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ILRI forage factsheet

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Oats (*Avena sativa*) for livestock feed

Abel Teshome, Lidiya Ashenafi and Chris S. Jones

Uses of oats

Oats are an annual grass, cultivated in the highlands of Ethiopia primarily under rain-fed conditions for grain, forage and fodder. They provide high yields of palatable, moderate-quality forage, mainly for sheep, dry dairy cows, beef cattle and horses [1]. A key winter fodder, oats are mainly provided as green feed, although the excess can be processed into silage or hay for use during fodder shortages (Figure 1).

Oats are the preferred food/feed crop for livestock mainly in the central highlands of Ethiopia due to the production of soft straw, in addition to grain. With low nitrogen needs (60 kg/ha), oats can be grown in environmentally friendly no-till systems [2].

Environmental adaptation

Oats are well adapted to grow in cool and moist climates. In comparison to other cereal crops, oats exhibit a broad adaptability to marginal environments, particularly those with low fertility soils and cool-wet conditions [3–5]. Furthermore, in contrast to most other cereal crops, oats display a remarkable tolerance to waterlogged conditions [6]. They are also known to thrive in a diverse range of soil types, including acidic soils [7]. Most of the global oat production is concentrated between latitudes 35–65° N, and 20–46° S [8].

Strengths

Fast establishment, with good seedling vigour

Good moisture stress tolerance

Ideal for hay and silage production as well as grazing

Suited to a wide range of soil types

Limitations

Less winter hardy than wheat or rye

Sensitive to hot and dry weather

Susceptible to pests and diseases

Figure 1 Oats trial at seedling and flowering stages, Holleta, Ethiopia.

Management

Field preparation: The field should be well drained and ploughed. Oats grow best in soil that is well-drained and a field that has been appropriately prepared. No-till planting is considered the optimal approach for establishment, although in certain scenarios shallow conventional tillage may be deemed necessary for purposes of nitrogen integration, facilitating weed control, and enhancing contact between the seeds and soil.

Establishment: Seeds should be sown at a density of 25–120 kg/ha and a depth of 50–75 mm in rows spaced 18–25 cm apart, in moist soil, in a well-prepared seedbed. In mixtures with legumes, it is advised to sow 15– 50 kg/ha of seeds. Forage oats are often sown in a mixture with a legume such as vetch *(Vicia* spp.*)*, pea *(Pisum sativum)*, or berseem clover *(Trifolium alexandrinum)* [9–11].

Time: Optimum sowing times vary for each variety in respective zones. Sowing too late or too early increases the risk of lower forage yield [12].

Temperature: The optimum soil temperature for the germination and establishment of oats is 15–25 °C.

Fertilizer: An initial application of nitrogen, ranging from 40–80 kg/ha is recommended during planting, but it should be kept separate from the seed, as the fertilizer can damage the seed and reduce its germination. Alternatively, the application of 100 kg/ha manure is also a viable option that can replace nitrogen fertilizer at a similar rate [13]. An application of nitrogen after grazing (20–40 kg/ha) will increase the speed of plant recovery, reduce tiller death and increase overall forage yield [14].

Weeding: Hand weeding and no-till techniques, such as crop rotation and applying herbicides with multiple modes of action (employ different types of herbicides that target different sites of action, to mitigate the development of chemical resistance in weeds) are appropriate [15].

Major pests and diseases: Major pests that commonly infest oats are the cereal cyst nematode, stem nematode, thrips, cereal aphids (known for transmitting barley yellow dwarf virus), cutworms, webworms and lucerne flea [16–18].

The oat diseases that pose a noteworthy global threat to productivity are crown rust, powdery mildew, fusarium head blight, leaf rust, stem rust, Septoria blotch, bacterial blight and barley yellow dwarf virus [8,19,20].

Grazing: Begin grazing when plants are 6–8 inches tall, after the roots have had time to develop. For the quickest recovery, graze only to the height of the lowest stem node, which is about 5–6 inches above ground level [21]. Repeat grazing after a month of recovery [22].

Harvesting: Oats harvested at the boot stage (when the grain swells in its sheath) will produce high-quality forage, suitable for lactating cows to maximize milk production. At this stage, oats are high in digestible fibre and crude protein [23].

In contrast, harvesting during the dough stage results in oat silage with greater dry matter and energy value. However, such silage has lower crude protein content and palatability, making it a more viable option when a greater forage quantity is required [24]. When oats are designated for hay production, harvesting them at the milky dough stage represents an optimal balance between achieving high yield and maintaining high quality [25].

Forage and seed production: Under favourable conditions, oats produce a high volume of forage biomass and grain yield. The average yield of forage dry matter ranges from 8.4 to 14.2 tons per hectare, while grain yield ranges from 0.75 to 2.40 tons per hectare [26].

The differences observed in the dry matter of forage and seed yield of oats can be ascribed to variations in the genetic composition of different varieties, soil type, diverse rates of fertilizer application, the stage of growth during cutting, and the prevailing environmental conditions [25–28].

Feed quality: Oats are a good source of energy, protein and vitamins. They have a high crude protein content (12–17%) with balanced amino acids and are gluten-free [29]. Crude protein content varies, depending on the stage of development; a high content in the boot stage and lower content in the late dough stage [30]. Contents of magnesium (Mg), iron (Fe), phosphorous (P), calcium (Ca), and vitamins E and B1 are also higher in oats compared with other cereals [31].

Released varieties

Table 1: Recently released forage oat varieties in Ethiopia

Variety name	Accession no.	DOI	Year	Institute
Ezo ote	5527	10.18730/G56V9	2022	Arbaminch ARC
Dumant-DZF-583			2021	EIAR
Bareda	5450	10.18730/G547U	2020	OARI
Was (CI-1506)			2019	EIAR
Walqaa (SRCP X 80 Ab 2596)			2019	EIAR
Bate	5453	10.18730/G54A2	2018	OARI
SRCPX 80Ab2806			2015	EIAR
SRCPX 80Ab2291			2015	EIAR
CI-8237			2013	EIAR
Bonsa PI-79AB384			2011	OARI
Bona-bas PI660			2011	OARI

EIAR: Ethiopian Institute of Agricultural Research
OARI: Oromia Agricultural Research Institute

Field trial to improve oats for fodder production

The International Livestock Research Institute (ILRI) forage genebank contains 122 oats accessions, including multiple improved varieties that have been developed and released for the purpose of fodder and grain production (as seen in Table 1). Moreover, through field experimentation, several promising accessions have been identified for both forage biomass and grain yield [1,26,31]. Consequently, these released varieties and promising accessions represent potential candidates for fodder evaluation and adaptation studies in diverse tropical environments with comparable climatic and edaphic conditions, thus facilitating the rapid development of improved varieties.

Field evaluation procedure

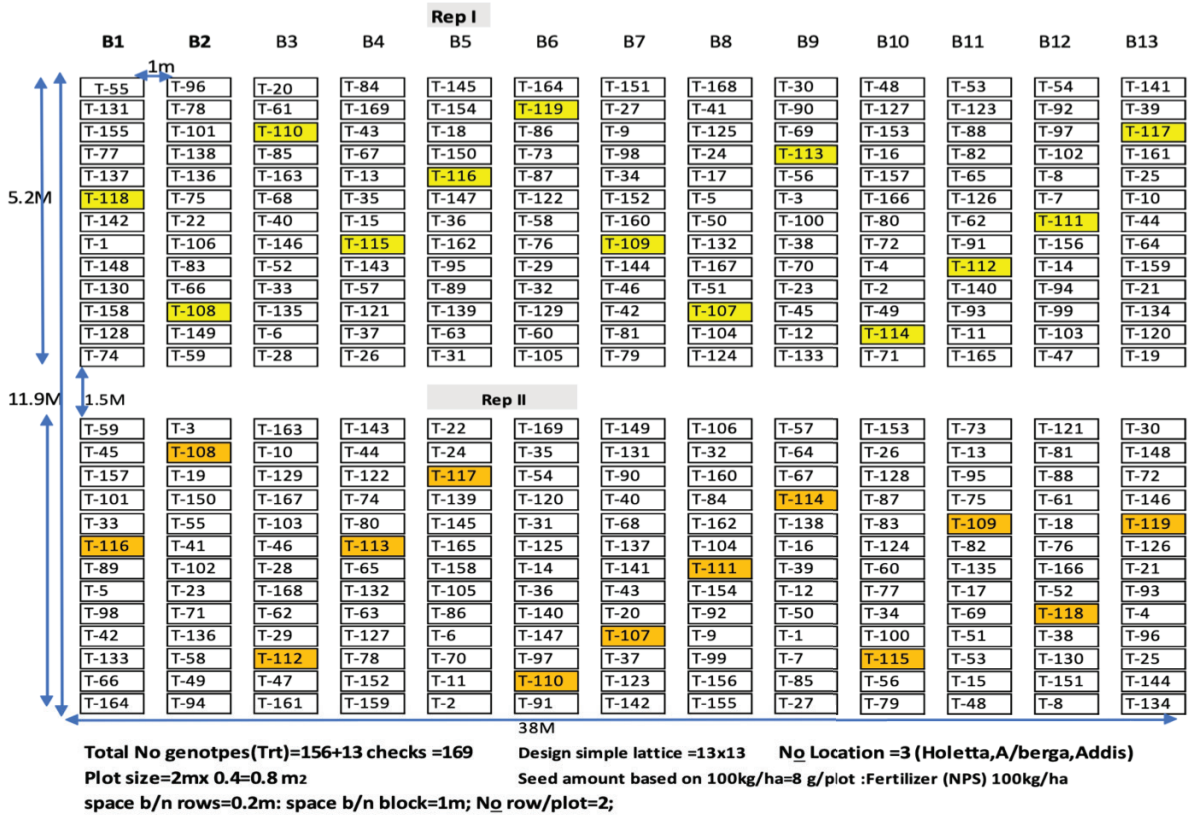
To assess the suitability and effectiveness of oat varieties, a standardized field assessment is recommended to ensure the acquisition of dependable data for comparative analysis [32]. Researchers conduct evaluations on recently released and experimental oat varieties to determine their potential for superior forage performance over a span of two to three years across different ecological conditions.

Nutritional quality, yield and other factors are assessed during the experiment to select high-performing oat cultivars. For example, a field evaluation of oats aimed at releasing new varieties is currently being conducted at three locations in Ethiopia, starting from 2022 (a collaborative project between EIAR and ILRI).

Field layout

Figure 2 is an illustration of the field layout, which is a partially incomplete block design with two replications per site. Each accession is planted in two rows, a total of (2*13=26 rows) / per incomplete block / per replication. The distance is set at 1 m between incomplete blocks and 1.5 m between replications.

Figure 2: Field layout



Total No genotpes(Trt)=156+13 checks =169 **Design simple lattice =13x13** **No Location =3 (Holetta,A/berga,Addis)**
Plot size=2mx 0.4=0.8 m2 **Seed amount based on 100kg/ha=8 g/plot :Fertilizer (NPS) 100kg/ha**
space b/n rows=0.2m: space b/n block=1m; No row/plot=2;

Data collection

As oats are a dual-purpose crop, the traits collected for evaluation include both forage biomass yield and quality, and grain yield.

Phenological data: The number of days to 50% heading, full heading, dough stage and grain maturity data are collected from the field.

Morphological data: Plant height, number of tillers, number of plants per plot, leaf length, leaf width, leaf area and stem thickness data are collected at the 50% flowering stage.

Agronomic data: Fresh and dry biomass yield are recorded immediately after 90% pod maturity from 5–10 tagged plants. Fresh yield data is collected immediately after harvest. For dry biomass yield records, the weight is recorded after samples are dried in an oven at 70°C for 72 hours.

Grain data: The 500-grain weight, total grain weight, grain area, grain width and grain length data are collected from 500 randomly selected seeds.

Feed nutrition data: After dry biomass yield is recorded, the oven-dried samples are used for the analysis of feed quality traits such as acid detergent fibre (ADF), neutral detergent fibre (NDF), acid detergent lignin (ADL), crude protein (CP), *in vitro* organic matter digestibility (IVOMD), metabolizable energy (ME), dry matter (DM), and ash.

Field trial management

- Intercropping oats with legumes such as vetch *(Vicia* spp.*)*, pea (*Pisum sativum)*, or berseem clover *(Trifolium alexandrinum)* [9–11], is effective at reducing diseases, suppressing weeds, capturing a greater share of available resources and improving the nutritive (protein) value of the crop compared to oats alone [33,34].
- The optimal sowing time differs for every variety within their respective zones. Deviating from the recommended sowing schedule poses a potential threat of yield reduction.
- Avoid planting on steep slopes where there is an increased risk of losing valuable nutrients, organic matter and topsoil from erosion.
- Higher fertilizer rates and seeding rates above 70 kg/ha are not recommended because the former results in higher lodging of oat plants and the latter reduces seed size and quality [35].
- A nitrogen rate of 63 kg/ha was determined to be the optimal combination for achieving maximum yield in the production of oats [36].
- Harvesting oats early for hay or silage improves the legume establishment process. This is because oats compete with the legumes for moisture and essential nutrients during the year.
- The timely harvesting of silage prevents lodging and smothering issues that tend to arise later in the growing season.

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Authors
Abel Teshome, Lidiya Ashenafi and Chris S. Jones work for ILRI.

Contact
Abel Teshome, Feed and Forage Development
ILRI Ethiopia
A.Gari@cgiar.org

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