PERFORMANCE OF SOME PERENNIAL GRASSES UNDER CLIMATIC CONDITIONS OF JUGLOTE GILGIT, PAKISTAN

By

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ABSTRACT
An experiment was conducted for three years (2003 to 2005) with the main objective to evaluate the performance of five perennial grasses, at KARINA, Gilgit, Northern Areas, Pakistan. The design of the experiment was randomized complete-block replicated four times. Morphological characters like plant height, number of tillers plant\(^{-1}\), green fodder yield, and dry matter yield were determined. Highly significant differences among the fodder genotypes under study were observed. Maximum Plant height (61.67 cm), maximum number of tiller plant\(^{-1}\)(38.85) dry matter yield (3.55 t ha\(^{-1}\)) and green fodder yield (8.87 t ha\(^{-1}\)) were obtained from Panicum antidotale genotype, whereas, minimum Plant height (36.19 cm), no. of tiller plant\(^{-1}\) (21.59), dry matter yield (1.97 t ha\(^{-1}\)) and green fodder yield (5.05 t ha\(^{-1}\)) were recorded in genotype Agropyron trachycalum (mix). The results indicated that the genotype Panicum antidotale significantly produced the highest yield and quality than other four grasses under study thus showing good prospects for cultivation under Juglote conditions of Pakistan.

KEYWORDS: Perennial grasses, Yield and yield component, indigenous cultivars

INTRODUCTION
Pakistan is located between 24 and 37\(^o\) N and 61 and 75\(^o\) E. The climate is arid with low rainfall and humidity and high solar radiation over most parts of the country. Most areas receive less than 200 mm annual rainfall, except for the high altitude northern mountains, which receive more than 500 mm annually. The rainfall distribution varies widely: 60% of rainfall in Sindh and Punjab Provinces occurs during the monsoon season i.e. from July to early September. Balochistan and the northern mountains receive maximum rainfall during October to March (FAO, 1987). The total land area of Pakistan, including Azad Kashmir, is 88 M ha. The main land uses in the country are agriculture, livestock production, and forestry. About 5 M ha of the cultivated area (24% of total area) is rainfed while 16 M ha is irrigated. Mohammad (1989) and NCA (1988) estimated that around 60% (45.2 M ha) of the total area is rangelands. Most of these rangelands receive less than 200 mm rainfall, and are located on rocky soils, deserts, and rough topography. Therefore, productivity is very low and it is not possible to utilize the same for sustained farming purposes. However, these rangelands partly support 93.5 M livestock during the summer (Mohammad, 1989). Perennial grasses provide humans with food and fiber via ruminant animals and areas for recreation. Recently, new applications and uses are being found for grasses and some species are being genetically altered and enhanced for these purposes. These include using specific grasses to meet specific or unique livestock production goals, developing grasses to meet specific turfgrass and ornamental requirements, utilization and development of grasses for specific conservation requirements, and developing grasses into industrial crops.
Human activity has altered the distribution and abundance of many species (Drake et al. 1989). Once established in new areas, introduced species can alter ecosystem structure and function, and reduce habitat for native plants and animals (Vitousek 1990). Introduced grasses are especially adept invaders of North American grasslands (D’Antonio and Vitousek 1992). Agropyron cristatum (L.) Gaertn, an Asian C3 grass, has been seeded throughout western North America because it establishes rapidly, prevents erosion, provides nutritious spring forage (Lesica and DeLuca 1996), and produces more forage than native grasses (Lawrence and Ratzlaff 1989). However, Agropyron also limits succession changes Looman and Heinrichs (1973), invades adjacent lands (Hull and Klomp 1967), reduces plant and animal diversity (Wilson 1989; Sutter and Brigham 1998), and alters soil chemistry (Dormaar et al. 1995; Christian and Wilson 1999).

Differences in competitive ability may explain the maintenance of existing plant populations and the invasion of new areas by plant species. Competitive ability includes the effect of competition from an individual on neighboring individuals and the response of an individual to competition from neighboring individuals Goldberg (1990).

The paucity of native species from Agropyron fields (Looman and Heinrichs 1973; Wilson 1989; Christian and Wilson 1999) suggests that Agropyron is a strong competitor which can displace plant or prevent the establishment of native species. However, Agropyron also responds to competition: neighboring Bromus inermis Leyss suppressed Agropyron transplants to about the same extent as it suppressed transplants of Bouteloua gracilis (HBK.) Lag a C4 grass native to the northern Great Plains of North America (Gerry and Wilson 1995). Cenchrus ciliaris is locally called Dhaman. It is very nutritious, very palatable and perennial grass. It is grazed by all kinds of livestock. It grows maximum up to 60 cm. It is mostly overgrazed due to deliciousness.

Cenchrus ciliaris L. (African foxtail grass, buffalo grass or buffel grass) is a valuable perennial species especially in the deserts of Pakistan. It grows well on sandy to sandy-loam soils in semiarid and arid regions, forming mats or tussocks. Mountain brome is considered a short lived perennial cool season bunchgrass of the C3 type (Wasser, 1982). It is native to the mountains and foothills of the Rocky Mountains and Pacific Coast regions (Stefferud, 1948). It does well on 18 inches or more of annual precipitation and grows at elevations from 5,000 to 10,000 feet (1,525-3,050 meters) [(Wasser, 1982 and Herzman, et al., 1975)]. It has been noted to interbreed with California brome (B. carinatus) and foothills brome (B. polyanthus) when found in close proximity (Wasser, 1982). Sheaths and leaves are normally pubescent and panicles are open. Mountain brome does well on moderately deep fertile medium textured soils (Wasser, 1982). It has a deep well branched root system that is important for protecting erodible slopes (Hanson, 1972). Mountain brome starts growth in early spring and is important palatable forage for wildlife and all livestock. It has large seeds with good seedling vigor, but seeds do deteriorate rapidly in storage. Mountain brome has approximately 7 1,000 seeds per pound. In comparison, ‘Garnet’ mountain brome has 77,879 seeds per pound (seed count by Colorado Seed Laboratory on the 1998 seed lot). Panicum antidotale is locally called Murret. It is perennial and semi-palatable. It is grazed when more palatable grasses are exhausted. It gains height between 90 and 150 cm. It is mostly grazed by cattle and its ears in green condition are eaten by small birds.

Northern Areas of Pakistan cover 72,500 square km of steep, broken and mountainous land with some of the world’s highest peaks. Cultivable land is extremely limited, averaging 0.075 ha. per capita while there are some 3 M livestock, mainly small stock and cattle. Lack of quality fodder, especially during winter, is a major limiting factor in improving livestock production. During winter all stock has to rely on crop residues and fodder, so many animals are undernourished and become weak by the spring. Because of very limited land holdings, lack of water and extreme weather conditions, fodder crop cultivation is practiced on small areas. So, traditionally there is a fodder deficit from November to March, when the main summer fodder crop season (for example maize) is over and the traditional winter fodder, especially shaftal (Trifolium resupinatum) and lucerne (Medicago sativa), are still dormant during the freezing temperatures. Due to limited land holdings, farmers also practice a highly integrated and subsistence type of farming system that is not very flexible.
The majority of farmers who have livestock also have fruit trees; an integrated approach that should complement rather than compete is required. Fodder legumes such as alfalfa or lucerne (Medicago sativa), berseem (Trifolium alexandrinum), shaftal (Trifolium resupinatum), vetch (Vicia sativa), cowpeas (Vigna unguiculata) etc and some other perennial grasses can be grown to provide fodder for livestock as well as improving soil fertility through biological nitrogen fixation.

Livestock industry of Pakistan is expanding rapidly due to increase in demand of meat, beef, milk, butter and their by-products by fast growing human population. For this purpose, more nutritious and high yielding varieties of fodder crops are needed. Fodder legumes and perennial grasses provide an excellent choice to meet the demand of rapidly growing livestock industry of Pakistan. Singh and Singh (1992) evaluated 11 oat cultivars and reported that JHO 811 produced higher green fodder yield (55 t/ha) followed by JHO 16 (54.3 t/ha) and JHO 17 (53.9 t/ha). These varieties also had greater plant height, number of tillers, leaves and leaf area. Bhatti et al. (1992) observed that higher green fodder yielding cultivars were also superior to other cultivars in plant height, tillering, leafiness and leaf area. Mufti et al. (1996) tested ten promising cultivars of oats and found that plant height, number of tillers per meter, number of leaves per tiller and leaf area directly affected the green fodder yield. Similarly, Chohan et al. (2004) observed that varieties producing higher green fodder yield were also superior in plant characters like plant height, tillering, leafiness and leaf area. Considering the above studies by different fodder scientists, we hypothesized that introduced and native grasses would differ in competitive ability and that these differences would be evident in their growth and biomass allocation patterns. To test this hypothesis, we designed field experiments to examine the competitive responses of some perennial grasses grown under agro ecological condition of Northern Areas of Pakistan.

MATERIALS AND METHODS
This study was conducted at Karakuram Agricultural Research Institute for Northern Areas (KARINA) Juglote, Gilgit Pakistan. The seeds of five genotypes of perennial grasses i.e. Panicum antidotale, Bromus marginatus, Agropyron trachyalum, Chenchrus ciliarus and Agropyron trachychalum obtained with the courtesy of NARC, Islamabad were planted in RCBD replicated four times having a plot size of 5.0 x 2.0m. Each plot consisted of 6 rows, each 5 m in length, with 20- cm spacing between rows. Sowing with the seed rate of 1g m$^{-2}$ was done in mixture of sand, soil and well rotted farm yard manure in equal proportion in the mid of November. The investigation was carried out for three years from 2003 to 2005 on sandy loam soil with pH 7.3 (Table.1). Three cuts were taken in each year at full-bloom stage of plants. The cutting height was approximately 8-10 cm above the ground level. Plant height (cm) and number of tillers/plant was determined. Herbage yield was determined m$^{-2}$, and the yield per hectare was calculated. Approximately 500g samples were dried at 78 °C for 24h to determine dry matter. Yield was calculated as t ha$^{-1}$. The results were analyzed using the State view statistical program.

Table-1: Physiochemical properties of Soil

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>7.3</td>
</tr>
<tr>
<td>EC</td>
<td>0.87dS/m</td>
</tr>
<tr>
<td>OM</td>
<td>0.90%</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>0.39%</td>
</tr>
<tr>
<td>P2O5</td>
<td>143.3 mg kg$^{-1}$</td>
</tr>
<tr>
<td>K2O</td>
<td>95.60 mg kg$^{-1}$</td>
</tr>
<tr>
<td>Lime contents</td>
<td>6.250%</td>
</tr>
<tr>
<td>Textural class</td>
<td>Sandy loam</td>
</tr>
</tbody>
</table>

Results and Discussion
Performance of perennial grasses in relation to yield and yield components
The year-wise and average performance along with statistical analysis (LSD 5% probability level) of perennial grasses for herbage yield and other yield components is shown in Table-2 and in figures 1-3, whereas, correlation among various characters is shown through figures 4-5. The results are discussed heading-wise here under:
Plant Height
Statistically there existed highly significant differences among different genotypes of grasses for this character. Numerically, maximum plant height was recorded in genotype *Panicum antidotale* (61.87 cm) followed by *Cenchrus ciliaris* with 54.89 cm. Minimum plant height (36.19 cm) was recorded from *Agropyron trachycaulum* (mix). Variation in the plant height is genotypic character and therefore is expressed in the form of better adaptability to environmental conditions. The present results are in accordance with those of Mufti et al. (1996) and Chohan et al. (2004) who observed that varieties producing higher green fodder yield were also superior in plant characters like plant height, tillering, leafiness and leaf area.

Number of tillers per plant
The mean tillers per plant data indicated that *Panicum antidotale* produced maximum number of 38.85 tillers per plant followed by *Agropyron trachycaulum* Sluis (34.67) tillers per plant respectively, whereas, *Agropyron trachycaulum* (mix) produced the minimum number of (21.59) tillers per plant. The difference among various cultivars may be due to genetic make up. The results recorded by Singh and Singh (1992), Mufti et al. (1996) and Chohan et al. (2004) are in line with the results of present study. These scientists were also of the view that fodder varieties having smaller plants produced less number of tillers consequently lower yield. During present study, we also conducted correlation studies on these five perennial grasses under study, which revealed that plant height showed significant positive correlation with number of tillers and yield; hence the fodder genotypes with maximum plant height produced maximum number of tillers per plant and higher fodder yield.

Fresh Weight/Green Fodder Yield
Statistical analysis of data revealed that significantly maximum fresh weight (8.87 t ha⁻¹) was noted in *Panicum antidotale* followed by *Cenchrus ciliaris* which produced 7.51 t ha⁻¹ fresh weights. Minimum fresh yield of (5.05 t ha⁻¹) was recorded in *Agropyron trachycaulum* (mix). Our results are in line with those of Singh and Singh (1992), Mufti et al. (1996), Bhatti et al. (1992) and Chohan et al. (2004). Fodder yield of all genotypes was appreciable. The high yielding varieties showed that these genotypes are more suited to agro-ecological conditions of Juglote and their adoption can bring substantial increase in yield per unit area.

Dry Weight/Dry Matter Yield
The result present in table-2 revealed that dry matter yield of perennial grasses varied due to climatic adaptability of genotypes. Among Five genotypes, dry matter yield (DMY) recorded was maximum (3.55 t ha⁻¹) for *Panicum antidotale* and was lowest (1.97 t ha⁻¹) in case of *Agropyron trachycaulum* (mix) Local Ghizer. Nevertheless, from animal nutrition point of view, DMY is a more meaning full estimate for comparing fodder yield. All the varieties used in the present study were of improved type and the high DMY suggests that fodder yield could be increased more than two folds by using seeds of improved verities.

Results of analyses for the traits investigated are given Table 2, plant height, and number of tiller plant⁻¹ are important traits that are used to estimate herbage yield, *Panicum antidotale* gave higher values (P<0.01) than other cultivars for main plant height (61.67 cm), Number of tillers plant⁻¹ (61.67), herbage yield (8.87 t ha⁻¹), and dry matter yield (3.55 t ha⁻¹). Perennial grasses such as *Elymus nutans*, *Bromus inermis*, *Clinelymus nutans*, and their mixtures can produce higher DM yield (around 8–14 t ha⁻¹) than oats and resist wind successfully (Dong 2001). Mixtures of perennial grasses are sustainable and productive farming system in this legume-deficient alpine region. Perennial grass mixtures are recommended, but little information on grazing management is available.

Correlation of yield with different yield components
Correlation may be positive or negative. Positive correlation may be indicated by the increase in one character associated with a simultaneous increase in the other, whereas, the correlation between two characters could be negative if an increase in one character is associated with a simultaneous decrease in the other. Positive correlation exhibiting between two desirable characters and negative correlation between a desirable and undesirable character could be usefully exploited towards development of new improved genotypes.
It was observed that herbage yield and dry matter yield had significant positive correlation with plant height, (Figure-4). Correlation among the component level showed that the green fodder yield and dry matter yield was positively and significantly correlated with plant height and number of tillers (Figure-5). This indicated that increment in yield components was due to simultaneous positive contribution by the plant height which ultimately increased the yields (fresh weight and dry matter yield).

**Recommendations**

Maximum fresh weight and dry weight were obtained from *Panicum antidotale* and *Cenchrus ciliarus*. Based upon the results recorded from present study, it is recommended that high yielding fodder genotypes under study may be taken out to the farmer’s fields. The farmers may be advised for timely irrigation, fertilization and application of FYM to obtained maximum yield, which may coup the scarcity of fodder in Northern Areas of Pakistan.

**Morphological Characteristics and yield components of Perennial Grasses**

<table>
<thead>
<tr>
<th>Fodder Genotypes</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Bromus marginatus</em></td>
<td>35.45</td>
<td>42.11</td>
<td>42.33</td>
<td>39.96</td>
</tr>
<tr>
<td><em>Agropyron trachycaulum</em> (sluis)</td>
<td>41</td>
<td>48</td>
<td>45.67</td>
<td>44.88</td>
</tr>
<tr>
<td><em>Panicum antidotale</em></td>
<td>60.89</td>
<td>64.22</td>
<td>59.89</td>
<td>61.67</td>
</tr>
<tr>
<td><em>Cenchrus ciliarus</em></td>
<td>56.78</td>
<td>55.33</td>
<td>52.56</td>
<td>54.89</td>
</tr>
<tr>
<td><em>Agropyron trachycaulum</em> (mix)</td>
<td>33.34</td>
<td>39.11</td>
<td>36.11</td>
<td>36.19</td>
</tr>
<tr>
<td><strong>LSD (0.05)</strong></td>
<td>2.17</td>
<td>1.79</td>
<td>1.33</td>
<td>1.51</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fodder Genotypes</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Bromus marginatus</em></td>
<td>25.11</td>
<td>23.78</td>
<td>24.44</td>
<td>24.44</td>
</tr>
<tr>
<td><em>Agropyron trachycaulum</em> (sluis)</td>
<td>30</td>
<td>36.44</td>
<td>37.56</td>
<td>34.67</td>
</tr>
<tr>
<td><em>Panicum antidotale</em></td>
<td>29.11</td>
<td>41.78</td>
<td>45.67</td>
<td>38.85</td>
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<tr>
<td><em>Cenchrus ciliarus</em></td>
<td>25.11</td>
<td>34.77</td>
<td>38.11</td>
<td>32.67</td>
</tr>
<tr>
<td><em>Agropyron trachycaulum</em> (mix)</td>
<td>19.78</td>
<td>20.23</td>
<td>24.78</td>
<td>21.59</td>
</tr>
<tr>
<td><strong>LSD(0.05)</strong></td>
<td>1.36</td>
<td>1.51</td>
<td>1.44</td>
<td>1.10</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
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<th>2004</th>
<th>2005</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Bromus marginatus</em></td>
<td>5.03</td>
<td>5.35</td>
<td>5.59</td>
<td>5.32</td>
</tr>
<tr>
<td><em>Agropyron trachycaulum</em> (sluis)</td>
<td>5.67</td>
<td>6.28</td>
<td>6.53</td>
<td>6.16</td>
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<tr>
<td><em>Panicum antidotale</em></td>
<td>8.2</td>
<td>9.15</td>
<td>9.27</td>
<td>8.87</td>
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<tr>
<td><em>Cenchrus ciliarus</em></td>
<td>6.94</td>
<td>7.66</td>
<td>7.94</td>
<td>7.51</td>
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<tr>
<td><em>Agropyron trachycaulum</em> (mix)</td>
<td>4.52</td>
<td>5.08</td>
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<td>5.05</td>
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<tr>
<td><strong>LSD (0.05)</strong></td>
<td>0.39</td>
<td>0.32</td>
<td>0.32</td>
<td>0.33</td>
</tr>
</tbody>
</table>

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<thead>
<tr>
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<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Bromus marginatus</em></td>
<td>2.09</td>
<td>2.07</td>
<td>2.35</td>
<td>2.17</td>
</tr>
<tr>
<td><em>Agropyron trachycaulum</em> (sluis)</td>
<td>2.55</td>
<td>2.5</td>
<td>2.70</td>
<td>2.58</td>
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<tr>
<td><em>Panicum antidotale</em></td>
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<td>3.16</td>
<td>3.82</td>
<td>3.55</td>
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<tr>
<td><em>Cenchrus ciliarus</em></td>
<td>2.69</td>
<td>2.75</td>
<td>3.31</td>
<td>2.92</td>
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<tr>
<td><em>Agropyron trachycaulum</em> (mix)</td>
<td>1.73</td>
<td>1.96</td>
<td>3.23</td>
<td>1.97</td>
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<tr>
<td><strong>LSD(0.05)</strong></td>
<td>0.29</td>
<td>0.33</td>
<td>0.21</td>
<td>0.14</td>
</tr>
</tbody>
</table>
**Figure:** First year’s data

**a. Plant height (cm)**

**b. Number of tillers/plant**

**c. Green fodder Yield**

**d. Dry matter yield**

**Fig (1)** Agronomic parameters of different perennial grasses cultivated in KARINA
(a) Plant height, (b) Number of tillers\(^{-1}\), (c) Green fodder yield (d) Dry matter yield

On the top of figure: (A) Indicates *Bromus marginatus*, (B) *Agropyron trachycaulum* (sluis) (C) *Panicum antidotale*, (D) *Chenchrus ciliarus*, (E) *Agropyron trachycaulum* (mix)

On the bottom of Figure: (1) Indicates 1\(^{st}\) cut (2) Indicates 2\(^{nd}\) cut and (3) Indicates 3\(^{rd}\) cut
**Figure:**-2 Second year’s data

1. **Plant height (cm)**
2. **Number of tillers/plant**
3. **Green fodder Yield**
4. **Dry matter yield**

**Legend:**
- A: *Bromus marginatus*
- B: *Agropyron trachycaulm* (sluis)
- C: *Panicum antidotale*
- D: *Chenchrus ciliarus*
- E: *Agropyron trachycaulm* (mix)

**Figure Parameters:**
- (a) Plant height, (b) Number of tillers$^{-1}$, (c) Green fodder yield, (d) Dry matter yield

**Legend on the top of figure:**
- (A) Indicates *Bromus marginatus*, (B) *Agropyron trachycaulm* (sluis), (C) *Panicum antidotale*, (D) *Chenchrus ciliarus*, (E) *Agropyron trachycaulm* (mix)

**Legend on the bottom of Figure:**
- (1) Indicates 1st cut, (2) Indicates 2nd cut, and (3) Indicates 3rd cut.
**Figure:**-3 Third year’s data

a. **Plant height (cm)**

b. **Number of tillers/plant**

c. **Green fodder Yield**

d. **Dry matter yield**

Fig-(3) Agronomic parameters of different perennial grasses cultivated in KARINA 
(a) Plant height, (b) Number of tillers⁻¹, (b) Green fodder yield (d) Dry matter yield

On the top of figure: (A) Indicates *Bromus marginatus*, (B) *Agropyron trachycaulum* (sluis) (C) *Panicum antidotale*, (D) *Chenchrus ciliarus*, (E) *Agropyron trachycaulum* (mix)

On the bottom of Figure:  (1) Indicates 1ˢᵗ cut (2) Indicates 2ⁿᵈ cut and (3) Indicates 3ʳᵈ cut

Figure 4
Relation ship between green fodder yield and dry matter yield t ha⁻¹ versus number of tillers plant⁻¹ for different perennial grasses

Y = .668 + .194 * X; R² = .763

Y = .201 + .08 * X; R² = .839

Figure 5
Relation ship between green fodder yield and dry matter yield t ha⁻¹ versus plant height for different perennial grasses

Y = -.562 + .15 * X; R² = .982

Y = -.136 + .058 * X; R² = .959

REFERENCES


Stefferud, Alfred. 1948. Grass - The yearbook of agriculture 1948. USDA.


