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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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The study was undertaken to assess and analyze the existing Oats (*Avena sativa*) production and utilization systems followed by launching possible intervention options and scaling up of the feasible intervention in north Shewa zone of the Oromiya regional state. The assessment result indicated that rough estimate of farm households who grow Oats for food and/or feed in the zone was close to 20,748 out of the total 216,000 farm households during the study. But 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 farmers fields. 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%) were recorded at Girar-Jarso when compared to Jida and Wuchale, respectively. The combined analysis showed that Lampton 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 result indicated that Lampton and CI-8237 gave 59.0 and 51.3% DM yield advantage over the local variety. The combined analysis also indicated that Coker SR res 80SA130 produced the highest seed yield (2810 kg ha^{-1}) followed by SRCP X 80 Ab 2252 (2320 kg ha^{-1}) and the varieties showed 57.0 and 29.6% seed yield advantage over the local variety respectively. Though, the cultivation of Oats was limited/banned by both zonal and regional officials especially for grain production since 2012 cropping season, Lampton and Coker SR res 80SA130 varieties were recommended for forage and grain production 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

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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 Shewa and some parts of west Shewa 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 Shewa 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 Shewa 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 Shewa 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 was 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

The study was mainly undertaken in north Shewa zone of the Oromiya regional state. 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.

Phase I: Assessment of the existing Oats production and utilization systems

In this phase, 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 helped to obtain a general understanding of the position of Oats in the study areas and hence 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 develop an exhaustive checklist for informal (PRA) survey. Major Oats producing PAs within the woredas were identified out of which representative PAs were picked for the PRA. Representative farmers from the identified PAs were consulted using the 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 included 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. In this phase, 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. 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 were 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 included for the study. A land plot on which farmers were 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 experts and development agents were also involved in the evaluation and shared their views. Views of the participating and surrounding farmers regarding the tested Oats varieties were also captured. The collected biological data (vigor, plant height, herbage yield and seed yield) were analyzed using the analysis of variance (ANOVA) procedures of SAS general linear model (SAS, 2002). Least significance difference at 5% significance level was used to compare treatment means.

Phase III: Seed multiplication and scaling up of the preferred Oats varieties

In this phase, it was intended to multiply foundation seeds of the varieties selected in phase II for grain and/or herbage production on farmers field for subsequent scaling up activities. However, the issue of pushing Oats further was not adequately supported by the concerned stakeholders, mainly the extension system of the study areas. As a result, they refrain to cooperate in this regard and hence the activity did not materialize.

RESULTS AND DISCUSSION

Phase I: Assessment of the existing Oats production and utilization systems

As it is well known, north shewa 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, roof thatching (straw), source of income and its better performance on poor soils without any input are common ones. According to the information obtained from the area, Oats was introduced to the area by a man called San George in 1960's for use as animal feed. Jida is known to be the first place where Oats initially introduced. Gradually, more surrounding farmers also started producing Oats, but the variety produced in the area is not known. Farmers 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 has emerged due to frequent failure of belg season crops, like barley as Oats comparatively withstand moisture stress according to the farmers. 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 most north shewa areas prefer Oats, as the available land and weather condition in the area are detrimental to staple food crops production. Some of the important limiting factors for crop production in the area include waterlogging, frost, low soil fertility with the consequent low productivity. Oats on the other hand has been well acknowledged by farmers for its 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 also one of the major sources of feed for livestock production in the form of green feed, hay, straw and grain as supplementary feed.

People in the areas started using Oats as food crop since the mid 1980s. Zonal average grain yield of Oats is estimated to 300-500 kg ha^{-1} without any input and intensive management. However, out of this yield, only 50% floor (consumable part) can be recovered. As a result, 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, major Oats growing weredas are identified as the food insecure areas. 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 it is well known, north shewa has better potential for livestock production. So, this gap should be bridged by changing the attitude of the extension workers and farmers, i.e. linking Oats with productive livestock enterprise like dairying boost animal output. 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 feed, the straw of Oats is also highly required for roof thatching 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, they attested that, as a policy they all have reached to consensus to extinct Oats production from all weredas of north shewa. This directive was circulated to all extension workers to control Oats cultivation and substitute Oats by Triticale. Some of the weredas were also declared that they have stopped Oats production. But the ground reality revealed that still large tract of land was covered by Oats in most of the woredas. The extensionist perceived that Oats has been expanding from time to time at the expense of other crops, and the fact that it is not demanding much managerial inputs may diminish working culture of the farmers. However, there was no similar perception from farmers' side.

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 during the study. Considering an average minimum family size of 6 persons per household, close to 124,488 people are expected to depend 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 such as tef and barley 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 300 to 750 kg ha^{-1} (Table 1). The extensionist also blame Oats for declining soil fertility by extracting nutrient from the already poor soils as it can grow on poor soils and produce relatively high biomass and grain yields. This phenomenon has led 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 1200-1500 kg 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 fact understood from the study is the very low attention given for contribution of Oats to the livestock sector. Professionals in the sector have no database on its contribution and even concern while the crop sector is launching a campaign to extinct Oats from the area.

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. Farmers

Table 1: Major Oats growing weredas of north Shewa zone

SN	Woreda	Total area (ha)	Total yield (ton)	Grain (kg ha^{-1})
1	Girar Jarso	787	590.3	750
2	Yaya Gulele	65	19.5	300
3	Wuchale Jida	890	355.1	399
4	Sululta Mulo	312	156.3	501
5	Bereh aleltu	200	60.0	300
6	Kinbibit	4430	1749.9	395
7	Abichu	3642	1821.0	500
8	Kuyu	125	40.1	321
9	Degem	100	59.7	597
10	Ida' am	10552	4853.9	460

Source: North Shewa 1997 report

allow a group of cattle to feed on harvested green Oats in-situ. 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, the amount of which cannot exceed 15 kg fresh forage (an equivalent of about 5 kg dry matter), is sold for at least 10 Ethiopian birr. 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 Ethiopian birr could be obtained from green Oats grown on a hectare of land. With the escalating feed price in recent time, the income potentially obtained from a hectare of green Oats could be at least two fold of the figure indicated above. 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 limit/ban Oats production especially for grain since 2012 cropping season.

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 2. The result indicated significant ($P<0.05$) difference among the tested Oats varieties for plant height, DM yield and seed yield. Location and year also had significant ($P<0.05$) effects on 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 and variety by location by year interaction effect was significant for seed yield. Agronomic performance of Oats varieties tested across locations and years varied significantly ($P<0.05$) as indicated on Table 3. The result showed that in both years, the performance of Oats varieties for most measured traits was higher at Girar-Jarso than the other two locations. The combined analysis also revealed higher vigor, plant height, DM yield and seed yield performance of Oats varieties 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 as compared to Jida. Similarly, the varieties performed better in terms of the agronomic traits viz., vigor (21.2%), plant height

Table 2: 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

Table 3: 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})
Year 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}
	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**
Year 2	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}
	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)

(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.

Vigor is one of the important agronomic traits used to

Table 4: Mean vigor (%) of different Oats varieties combined over years at each location and combined over locations at 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 5: Mean plant height (cm) of Oats varieties combined over years at each location and combined over locations at 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)

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 4. 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 SRCP X 80 Ab 2252. The combined analysis showed that Lampton was more vigorous (3.8%) followed by CI-8237 (3.7%) while SRCP X 80 Ab 2252 was less vigorous (3.4%) 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 5. The plant height recorded for Lampton was 118.8, 100.3 and 102.8 cm at Girar-Jarso, Wuchale and Jida respectively. On the other hand, SRCP X 80 Ab 2252 was shorter with a plant height record of 84.5, 69.8 and 76.7 cm at Girar-Jarso, Wuchale and Jida, respectively. Generally, the combined analysis showed that maximum plant height (107.3 cm) was recorded for Lampton followed by CI-8237 (104.4 cm) and the lowest for SRCP X 80 Ab 2252 (77.0 cm) over locations and years. Varietal variation in plan height observed in 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.

Dry matter yield of the Oats varieties varied significantly (P<0.05) at each location combined over years and each year combined over locations as indicated in Table 6.

Table 6: Mean DM yield (t ha^{-1}) of Oats varieties combined over years at each location and combined over locations at each year

Variety	Girar-Jarso	Wuchale	Jida	Year 1	Year 2	Combined
Coker SR res 80 SA130	5.1^{b}	3.0^{b}	4.4^{b}	4.8^{b}	3.6^{c}	4.2^{b}
SRCP X 80 Ab 2252	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)

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

Variety	Girar-Jarso	Wuchale	Jida	Year 1	Year 2	Combined
Coker SRres80SA130	3730^{a}	1880^{a}	2820^{a}	2970^{a}	2640^{a}	2810^{a}
SRCPX80Ab2252	2660^{b}	1550^{b}	2740^{a}	2260^{b}	2410^{a}	2320^{b}
CI- 8237	2090^{c}	1230^{c}	1820^{b}	1480^{c}	1960^{bc}	1720^{c}
Lampton	2410^{bc}	1260^{c}	1840^{b}	1510^{c}	2160^{b}	1830^{bc}
Local variety (control)	2170^{bc}	1290^{c}	1920^{b}	1700^{c}	1890^{c}	1790^{c}
Mean	**2610**	**1440**	**2230**	**1980**	**2210**	**2090**
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)

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 gave higher DM yield at Girar-Jarso and Jida 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. The 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 gave 48.9, 85.7 and 48.8% DM yield than the local variety at Girar-Jarso, Wuchale and Jida respectively. The local variety gave the lowest DM yield over locations and years. The combined analysis also showed that Lampton 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. It was also shown that Lampton and CI-8237 had DM yield advantage of 59.0 and 51.3%, respectively 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). Nawaz *et al*., (2004) also 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) indicated 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.

Seed yield of Oats varieties differed significantly (P<0.05) across locations and years as shown in Table 7. The varieties gave the highest mean seed yield (2610 kg

ha^{-1}) at Girar-Jarso followed by Jida (2230 kg ha^{-1}) and Wuchale (1440 kg ha^{-1}). Highest mean seed yield was recorded in the second year (2210 kg ha^{-1}) than the first year (1980 kg ha^{-1}) of production. Among the tested varieties, the grain type Oats varieties (Coker SR res 80 SA 130 and SRCP X 80 Ab 2252 in that order) produced better seed yield over locations and years than the other varieties. The result showed that Coker SR res 80 SA 130 gave the highest seed yield at Girar-Jarso (3730 kg ha^{-1}) followed by Jida (2820 kg ha^{-1}) and Wuchale (1880 kg ha^{-1}) and also the variety produced the highest seed yield (2970 kg ha^{-1}) in the first year when compared to the second year of production (2640 kg ha^{-1}). On the other hand, SRCP X 80 Ab 2252 gave better seed yield at Jida (2740 kg ha^{-1}) followed by Girar-Jarso (2660 kg ha^{-1}) and Wuchale (1550 kg ha^{-1}). Coker SR res 80 SA 130 gave 71.9, 46.9 and 45.7% more seed yield advantage over the local variety at Girar-Jarso, Jida and Wuchale respectively. The second grain type Oats variety (SRCP X 80 Ab 2252) also gave 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 SR res 80 SA 130 produced the highest seed yield (2810 kg ha^{-1}) followed by SRCP X 80 Ab 2252 variety (2320 kg ha^{-1}) over locations and years. When pooled over locations and years, Coker SR res 80 SA 130 and SRCP X 80 Ab 2252 gave seed yield advantages of 57.0and 29.6%, respectively over the local variety. The variability among the Oats varieties in different agronomic attributes 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).

CONCLUSION AND RECOMMENDATION

North Shewa zone is one of the most Oats growing areas in the highlands of Ethiopia. Oats was first introduced to the area by a private dairy farm owner called San George in the early 1960s for feed, but farmers in the area also have been growing Oats as a food crop since the mid 1980s. It is preferred by farmers due to its better performance under various biotic and abiotic stresses prevailing in the area. Moreover, higher livestock population in the area demands adequate feed and Oats is one of the major sources of animal feed in various forms. Nearly about 20,000 farm households or more than 100,000 people in Selale area north shewa either partially or totally depend on Oats for their staple food supply. However, the farmers had no awareness on availability of alternative Oats varieties with varying merits and have been limited to grow a single variety which they could not name. The Oats varieties evaluated along with the locally produced variety have been found to outperform the local variety in most of the measured agronomic traits, DM forage yield and seed yield, and could serve as potential candidates to be promoted for the intended purpose of production in the area. However, production and using Oats as a food grain has not been acknowledged by the local authorities and agricultural offices and efforts were made to curb the expansion of Oats in the zone. The rationales behind this move was the perception that Oats was poor in productivity, low in dietary value, does not require intensive management like weeding and hence does not engage full time and labors of farmers and hence weaken working culture farmers. Despite this, it has been keeping on expanding as attested in the present study. This calls for further critical assessment and in-depth understanding of the factors underlying Oats utilization as a decision support tool regarding Oats production and possible interventions for improvement in the area.

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