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Original Article

Study on Current Production and Utilization Status and Further Prospects of Oats (*Avena sativa*) in Mixed Farming Systems of the Central Highland Areas of Ethiopia

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ABSTRACT

The study was conducted to generate information for detailed understanding of Oats (*Avena sativa*) production and utilization in the area thereby to outline supportive evidences as basic decision tools for future uses of the crop in North Shoa zone of the Oromiya Regional State of Ethiopia. The study was undertaken in three phases with the first phase aiming at assessment and analysis of the existing Oats production and utilization systems followed by launching possible intervention options and scaling up of the feasible intervention in the third phase. The overall history of Oats production and utilization in the study areas was assessed using both primary and secondary sources of information. The result indicated that rough estimate of farm households who grow Oats for food and/or feed in the zone is close to 20,748 out of the total 216,000 farm households. Though, the area covered with Oats production was very large, the grain productivity was very low because the farmers used only the forage type of Oats for both feed and food purposes. During the second phase, two forage types and two grain types of Oats varieties with local check were selected to evaluate their agronomic performances under farmer's field conditions. The result showed that the selected Oats varieties varied significantly ($P<0.05$) for plant height, DM yield and seed yield across locations and years. The tested Oats varieties showed that yield and yield component advantage in terms of vigor (11.1 and 21.2%), plant height (15.4 and 19.2%), DM yield (11.8 and 50.0%) and seed yield (17.0 and 81.3%) was recorded at Girar-Jarso when compared to Jida and Wuchale respectively. The combined analysis showed that Lampton variety gave the highest DM yield (6.2 t ha^{-1}) followed by CI-8237 (5.9 t ha^{-1}) while the lowest DM yield (3.9

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t ha^{-1}) was recorded for local variety. The analysis also indicated that Lampton and CI-8237 Oats varieties gave 59.0 and 51.3% DM yield advantage over the local variety. The combined analysis indicated that Coker SR res 80SA130 variety produced the highest seed yield (28.1 qt ha^{-1}) followed by SRCPX80Ab2252 variety (23.2 qt ha^{-1}) over locations and years. The result showed that Coker SRres80 SA130 and SRCPX80Ab2252 varieties showed 57.0 and 29.6% seed yield advantage over the local variety over locations and years respectively. Cultivation of Oats was limited/banned by both zonal and regional officials especially for grain production since 2012 cropping season. Due to this inconvenient situation, seed multiplication and scaling up activities were discontinued. Despite that, Lampton and Coker SRres80SA130 varieties were recommended for forage and grain production purpose respectively. Therefore, the observed controversial issues with regard to Oats production and utilization should be resolved with all concerned bodies in order to fix its future use in the study areas.

Keywords: forage type, grain type, oats varieties, production, utilization, yields

INTRODUCTION

Among the different forage crops recommended for various agro-ecological zones of Ethiopia, common Oats (*Avena sativa*) is abundantly grown in the central highlands especially at Selale highlands in North Shoa and some parts of West Shoa like Meta-Robi and Galessa areas of Dendi woreda. It is also grown to a considerable scale in other parts of the country like Arsi, Bale and Gojjam (Lulseged, 1981). Production of Oats by smallholder farmers in different parts of the country dates back at least three decades as conventional research on the species was initiated in the early 1970`s following introductions of about 9,054 lines of Oats collected from over 55 countries of the world (Astatke, 1976). After rigorous screening and evaluation works, about six promising varieties were identified and recommended for forage production in the highlands of the country in the mid 1970`s. The varieties include CI-8237, Jasari, Lampton, Grey-Algiers, CI-8251 and CI-8235 and it has been anticipated that the oats which is being owned by smallholder farmers could belong to either of the aforementioned varieties. About 40 additional dual-purpose (forage and/or grain) Oats varieties were also introduced from CIMMYT in the mid 1980`s out of which some ten varieties have been selected for better overall performance in the highlands. In the recent intensive evaluation of 20 Oats varieties encompassing both the previously recommended ones and those introduced from CIMMYT, it became evident that there exists a marked variability among the varieties in most of the traits measured (Fekede, 2004). Maturity, herbage and grain yields are among the major parameters of practical significance for the farming community engaged in growing Oats. According to recent study at Holetta (Fekede, 2004), average herbage DM yield of 20 Oats varieties ranged from 11 to 17 t ha^{-1} while grain yield ranged from 1.8 to 5.2 t ha^{-1}. There was also a difference of about one month between an early and late maturing variety to attain a given physiological maturity. This range of variability among the different Oats varieties shows the presence of a wide opportunity for efficient utilization of the species through exploitation of varietal differences.

Oats has been well accepted by the farming community because of its hardy nature which performs better under stressful conditions (poor soil fertility, water logging, frost and disease outbreaks) with very minimal managerial inputs. Generally, it is possible to grow Oats under circumstances detrimental for growing other crops. North Shoa is characterized by most of the stressful conditions mentioned above and this could be one of the reasons why Oats has acquired relative importance in the zone. Since there has been no formal variety release mechanism for forage crops in the country, Oats was informally distributed to the farming community by different livestock development projects of the Ministry of Agriculture. North Shoa has been one of the beneficiaries of various dairy development projects and Oats

belonging to either of the six varieties recommended in the mid 1970`s was introduced to the region along with the projects. Although the initial aim of Oats introduction to the smallholders was for feed production, it has been realized that it is also being extensively grown as a food grain. However, it has been perceived that farmers have no awareness on the existence of different Oats varieties with different merits and consequently they grow the single variety they own for multipurpose uses (Getnet, 1999). The extent of horizontal expansion and utilization trend (forage vs grain), socio-economic factors governing production and utilization of Oats, available improvement opportunities and the overall prospect of Oats in the region have not been clearly understood. It is also essential to create awareness on the presence of alternative Oats varieties in order to enable farmers to make their best choice based on the intended purpose of growing Oats. The rural and agricultural development office of North shoa zone has launched an informal directive to limit the expansion of Oats especially as grain crop. The intention of the directive has been to replace the area covered by Oats with more productive food crops. Despite this, Oats has still been widely grown by the community both for feed and grain purposes. Therefore, this study is anticipated to generate matters of practical relevance for detailed understanding of the overall history of Oats in the area thereby to outline supportive evidences as basic decision tools for future production and utilization of the species in the system.

MATERIALS AND METHODS

Phase I: Assessment of the Existing Oats Production and Utilization Systems

The study was mainly undertaken in North Shoa zone of the Oromiya Regional State of Ethiopia. The study was conducted in three phases with the first phase aiming at assessment and analysis of the existing Oats production and utilization systems followed by launching possible intervention options in phase II and scaling up of the feasible intervention in phase III. In phase I, the overall history of Oats in the study areas was assessed using both primary and secondary sources of information. Zonal Agricultural and Rural Development Offices, central statistics agency reports and other documented sources were used as secondary sources of information. Information regarding temporal production coverage (land area) and utilization trends, major Oats producing woredas and grain production trends were gathered from recorded sources of information. This has helped to obtain a general understanding of the position of Oats in the study areas and to develop guideline for quick preliminary survey. Then, a quick preliminary survey was conducted in the major Oats producing woredas in order to develop a further understanding of dissemination and utilization of Oats and to design an exhaustive checklist for informal (PRA) survey. Major Oats producing PAs within the woredas were identified out of which representative PAs were picked for a check list based intensive study. Representative farmers from the identified PAs were consulted using an appropriate checklist to collect all relevant information concerning Oats under real situations. In this case, several types of information such as when, how and purpose of Oats introduction in the area, status of horizontal expansion, purpose of the ongoing Oats production and major governing reasons, utilization systems (food/feed including markets and marketing of grain or hay/green forage), socio-economic significance of producing Oats versus other crops (descriptive), aspects of using Oats grain for food (in what forms), cultural practices in producing Oats, whether research recommendations have been followed in production and utilization of Oats as livestock feed, categories of farmers who are producing Oats for different purposes, other non food/feed uses of Oats and problems that influenced production and utilization of Oats were collected. Purposive sampling was employed so as to ensure that farmers owning crossbred dairy cows and those who do not own crossbreds and those with different socio-economic status were grouped accordingly to exploit different views on the subject matter.

Phase II: Possible Interventions for Improved Production and Utilization of Oats

Based on the likely outcomes/feedbacks of the overall description and analysis of the existing Oats production and utilization in the study areas in phase I, possible intervention options of practical significance for improving production/utilization of Oats was launched. The interventions would accommodate biological, social, economic and policy perspectives of relevance as basic decision tools to delineate the prospects of Oats in the farming system. Although liable to modification based on the likely outcomes of phase I, one probable intervention area could be participatory evaluation of some selected Oats varieties versus the locally owned variety for important biological traits. Establishment of the varieties was made on selected farmers' field conditions. Farmers have provided their lands, prepare the land based on their cultural practices and were involved in planting, management and evaluation of the trial. Seed and all the required technical inputs was provided from Holetta research center through pertinent research staff. A total of four known varieties (2 grain types and 2 forage types) and a locally owned variety were considered for the study. A land plot on which farmers would be intending to cultivate Oats was used for the trial. An estimated amount of the grain of the same crop expected to be obtained from the trial plots was produced on station and provided to the farmers as compensation. Each variety was planted on 10m X 10m plots and replicated three times per farm. Two farmers from each three major Oats growing woredas were involved in the trial on voluntary basis. Concerned zonal and woreda level experts were also involved in the evaluation and shared their views. A possible arrangement was planned to organize field days in order to capture the views of the surrounding farming community. Data on vigor, plant height, herbage yield and seed yield were collected and analysis of variance (ANOVA) procedures of SAS general linear model (GLM) was used to compare treatment means (SAS, 2002). Least significance difference at 5% significance level was used for comparison of means.

Phase III: Seed Multiplication and Scaling up of the Preferred Oats Varieties

Foundation seeds of the varieties selected in phase II for grain and/or herbage production was planned to be multiplied on farm for subsequent scaling up activities. Number of participant farmers to be involved in seed multiplication and plot size was planned to be determined based on availability of initial seeds of the selected varieties. Based on the amount of seed multiplied, the number of farmers involved in the scaling up activities was planned to be determined.

RESULTS AND DISCUSSION

Phase I: Assessment of the Existing Oats Production and Utilization Systems

As it is well known, north shoa zone is one of the most Oats growing areas of the country. Farmers in the area are highly interested in growing Oats for various reasons among which, feed, housing, source of income and its better performance on poor soils without any input are common ones. For the questions raised on the historical beginning of Oats production in the area, in 1960's a man called San George has introduced Oats in the area to be used for as animal feed. Jida is known to be the first place where this man began Oats cultivation. Gradually, local farmers also started Oats production. Though they produce Oats, the variety used in the area is not known. They locally call it "Shallo". In the area, morphologically varying Oats varieties are also observed. However, farmers in the area do not differentiate the varieties and even they are not aware of the existence of different varieties of Oats. They usually purchase Oats seed from local market. Current utilization of Oats is also shifted to supplement human diet. This is brought in to practice because of frequent failure of belg season crops, such as barley. But relative to other crops, it withstands limited moisture stress

condition during the belg season. Oats production is highly popularized in the highland areas. Farmers in the highland areas usually use Oats both for feed and food. In general, farmers in wider capital North shoa areas prefer Oats, because of poor unsuitability of arable land for crop production, very large water logged and frost prone areas, fertility of the soil in most areas that cannot support other crops production without adequate input supply, Oats ability to grow on wider range of soil types and resistance to biotic and abiotic stresses. On top of these, higher livestock population in the area demands adequate feed and Oats is one of the major sources of feed for livestock production.

Rough estimate of farm households growing Oats for food and/or feed in the zone is close to 20,748 out of the total 216,000 farm households. Considering an average minimum family size of 6 persons per household, close to 124,488 people are expected depending on Oats either partially or totally to fulfill their food supply in any given year. Visual assessment indicated that in some woredas of the zone like Jida, Wuchale and Bereh-aleltu, the area of cultivable land covered with Oats could not be less than 50%. From this, it seems logical to expect more people to depend on Oats than indicated in the figure above. The use of Oats as a food commodity in the zone is not limited to the smallholder farmers level, but it is also common to enjoy the 'Injera' prepared from mixtures of Oats with other crops (Tef, barley etc) at Hotels in the respective towns of the zone. Though, the area covered with Oats production is very large, the grain yield obtained from a hectare of land is very low which ranges from 3.0 to 7.5 qt ha^{-1} (Table 1). Oats is also considered as a crop extracting soil nutrient and the cause for declining fertility of the soil in the area, as they are deep rooted and high biomass yielder on poor soil. This phenomenon leads to fallowing practice after Oats in Jida, Abichu, Kinbibit and Wuchale areas. Due to the above-mentioned disadvantages and the presence of other crops that can potentially replace Oats like Emer wheat yielding 12-15 qt ha^{-1} with optimal input, the experts usually do not recommend Oats production in the area especially for food though farmers are practicing until now. One general thing, which we have observed, is very low attention given for Oats contribution to the livestock sector. Professionals in the sector have no database on its contribution and even concern while the crop sector is launching to extinct Oats from the area. The crop people also do not consider its benefit to the livestock sector.

Table 1. Major Oats growing weredas of North Shoa zone

SN	Woreda	Total area (ha)	Total yield (qt)	Grain (qt ha^{-1})
1	Girar Jarso	787	5903	7.50
2	Yaya Gulele	65	195	3.00
3	Wuchale Jida	890	3551	3.99
4	Sululta Mulo	312	1563	5.01
5	Bereh aleltu	200	600	3.00
6	Kinbibit	4430	17499	3.95
7	Abichu	3642	18210	5.00
8	Kuyu	125	401	3.21
9	Degem	100	597	5.97
10	Ida' am	10552	48539	4.60

Source: North Shoa 1997/8 report; 1 qt= 100 kg

People in the areas started using Oats as food crop since 1992. Zonal average annual yield of Oats is estimated to 3-5 qt ha^{-1} without any input and intensive management. However, out of this yield, only 50% floor (consumable part) can be obtained. With this respect, the potential

of existing materials to be used as a grain crop is very low. According to the extension workers, due to this low productivity of Oats, the major Oats growing weredas are identified as the food insecure areas requiring support every year. As of our understanding from their explanation, the livestock contribution to the livelihood of the farmers and the role of Oats to the livestock sector is generally overlooked. This database is also obtained from crop division and there is no documented information on the socio-economic role of Oats to the livestock production and livelihood of the farming community. As clearly seen, the area is endowed for specialization on livestock production. So, this gap should be bridged by changing the attitude of the extension workers and farmers in livestock sector. As an approach, designing an integrated crop-livestock production system is of paramount to bring robust change on the livelihood of food insecure farmers of the area. Besides using as feed, the straw of Oats is also highly required for housing and farmers around the urban areas used it as a source of income. Green feed marketing in the towns is becoming a common practice. For the question raised to the expert regarding their view on government strategy to stop Oats production in the zone, he responded that, as a policy we all have reached to consensus to extinct Oats production from all weredas of north shoa. This agreement was circulated for all extension workers to control Oats cultivation and substitute Oats by Triticale. Some of the weredas were even demonstrate some areas stopping Oats production. But in those wereda even large tracts of land was covered by Oats (Table 2). But in that season, all weredas reported, as there was no Oats production at all. He also added that, as an extensionist, I do not recommend Oats for food production as it is replacing other crops and expanding from time to time. This is mainly due to the nature of crop thriving on low fertile soil with low management system. We consider it also as if Oats is "planting laziness'' in our farmers.

However, observations made during the survey attested that the Oats grown specially using belg rains has got a tremendous use as livestock feed through cut-and-carry systems during the critical feed shortage periods of the main rainy season (June- August). Using green Oats through this system is common in most woredas of the zone with reasonable belg rain. Figure 1 below, shows how farmers' cut-and-carry green Oats grown following belg rains (March-April) and reach harvestable stage as of mid June. Farmers also allow a group of cattle to feed on harvested green Oats in-situ as shown in figure 2. The green Oats harvested during this time is used not only to feed own animals, but also is highly marketed and is used as a good source of cash income for the farmers. According to the farmers, the green Oats harvested and tied (as shown in fig 1), the amount of which cannot exceed 15 kg fresh forage (an equivalent of about 5 kg dry matter), is sold for at least 10 ETB. Long term records indicate that Oats can give a forage dry matter yield range of 7 t (7000 kg) to 10 t (10000 kg) per hectare. Based on this estimation, a minimum of 14,000 ETB could be obtained from green Oats grown on a hectare of land. The interesting part of this scenario is that such huge income could be obtained without incurring significant production costs except family labor as the crop is naturally grown without using of fertilizer inputs and also performs well on lands marginal for growing other crops. Despite all these merits, Oats has been overlooked and even the statistical records on its production coverage and contribution as one of the agricultural commodities in the zone are usually underestimated and do not reflect the reality on the ground. This might have partly been arisen from the declaration launched by both the zonal and regional officials to abandon/ban Oats production especially for grain since 2012 cropping season.

Table 2: Crop cultivated land in major weredas of North Shoa zone

No	Crop	W/jarso	Kuyu	H/Abote	Degem	G/Jarso	Y/Gulele	W/Jida	S/Mulo	B/Aleltu	Kinbibit	Abichuna	Dara	Ida'am
1.	**Small Cereals**	**31097**	**26496**	**18825**	**22582**	**15058**	**29027**	**31259**	**42183**	**61996**	**14425**	**19002**	**25067**	**337014**
	Tef	20617	21893	13421	4631	6194	12368	9958	6484	20902	245	4163.75	21082.5	141960
	Wheat	6325	2990.8	5012	9869.5	3840.5	14053	12206	11780	32090	5313	6011.25	3053	112542
	Triticale	5	4.3	-	-	-	-	74	-	66.5	27	-	-	176.8
	Barley	4000	1482.5	392	7981	4107	2499	7400	23566.5	8657	4264	5025.5	931	70306
	Rye	150	-	-	-	129	42	731	40	80	146	159	-	1477
	Oats	**-**	**125**	**-**	**100**	**787**	**65**	**890**	**312.5**	**200**	**4430**	**3642**	**-**	**10552**
2.	**Large cereals**	**14700**	**13956**	**10787**	**4153**	**7949**	**7660**	**-**	**1064**	**159**	**-**	**-**	**28281**	**88706**
	Maize	1500	2704	1317	89	178	60	-	217	20	-	-	1740	7822
	Sorghum	13200	11251.7	9470	4064	7771	7600	-	847	139	-	-	26541	80884
3.	**Pulses**	**5623**	**4637**	**5772**	**5606**	**4959**	**10195**	**10336**	**9291**	**12875**	**9574**	**6167**	**13512**	**98546**
	F. bean	400	1139	1364	2974	3330	6735	6129	6647	5640	3800	4141.75	2160	44459
	F. pea	300	1055	1636	1952.5	669.5	502	2494	1603	2300	1100	497.5	2642	16751
	Lentil	233	743	545	204	406.7	205	520	786	2149.4	3529	584.5	1570	11476
	Chickpea	2080	850	1136.6	288	188.5	1264	483	92	2066	45	214	2160	10867
	Haricot bean	200	-	-	-	20	6	-	-	-	-	-	150	376
	Lathyrus	2410	850	1090	187	344.5	1483	710	163	720	1100	696.5	4830	14584
	Abish	-	-	-	-	-	-	-	-	-	-	32.5	-	32.5
4.	**Oil crops**	**3690**	**5158.8**	**500**	**151**	**120**	**197**	**645**	**336**	**375**	**770**	**740**	**5358**	**18041**
	Noug	3540	4546	275	68	55	105	110	148	50	770		1600	10497
	Linseed	150	465	225	83	65	62	535	188	325		740	1230	4838
	Gomenzer	-	77	-	-	-	10	-	-	-	-	-	610	697
	Safflower	-	68	-	-	-	17	-	-	-	-	-	718	803
	Sesame	-	2.88	-	-	-	3	-	-	-	-	-	1200	1206
	Total	**55110**	**50248**	**35884**	**32492**	**28086**	**47079**	**42240**	**52874**	**75405**	**24769**	**25909**	**72217.5**	**542307**

Figure 1. A farmer harvesting green Oats for indoor livestock feeding in Degem Woreda

Figure 2. Cattle feeding on harvested green Oats in-situ, Degem woreda

Phase II: Possible Interventions for Improved Production and Utilization of Oats

Combined analysis of variance for measured agronomic traits of Oats varieties over locations and years is shown in Table 3. The result indicated that there is significant ($P<0.05$) difference among the tested Oats varieties for plant height, DM yield and seed yield. Location and year also differed significantly ($P<0.05$) for vigor, plant height, DM yield and seed yield. The interaction effects also vary significantly ($P<0.05$) for some measured agronomic traits. The result revealed that variety by location interaction was significant for seed yield; variety by year interaction was significant for DM and seed yields; location by year interaction was significant for plant height, DM yield and seed yield; variety by location by year interaction effect was significant for seed yield.

Table 3: Combined analysis of variance for measured agronomic traits of Oats varieties over locations and years

Mean squares	Vigor	Plant height (cm)	DM yield (t ha^{-1})	Seed Yield (qt ha^{-1})
Variety	NS	**	**	**
Location	**	**	**	**
Year	*	**	**	**
Variety * Location	NS	NS	NS	**
Variety * Year	NS	NS	**	**
Location * Year	NS	**	**	**
Variety * Location * year	NS	NS	NS	**
Mean	**3.6**	**95.1**	**4.9**	**20.9**
CV (%)	**12.4**	**10.1**	**15.1**	**14.4**
R^2	**0.51**	**0.81**	**0.87**	**0.94**

* = P<0.05, ** = P<0.01, NS= Non significant (P>0.05), Variety * Location = variety by location interaction

Agronomic performance of Oats varieties tested across locations and years vary significantly ($P<0.05$) as indicated on Table 4. The result showed that in both production years and combined analysis, the performance of Oats varieties for most measured traits at Girar-Jarso was the highest when compared to the other two locations. In combined analysis, the highest vigor, plant height, DM yield and seed yield of Oats varieties was recorded at Girar-Jarso followed by Jida and Wuchale. Accordingly, the tested Oats varieties showed yield and yield component advantage in terms of vigor (11.1%), plant height (15.4%), DM yield (11.8%) and

seed yield (17.0%) at Girar-Jarso when compared to Jida. In the same fashion, the varieties showed yield and yield component advantage in terms of vigor (21.2%), plant height (19.2%), DM yield (50.0%) and seed yield (81.3%) at Girar-Jarso when compared to Wuchale. Generally, the varieties respond differently across locations due to variation in weather and soil conditions. According to Bruzon (2007), fodder species and fodder production depend mainly on the climate (temperature, frost, duration of winter, availability of water, distribution of rainfall, length of growing period and on the soils (structure, texture) conditions.

Table 4: Mean agronomic traits of different Oats varieties tested across locations and years

Year	Location	Vigor	Plant height (cm)	DM yield (t ha^{-1})	Seed Yield (qt ha^{-1})
	Girar-Jarso	3.8^{a}	108.9^{a}	6.4^{a}	23.0^{b}
	Wuchale	3.2^{b}	89.8^{c}	3.4^{b}	7.3^{c}
Year 1	Jida	3.5^{b}	101.3^{b}	6.1^{a}	28.9^{a}
	Mean	**3.5**	**100.0**	**5.3**	**19.8**
	CV (%)	**13.0**	**9.5**	**15.5**	**24.0**
	LSD	**0.34**	**7.02**	**0.61**	**3.52**
	Girar-Jarso	4.1^{a}	101.9^{a}	5.0^{a}	29.2^{a}
	Wuchale	3.4^{b}	87.1^{b}	4.2^{b}	21.5^{b}
Year 2	Jida	3.7^{b}	81.4^{b}	4.1^{b}	15.6^{c}
	Mean	**3.7**	**90.1**	**4.4**	**22.1**
	CV (%)	**10.9**	**9.5**	**14.6**	**11.1**
	LSD	**0.30**	**6.31**	**0.48**	**1.82**
Combined analysis	Girar-Jarso	4.0^{a}	105.4^{a}	5.7^{a}	26.1^{a}
	Wuchale	3.3^{c}	88.4^{b}	3.8^{c}	14.4^{c}
	Jida	3.6^{b}	91.3^{b}	5.1^{b}	22.3^{b}
	Mean	**3.6**	**95.1**	**4.9**	**20.9**
	CV (%)	**11.5**	**10.3**	**21.0**	**35.1**
	LSD	**0.21**	**5.05**	**0.52**	**3.77**

Means within a column followed by different superscript vary significantly (P<0.05)

Vigor is one of the important agronomic traits used to evaluate the establishment performance of forage crops. Vigor of tested Oats varieties combined over years at each location, combined over locations and each year is indicated on Table 5. The varieties showed significant (P<0.05) difference in vigor at Girar-Jarso. The highest (4.3%) vigor was recorded for Lampton variety while the lowest (3.6%) was recorded for SRCPX80Ab2252 variety. The combined analysis showed that Lampton variety gave the highest (3.8%) vigor followed by CI-8237 (3.7%) while SRCPX80Ab2252 variety gave the lowest (3.4%) vigor over locations and years. Differences in plant height among varieties are expected due to genetic make-up of the varieties. Plant height of Oats varieties vary significantly (P<0.05) at each location and year as indicated on Table 6. The result showed that Lampton variety gave the highest plant height 118.8, 100.3 and 102.8 cm at Girar-Jarso, Wuchale and Jida respectively. On the other hand, SRCPX80Ab2252 variety produced the lowest plant height 84.5, 69.8 and 76.7 cm at Girar-Jarso, Wuchale and Jida respectively. Lampton (114.7 cm) and CI-8237 (100.9 cm) varieties gave the highest plant height in the first and second year of production respectively. Generally, the combined analysis showed that maximum plant height (107.3 cm) was observed in Lampton variety followed by CI-8237 (104.4 cm) variety over

locations and years while SRCPX80Ab2252 variety gave the minimum (77.0 cm) plant height. The significant effect of variety on plant height at the present study is in agreement with previous findings (Fekede 2004; Getnet *et al*., 2004). Zaman *et al*. (2006) explained that plant height may differ in varieties due to environmental conditions which in turn cause variation in hormonal balance and cell division rate.

Table 5: Mean vigor (%) of different Oats varieties combined over years at each location and combined over locations each year

Variety	Girar-Jarso	Wuchale	Jida	Year 1	Year 2	Combined
Coker SRres80SA130	4.0^{ab}	3.2	3.4	3.4	3.7	3.6^{ab}
SRCPX80Ab2252	3.6^{c}	3.2	3.3	3.2	3.5	3.4^{b}
CI- 8237	4.0^{ab}	3.5	3.7	3.6	3.8	3.7^{a}
Lampton	4.3^{a}	3.3	3.8	3.7	3.9	3.8^{a}
Local variety (control)	3.9^{bc}	3.3	3.8	3.6	3.7	3.6^{ab}
Mean	**4.0**	**3.3**	**3.6**	**3.5**	**3.7**	**3.6**
CV (%)	**7.5**	**10.8**	**16.0**	**13.0**	**10.9**	**11.5**
LSD	**0.36**	**0.42**	**0.69**	**0.44**	**0.39**	**0.28**

Means within a column followed by different superscript vary significantly (P<0.05)

Table 6: Mean plant height (cm) of Oats varieties combined over years at each location and combined over locations each year

Variety	Girar-Jarso	Wuchale	Jida	Year 1	Year 2	Combined
Coker SRres80SA130	92.2^{b}	80.6^{c}	81.4^{bc}	89.9^{b}	79.6^{b}	84.7^{b}
SRCPX80Ab2252	84.5^{b}	69.8^{d}	76.7^{c}	79.4^{c}	74.6^{b}	77.0^{c}
CI- 8237	116.4^{a}	99.7^{a}	97.1^{ab}	107.9^{a}	100.9^{a}	104.4^{a}
Lampton	118.8^{a}	100.3^{a}	102.8^{a}	114.7^{a}	99.9^{a}	107.3^{a}
Local variety (control)	115.2^{a}	92.0^{b}	98.7^{a}	108.3^{a}	95.7^{c}	102.0^{a}
Mean	**105.4**	**88.5**	**91.3**	**100.0**	**90.1**	**95.1**
CV (%)	**6.3**	**6.6**	**14.8**	**9.5**	**9.5**	**10.3**
LSD	**8.00**	**7.03**	**16.21**	**9.07**	**8.15**	**6.52**

Means within a column followed by different superscript vary significantly (P<0.05)

Dry matter yield of Oats varieties vary significantly (P<0.05) at each location combined over years and each year combined over locations as indicated on Table 7. The result showed that both forage types of Oats varieties (Lampton and CI-8237) gave better forage DM yield when compared to other Oats varieties at each location and year. Lampton variety gave better DM yield at Girar-Jarso and Jida locations and in the second year of production. On the other hand, CI-8237 variety gave better DM yield at Wuchale and in the first year of production. Oats varieties gave the highest mean DM yield at Girar-Jarso (5.7 t ha^{-1}) followed by Jida (5.1 t ha^{-1}) and Wuchale (3.8 t ha^{-1}). Year of production also affected the DM yield of Oats varieties and the mean DM yields were 5.3 and 4.4 t ha^{-1} for the first and second years respectively. Generally, Lampton variety gave 48.9, 85.7 and 48.8% DM yield advantage over the local variety at Girar-Jarso, Wuchale and Jida locations respectively. On the other hand, the local variety gave the lowest DM yield over locations and years. The combined analysis showed that Lampton variety gave the highest DM yield (6.2 t ha^{-1}) followed by CI-

8237 (5.9 t ha^{-1}) while the lowest DM yield (3.9 t ha^{-1}) was recorded for local variety. The analysis also indicated that Lampton and CI-8237 varieties gave 59.0 and 51.3% DM yield advantage over the local variety. Generally, considerable variation in terms of DM yield was observed among the tested Oats varieties and this result is in close conformity with the findings of Fekede (2004) and Getnet *et al*., (2004). These results are inconformity with Nawaz *et al*., 2004 who reported that Oats varieties differ in green and dry matter yields. Number of tillers per plant and plant height play a vital role in enhancing the green fodder yield. Bhatti *et al.* (1992) evaluated that among 12 Oats varieties, two varieties were found superior than other tested varieties by producing taller plants and more number of tillers per plant. Hussain *et al*. (1993) also reported that fresh forage yield differed due to differences in leaves per tiller and plant height. Likewise, Amanullah *et al.* (2004) stated that higher yields of fodder in Oats cultivars can be possibly attributed to their greater leaf area, responsible for more photosynthetic activities, having high capacity to store assimilative products of photosynthesis. Ahmad *et al*. (2008) in his findings explained that the variation in leaf area and other parameters in different varieties at different locations may also be attributed to varying genetic make-up, soil and environmental adaptability.

Table 7: Mean DM yield (t ha^{-1}) of Oats varieties combined over years at each location and combined over locations each year

Variety	Girar-Jarso	Wuchale	Jida	Year 1	Year 2	Combined
Coker SRres80SA130	5.1^{b}	3.0^{b}	4.4^{b}	4.8^{b}	3.6^{c}	4.2^{b}
SRCPX80Ab2252	5.1^{b}	2.8^{b}	4.4^{b}	4.7^{b}	3.5^{c}	4.1^{b}
CI- 8237	6.6^{a}	5.3^{a}	5.7^{a}	6.7^{a}	5.0^{b}	5.9^{a}
Lampton	7.0^{a}	5.2^{a}	6.4^{a}	6.1^{a}	6.3^{a}	6.2^{a}
Local variety (control)	4.7^{b}	2.8^{b}	4.3^{b}	4.2^{b}	3.7^{c}	3.9^{b}
Mean	**5.7**	**3.8**	**5.1**	**5.3**	**4.4**	**4.9**
CV (%)	**14.3**	**16.3**	**20.3**	**15.5**	**14.6**	**21.0**
LSD	**0.98**	**0.74**	**1.23**	**0.79**	**0.62**	**0.67**

Means within a column followed by different superscript vary significantly (P<0.05)

Seed yield of Oats varieties differed significantly (P<0.05) across locations and years as indicated on Table 8. The varieties gave the highest mean seed yield (26.1 qt ha^{-1}) at Girar-Jarso followed by Jida (22.3 qt ha^{-1}) and Wuchale (14.4 qt ha^{-1}). The second year of production gave the highest (22.1 qt ha^{-1}) mean seed yield when compared to the first year (19.8 qt ha^{-1}) of seed production. Among the tested varieties, the grain type Oats varieties (Coker SRres80SA130 and SRCPX80Ab2252) produced better seed yield over locations and years. The highest seed yield was obtained from Coker SRres80SA130 followed by SRCPX 80Ab2252 variety might be due to its genetic character and best adaptation to local conditions as compared to other varieties. The result showed that Coker SRres80SA130 variety gave the highest seed yield at Girar-Jarso (37.3 qt ha^{-1}) followed by Jida (28.2 qt ha^{-1}) and Wuchale (18.8 qt ha^{-1}) and also the variety produced the highest seed yield (29.7 qt ha^{-1}) in the first year when compared to the second year (26.4 qt ha^{-1}) of production. On the other hand, SRCPX80Ab2252 variety gave better seed yield at Jida (27.4 qt ha^{-1}) followed by Girar-Jarso (26.6 qt ha^{-1}) and Wuchale (15.5 qt ha^{-1}). Coker SRres80SA130 variety showed 71.9, 46.9 and 45.7% seed yield advantage over the local variety at Girar-Jarso, Jida and Wuchale respectively. The second grain type Oats variety (SRCPX80Ab2252) also showed seed yield advantage over the local variety at Jida (42.7%), Girar-Jarso (22.6%) and Wuchale (20.2%). Moreover, the combined analysis indicated that Coker SRres80SA130 variety produced the

highest seed yield (28.1 qt ha^{-1}) followed by SRCPX80Ab2252 variety (23.2 qt ha^{-1}) over locations and years. Accordingly, Coker SRres80SA130 (57.0%) and SRCPX80Ab2252 (29.6%) varieties showed seed yield advantage over the local variety over locations and years. The variability among the Oats varieties in different yield attributing characters was mainly due to their genetical behavior. These results are in close conformity with the findings of Fekede (2004) and Getnet *et al*., (2004). The significant effect of Oats varieties on yield performance in the present study is also in agreement with previous findings of the other countries (Singh and Singh, 1992; Lupingan *et al*., 1999; Naeem *et al*., 2002).

Table 8: Mean seed yield (qt ha^{-1}) of Oats varieties combined over years at each location and combined over locations each year

Variety	Girar-Jarso	Wuchale	Jida	Year 1	Year 2	Combined
Coker SRres80SA130	37.3^{a}	18.8^{a}	28.2^{a}	29.7^{a}	26.4^{a}	28.1^{a}
SRCPX80Ab2252	26.6^{b}	15.5^{b}	27.4^{a}	22.6^{b}	24.1^{a}	23.2^{b}
CI- 8237	20.9^{c}	12.3^{c}	18.2^{b}	14.8^{c}	19.6^{bc}	17.2^{c}
Lampton	24.1^{bc}	12.6^{c}	18.4^{b}	15.1^{c}	21.6^{b}	18.3^{bc}
Local variety (control)	21.7^{bc}	12.9^{c}	19.2^{b}	17.0^{c}	18.9^{c}	17.9^{c}
Mean	**26.1**	**14.4**	**22.3**	**19.8**	**22.1**	**20.9**
CV (%)	**16.6**	**11.0**	**20.5**	**24.1**	**11.1**	**35.1**
LSD	**5.19**	**1.90**	**5.46**	**4.54**	**2.35**	**4.87**

Means within a column followed by different superscript vary significantly (P<0.05)

Phase III: Seed Multiplication and Scaling up of the Preferred Oats Varieties

It was planned to plant these varieties on-farm on large scale for demonstration and scaling up. However, the MoA officials at North shoa have banned any farmer to plant Oats varieties on their farm otherwise, they lose their farm land. Due to that, the development agents working with farmers were reluctant to cooperate with us. Therefore, seed multiplication and scaling up activities was discontinued.

CONCLUSION AND RECOMMENDATION

North Shoa zone is one of the most Oats growing areas in the highlands of Ethiopia. Oats introduced to the zone by San George in the early 1968 to be used as a feed for his big dairy farm. However, from 1988 farmers were planting it as food crops. Farmers in most North Shoa areas prefer Oats because of the occurrence of various biotic and abiotic stresses. Moreover, higher livestock population in the area demands adequate feed and Oats is one of the major sources of feed for livestock production. The assessment has revealed that over 20,000 farm households or more than 100,000 people either partially or totally depend on Oats for their staple food supply. However, it was realized that all the farmers are used to grow a sole unknown variety for many years without knowing the availability of different Oats varieties and the associated merits. Upon understanding of the prevailing Oats production and utilization systems in the area, four Oats varieties (2 forage types, 2 grain types) have been evaluated in comparison to the one owned by farmers. Generally, varietal differences were observed among the Oats varieties in terms of vigor, plant height, DM yield and seed yield over locations and years. The grain type varieties (Coker SRres80SA130 and SRCPX80Ab2252) and forage type varieties (Lampton and CI-8237) could be the potential candidates to be promoted for grain and forage production in areas where Oats are grown for

human consumption and livestock feed. Based on the result, Lampton variety was selected for forage and Coker SRres80SA130 for grain production. Despite all these merits, Oats have been overlooked by both zonal and regional officials who have abandoned/banned Oats production especially for grain since 2012 growing season. Due to this, seed multiplication and scaling up activities were discontinued. So, controversial issues with regard to Oats production and utilization should be resolved with all concerned bodies to decide for future direction and utilization.

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