problems caused by genetic vulnerability. The good news is that we now have models of participatory and decentralized ensetbreeding that can potentially put much greater enset genetic diversity in the hands of farmers from the research centers, from which they can select for different agro-ecological conditions and their own preferences. From farmers' points of view, EXW is considered either the primary or secondary enset disease in the woreda. Most farmers in the district consider EXW is a constraint to enset production. A more comprehensive study (McKnight-CCRP, 2013) in southern region revealed that, on average 28.7 % of enset stands was lost due to this disease in the surveyed zones of Southern Ethiopia. Hencedesigning programs for the improved management of EXW disease, it is important to recognize that farmers face multiple problems. During the survey period, we recognized that the disease was widely distributed in the wereda. Farmers confirmed that EXW was widely distributed and causes a total damage of their enset farm. Yemataw*et al.,*

(2015) reported that 30% of enset farms during the 2013 growing season were infected with EXW. Farmers in the wereda were most familiar with sanitary practices and EXW control is largely based on this cultural practice but they not implemented properly. They were expecting chemical control from the concerned body. No chemical trial has been conducted so far and there is no information regarding the use of chemical as an option for the disease.

Conclusion

Conventionally, enset stands were very long-lived and farmers often innate the existing cultivar mixtures from earlier generations. The experience of generations communicated many farmers that their plantations performed better and survived longer with higher levels of crop diversity. High levels of diversity afforded a variety of outputs and minimized risk through multiple cropping. Farmers' appreciation of diversity is considerably high and this momentum has to be maintained through various encouraging measures. Cultivar diversity also reflected a variety of uses (for example: *Kocho, Bulla, Amicho*, Fiber, disease tolerance) and differential performance against a multitude of production criteria and stresses. This scenario points to the importance of cultivar diversity for food security in subsistence cropping systems. Certain traditional practices (for example spiritual or rituals) also lead farmers to maintain small quantities of uncommon cultivars that may not produce well. Widely distributed cultivars have probably been cultivated for long periods during which farmers developed a preference for those with the most favorable attributes. Further studies incorporating DNA analysis may be needed to confirm the nomenclature and the real extent of genetic diversity. An understanding of cultivar distribution and selection criteria will assist future germplasm conservation to ensure continued food security. Therefore, in order to maintain enset genetic diversity and to reduce the likelihood of incursion, establishment and growth of EXW in enset crops, a systematic operational approach to the management of EXW should be adopted. This should include the provision of training to farmers on appropriate production practices, using healthy suckers and planting in clean soils. Additional factors to be taken into consideration in controlling the disease should include: sanitation, cultural and post-harvest handling practices, crop rotation with non-host plants, and the use of available tolerant or resistant varieties.

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