Exploration of roadside Weedy grasses of Assam for Ecosystem Maintenance

.

ABSTRACT

|  |
| --- |
| Considering the rich diversity of grasses (Family: Poaceae) and their various roles in economic and ecological services, the study was conducted to enumerate the roadside grassy species in Jorhat district of Assam and to develop a Key for identification for easy recognition of the taxa. This study revealed the presence of 26 grass species in the study area belonging to 19 genera, these were observed to be potential weeds for neighboring cropping environments and roadside infestations may act as a source of seeds for wider spread. Out of recorded species, 10 were well- known annual grasses while five other typical annual species expressed a perennial habit in roadside situation, indicating the prevalence of perennial grasses in the roadside vegetation. Our phonological observations showed that *Axonopous compressus*, *Urochloa ramosa* and *Ischane globosa* bloomed almost round the year, eight other species produced their flowers and fruits during the rainy season, and the remaining species bloomed in the dry winter season. Maintenance of roadside landscaping primarily as soil binder, the grassy vegetation used to build up amicable environment for sheltering several non-grassy plant species and together acted as primary provider of green fodder for the primary consumers, including the ruminants. With moderate to high moisture content, 5.4 to 14.88% crude protein, and 18.20 to 39.40% crude fiber, these grasses possessed good palatability. A key for the identification of the grass species found was constructed based on their morphology for easy recognition of the species. |

*Keywords: Roadside grasses; Assam; Fodder quality.*

1. INTRODUCTION

Roadside grasses play several vital ecological and economical roles. They are often been raised and maintained along the edges of roads, irrespective of Country Road, Trunk Road or National Highways, mainly for binding of the soil with their tremendously branched stem system and numerous fibrous roots arising from each and every nodes of prostrate portion of the stem. In the road management engineering, the roadside grasses are given much importance for their functions in the maintenance of attractiveness for creation of local landscape by reducing potholes and cracks despite of their crucial role in ecosystem services like erosion control, water regulation, soil formation, air quality regulation, carbon sequestration, waste management, etc. (Bautista *et al*., 2019, Bautista *et al*., 2020; Francois, 2004). Roadside maintenance activities, like cutting or mowing and pruning, as well as grazing encouraged the reduction of apical dominance by removing the rapidly growing central apical shoots, which resulted in rapid and uniform growth of lateral branches, and thereby development of evergreen groundcover layers of grassy species. With the help of fibrous roots arising from every node of lateral branches, these grassy covers helped in limiting soil erosion and providing shelter to overwintering insects and pollinators (Jagdish, 2019). Sections of roadsides are among the patches of suitable habitat often used by environmental weeds as they leapfrog their way across landscapes (Sullivan *et al*. 2009) and also architect excellent ecosystem where many other non-grassy plants can grow in association, as well as shelter innumerable numbers of primary and secondary consumers and their predators. Grasses are primary food provider in the entire roadside ecosystem, country cattle and several herbivorous are feed upon the road side grasses. In Indian scenario, especially in Assam, the importance of roadside grasses in livestock livelihood is enormous. As per an assessment (Dixit *et al*., 2015), the grazing pressure in terms of livestock per unit of permanent pasture (PP) and grazing lands (GL) at country level increased from 35 to 52 animals during 1982 to 2007, whereas, carrying capacity per unit PP & GL was less than one adult cattle unit. In such as situation, the roadside grasses are the last asylum for the poor livestock holders. Keeping in view the scope and significance of grassy species in various ecosystems functioning, the present study was undertaken to enumerate the roadside grassy species of Assam exploring their fodder constituents and to develop a key for identification for their easy field recognition.

2. material and methods

* 1. **Study Area**

The study area was confined to Jorhat district, which is located in the Upper Brahmaputra Valley Agro-climatic zone of Assam in between 26o25' N to 26o55' N latitude and 93o56$'$E to 94o36'E longitude. The total geographical area of the district was around 1757 sq.km. and its average elevation was 116 meters from mean sea level. The study area located along the road networks of the district comprising of National Highway (NH-37, total 85 Km), Assam Trunk Road and other urban and village roads.

* 1. **Exploration and collection**

Different types of roads were visited repeatedly during 2022 to 2023 and the plant samples and their photographs were collected. The collected plant samples were processed for herbarium preparation by following a standard method of Radford (1986). Handmade mounting boards of approximately 42cm × 28cm size, collected from the local handmade paper industry, were used for herbarium preparation. Each species was characterized i*n situ* and at laboratory of the Department of Agronomy, Assam Agricultural University, Jorhat. Plants were identified by comparing the characters generated through field and laboratory studies with that of floristic literature and finally by matching with the existing herbarium specimens available at the “Weed Herbarium” of Assam Agricultural University, Jorhat. A dichotomous key was prepared by using the data generated during the study for easy field recognition of the taxa suitable for end users. The voucher specimens have been deposited in the Weed Herbarium of Assam Agricultural University, Jorhat. For chemical investigation, the samples were dried in an oven at 55°C for 48 hours and stored in polythene bags.

* 1. **Chemical investigation**

Proximate analysis of the grasses was done according to the Association of Official Analytical Collaboration International (AOAC, 2000). The dry matter (DM) was calculated by keeping the samples in forced air oven till constant weight. The crude protein (CP) was measured by Kjeldhal apparatus. Ash was calculated by burning the samples in furnace. The neutral detergent fiber (NDF) and acid detergent fiber (ADF) were determined by the method as described by van Soest *et al*., (1991).

3. results and discussion

The systematic study revealed an enumeration of as many as 26 numbers of species under 19 numbers of genera belonging to grassy family Poaceae growing along road sides in Jorhat district (Table-1). This enumeration has also revealed a presence of 10 numbers of annual species out of the total grassy flora, and 5 annual species expressing perennial habit in roadside situation, indicating the prevalence of perennial grasses in the study area. The phenological observation has shown that *Axonopous compressus*, *Urochloa ramosa* and *Ischane globosa* used to bloom almost round the year, 8 other species produced their flower and fruit during February-March to July-August (during rainy season) and rest of the species used to bloom in the letter part of the year, means in the dry winter season.

Out of the total 26 number of species, *Chrysopogon aciculatus* posed more or less serious weedy feature along roadsides by means of its sticking spikelet’s and the *Sporobolous diander* with its stiff and tufted erect culms. Out of that *Cynodon dactylon, Digitaria setigera, Eleusine indica, Imperata cylindrica, Megathyrsus maximus, Panicum repens* and *Setaria pumila* posed serious threat to the upland crops and *Leerisa hexendra, Paspalum* species and *Panicum repens* to aquatic and march-land crops, and their existence in roadside might be a source of continuous seed input to the nearby crop ecosystems. Most of the grasses of roadside situation recorded during the study possessed weedy nature, out of which few e.g. *Chrysopogon aciculatus*, *Digitaria setigera, Eleusine indica, Imperata cylindrica* and *Setaria pumila,* have often been considered as very troublesome species. However, almost all the species have been used by the local people for their livelihood support in one way or other. All the grassy species have played vital ecological role in soil binding and erosion control, as well as providing food for the entire ecosystem too. A key for identification constructed based on morphological characters of the taxa for field recognition and easy handling by the end users. Obviously, the study has opened up the prospect and need of wider expansion of the work to the state and the region for better conservation of the species and their appropriate management for sustainable maintenance of the roadside ecosystem.

Chemical composition of the roadside grasses of study area (Table-2) revealed that the dry matter (DM) contents varied from 13.75% (*Echinochloa colona)* to 52.70% (*Ischaemum rugosum*). DM is the weight of forage without water. The natural occurrence of grassy species in subtropical climate with high (*Echinochloa colona* and *Paspalum* spp.) to moderate moisture content indicated the better palatability of the grasses. Out of the studied 17 numbers of grasses in respect of fodder quality, almost all the species were subjected to remain creeping or in rosette form (e.g. *Eleusine indica*) because of continuous grazing as well as other disturbances caused by vehicle and human interventions triggering in higher stem-leaf ratio. Leaf losses resulted in CP losses and decreased digestible DM (Linn and Martin, 1989). In the present study the highest CP value (14.88%) was observed in *Eragrostis unioloides*, while, the least CP concentration (5.40%) in *Echinochloa colona*. The value of CP differs either due to age of plant (Distel *et al*., 2005) or may be due to seasonal effect (Dittberner and Olson, 1983). Soil fertility can be another cause of change in protein value in the forages. He *et al.* (2021) observed that *Axonopus compresus* has the capacity to grow in minimal fertilization and can resist well to abiotic and biotic stresses including low nitrogen stress and shown that the leaf tissues accumulated more anthocianins and other flavonoid metabolites, but reduced amount of amino acids, nucleic acids and their derivatives under low nitrogen stress.

The forage feeding values are negatively associated with fibre, since the less digestible portions of plants are contained in the fiber fraction (Linn and Martin, 1989). The Crude fiber (CF) content found maximum in *Imperata cylindrica* (39.40%) while the least CF was found in *Digitaria ciliaris* (18.20%). The neutral detergent fiber (NDF) contents varied from 13.59% (*Megathyrsus maximus*) to 70.7% (*Cynodon dactylon*). The lowest acid detergent fiber (ADF) (14.90%) was observed in *Echinochloa colona* and the highest (56.20%) in *Chrysopogon aciculatus*. Basic assumption is that high-quality forage has low ADF and NDF compared to low-quality forage; high-quality forage digests more completely and has higher energy values (Beleyea *et al.,* 1993). Bourquin *et al*., (1994) reported 72.4% NDF and 43.8% ADF in the Orchard grasses. The difference in the observations of NDF and ADF values might be due to the age of maturity of grasses (Cherney *et al*., 1993). The highest ash content (16.26%) was found for *Urochloa* spp. and the lowest (7.10%) for *Echinochloa colona*. The chemical composition of grasses analyzed provides a good source to be used as the nutrient source of ruminant feed. The findings of the present study are in line with those of Rahim *et al*. (2008) who analyzed range grasses and reported DM up to 38%.

**4.KEY FOR IDENTIFICATION**

**1a.** Spikelets 2-flowered, falling entire at maturity, usually with upper floret hermaphrodite and lower floret male or barren ……… (2)

**1b.** Spikelets 1 to many flowered, breaking up at maturity above the more or less persistent glumes, or if falling entire then not 2-flowered ………… (12)

**2a.** Ligule absent, represented by a slightly raised thick band ................ *Echinocloa colona*

**2b.** Ligule present, either membranous or ciliate ................. (3)

**3a.** Inflorescence of digitately arranged spikes ……………… (4)

**3b.** Inflorescence paniculate, never digitate …………… (6)

**4a.** Tillers laterally compressed. Sheaths ciliate along margins ……***Eleusine indica***

**4b.** Tillers terete. Sheaths eciliate ………… (5)

**5a.** Ligule membranous and densely ciliate. Sterile spikelet awned….… ***Dactyloctenium aegyptium***

**5b.** Ligule a rim of white hairs. Spikelet not awned…….………… ***Cynodon dactylon***

**6a.** Spikelets 1 or 2 flowered. Nodes distinctly thicker than internode. Ligule membrano-ciliate ……………. ***Sporobolus diander***

**6b.** Spikelets many flowered. Nodes as thick as or slightly thicker than internode. Ligule eciliate membrane... (7)

**7a.** Spikelet disarticulating above glume ………….………………..… ***Ischane globosa***

**7b.** Spikelet falling entire at maturity ….……………………….. (8)

**8a.** Spikelets distinctly gibbous ……………………….. (9)

**8b.** Spikelets not or slightly gibbous ……………………………………….. (10)

**9a.** Lower glume acute. Spikelets 2.0-.2.5mm long …… ***Cyrtococcum patens***

**9b.** Lower glume obtuse. Spikelets *ca* 1.5mm long …………***Cyrtococcum accrescens***

**10a.** Spikelets paired, one sessile and one pedicelled. Lower glume as long as spikelet…….. ***Chrysopogon aciculatus***

**10b**. Spikelets solitary or paired, all alike. Lower glume one third of spikelet ……..………………………… (11)

**11a.** Tall herb, 1 to 2m tall. Nodes hairy. Rhizomes short and thick, not differentiated. Nerves of upper glume and lower lemma obscure …………………………. ***Megathyrsus*** ***maximus***

**11b**. Short herb, 30 to 100 cm tall. Nodes glabrous. Rhizomes differentiated into thick bulbous and stoloniferous structures. Nerves of upper glume and lower lemma dominant …………………….. ***Panicum repens***

**12a.** Ligule eciliate membranous ………….…………………….…………. (13)

**12b.** Ligule membrano-ciliate or rim of hairs ………………….………………. (21)

**13a.** Stamens 6. Nodes prominently thicker than internodes and densely bearded ………. ….. ***Leerisa hexendra***

**13b.** Stamens 3. Nodes otherwise ………….…….…….……………… (14)

**14a**. Inflorescence very lax panicle ……………………………………...….………………. (15)

**14b.** Inflorescence spicate …………………………………… (17)

**15a.** Spikelets 20-50 flowered. Lemma falling from the base upwards ……….……. ***Eragrostis unioloids***

**15b.** Spikelets 3to10 flowered. Lemma falling from above downwards…………… ……………….…... (16)

**16a.** Lamina hardly up to 12cm long. Palea not ciliate ………………….......……… ***Eragrostis japonica***

**16b.** Lamina up to 20cm long. Palea ciliate along the keels …………………. ***Eragrostis tenella***

**17a**. Spikelets spirally arranged on the inflorescence axis ……………….…….. ***Sacciolepis myosuroides***

**17b.** Spikelets arranged in one-sided rows on the axis ……………….…………… (18)

**18a.** Inflorescence a panicle of 2-10 digitate or sub-digitate spicate racemes ……………………….. (19)

**18b.** Inflorescence a panicle of 2 spicate racemes ………………………………… (20)

**19a.** Racemes10-15cm long ………………..… ***Digitaria setigera***

**19b.** Racemes5-10cm long ………..……………. ***Digitaria ciliaris***

**20a.** Lamina 6-12mm wide, spikelets *ca* 1.5mm long ………. ***Paspalum conjugatum***

**20b.** Lamina 2-6mm wide, spikelets 2.5-3.5mm long…...…………… ***Paspalum distichum***

**21a.** Inflorescence with very dense silvery silky long hairs. Nodes thicker than internode ...… ***Imperata cylindrica***

**21b.** Inflorescence never silky hairy. Nodes usually as thick as internode ………. …..……….. (22)

**22a.** Culm strongly laterally compressed; nodes hairy …….…………….. (23)

**22b.**Culm not or slightly compressed; nodes glabrous ………………………….. (24)

**23a.** Spikelet with awn developed from upper lemma, lamina acuminate at apex ………. ***Ischaemum rugosum***

**23b.** Spikelet awn less, lamina obtuse or broadly acute at apex …………….…. ***Axonopous compressus***

**24a.** Inflorescence spike like panicle with reddish brown bristles, never digitate ……….………. ***Setaria pumila***

**24b.** Inflorescence terminal digitate of 2-6 spikes, never with bristles …………………. (25)

**25a.** Sheath densely silky hairy. Lamina often drooping. Amphibious perannials ……………. ***Urochloa mutica***

**25b.** Sheath glabrous or sparsely hairy. Lamina erect. Upland annuals …….………***Urochloa ramose***

**Table 1. The checklist of the grassy species available along the roadsides in Jorhat district, Assam**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **SI. No.** | **Species** | **Habit** | **Vernacular name** | **Flowering & Fruiting time** |
| 1 | *Axonopous compressus* (Sw.)P. Beauv. | P | Dolichabon (Asm.) | Almost throughout the year |
| 2 | *Chrysopogon aciculatus* (Retz.) Trin | P | Bonguti (Asm.) | June-October |
| 3 | *Cynodon dactylon* (L.) Pers | P | Dubori (Asm.) | March-September |
| 4 | *Cyrtococcum accrescens* (Trin.) Stapf | P(A) | - | August-March |
| 5 | *Cyrotococcum patens* (L.) A. Camus | A | - | May-June |
| 6 | *Dactyloctenium aegyptium* (L.) Willd. | A | Madana (H) | May-August |
| 7 | *Digitaria ciliaris* (Retz;) Koeler | A | Sirabon(Asm.) | May-December |
| 8 | *Digitaria setigera* Roth | A | Sirabon(Asm.) | February-June |
| 9 | *Echinochloa colona* (L.) Link | A | Binoi-bon(Asm.) | July-September |
| 10 | *Eleusine indica* (L.) Gaertn. | A | Bobosabon (Asm.) | July-October |
| 11 | *Eragrostis japonica* (Thunb.) Trin | P(A) | Panghas (H) | June-November |
| 12 | *Eragrostis tenella* (L.) P. Beauv. ex Roem. & Schult. | A | Bharbhusi (H) | March-September |
| 13 | *Eragrostis unioloides* (Retz.) Nees ex Steud | P(A) | Mota-dobori (Asm.) | August-October |
| 14 | *Imperata cylindrica* (L.) Raeusch | P | Ulubon (Asm.) | March-May |
| 15 | *Ischaemum rugosum* Salisb. | A | Maronda (H) | October-December |
| 16 | *Ischane globosa* (Thunb.) Kuntze | P(A) | Maronda (H) | Almost throughout the year |
| 17 | *Leersia hexandra* Sw | P | Erali-bon (Asm.) | March-June |
| 18 | *Megathyrsus maximus* (Jacq.) B.K.Simon & S.W.Jaobs  | P | Gobraghas,Kutki (H) | November-July |
| 19 | *Panicum repens* L. | P | Paraghas(H) | May-November |
| 20 | *Paspalum conjugatum* Bergius | P | Lokusabon(Asm.) | August-February |
| 21 | *Paspalum distichum* L. | P | Besak (H) | August-February |
| 22 | *Sacciolepis myosuroides* (R.Br.) Chase ex Camus & Camus | A | Hil–tauta (Asm.) | August-December |
| 23 | *Setaria pumila* (Poir.) Roem & Schult. | A | Bisabon,(Asm.) | August-October |
| 24 | *Sporobolus diander* (Retz.) P. Beauv | P(A) | Tupasoli(Asm.) | March-September |
| 25 | *Urochloa mutica* (Forssk.) T.Q.Nguyen | P | Para-ghanh (Asm.) | February-June |
| 26 | *Urochloa ramosa* (L.) T.Q.Nguyen | A | Tupa-soli(Asm.) | Almost throughout the year |

NB: A= Annual; P=Perennial; Asm. = Assamese language; H= Hindi language

**Table 2: Dry Matter (DM), Crude Protein (CP), Crude Fiber (CF), Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF) and Ash Content of some roadside grasses in Jorhat district of Assam**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Sl. No.** | **Weed species** | **DM(%)** | **CP(%)** | **CF(%)** | **NDF(%)** | **ADF(%)** | **Ash (%)** |
| 1 | *Cynodon dactylon* | 31.30 | 10.53 | 29.50 | 70.70 | 42.20 | 11.53 |
| 2 | *Chrysopogon aciuculatus* | 33.70 | 5.03 | 29.90 | 79.00 | 56.20 | 13.33 |
| 3 | *Dactyloctenium aegypticum* | 30.30 | 8.23 | 28.80 | 70.61 | 46.33 | 10.03 |
| 4 | *Digitaria ciliaris* | 27.70 | 11.00 | 18.20 | 69.80 | 42.70 | 7.87 |
| 5 | *Digitaria setigera* | 31.80 | 12.22 | 23.34 | 55.20 | 32.00 | 13.60 |
| 6 | *Echinochloa colona*  | 13.75 | 5.40 | 27.15 | 36.00 | 14.90 | 7.10 |
| 7 | *Eleusine indica* | 27.00 | 10.90 | 29.00 | 64.40 | 34.10 | 11.20 |
| 8 | *Eragrostis unioloides* | 35.87 | 14.88 | 19.50 | 39.80 | 25.87 | 8.43 |
| 9 | *Imperata cylindrica* | 31.90 | 7.80 | 39.40 | 74.30 | 45.70 | 8.82 |
| 10 | *Ischaemum rugosum* | 52.70 | 6.70 | 22.70 | 42.00 | 18.10 | 7.80 |
| 11 | *Leersia hecandra* | 35.20 | 6.30 | 30.80 | 66.20 | 36.20 | 12.80 |
| 12 | *Megathyrsus maximus* | 48.30 | 8.87 | 32.10 | 13.59 | 24.21 | 11.20 |
| 13 | *Panicum repens* | 38.80 | 10.80 | 32.40 | 73.20 | 38.50 | 10.80 |
| 14 | *Paspalum conjugatum* | 21.70 | 7.06 | 30.20 | 68.10 | 35.60 | 8.57 |
| 15 | *Paspalum distichum* | 14.24 | 8.80 | 35.10 | 70.27 | 38.52 | 8.23 |
| 16 | *Setaria pumila* | 27.50 | 10.70 | 35.20 | 63.75 | 35.50 | 8.70 |
| 17 | *Urochloa* spp. | 29.60 | 11.60 | 36.40 | 57.10 | 37.12 | 16.26 |

4. Conclusion

Altogether 26 numbers of grasses have been explored in the roadside situation of Jorhat district of Assam, which were found to be potential weeds for neighboring crop ecosystems and acted as sources of seeds for invasion. Maintenance of roadside landscaping primarily as soil binder, the grassy vegetation used to build up amicable environment for sheltering several non-grassy plant species and together acted as primary provider of green fodder for the primary consumers, including the ruminants. With moderate to high moisture content, 5.4 to 14.88% crude protein, and 18.20 to 39.40% crude fiber, those grasses possessed good palatability. A key for identification of the enumerated grassy species was constructed based on their morphology for easy recognition of the species.

References

AOAC. 2000. Official methods of analysis. Association of Analytical Chemists. 15th edition. Arlington Virginia, USA.

Bautista, S., Espinoza, A., Narvaez, P. and Camargo, M. 2019. A system dynamics approach Colombia baseline simulation. *J. Clean. Prod.* 213:1-20.

Bautista, S., Camargo, M. and Bachmann, C. 2020. Sustainable roadside management from an innovative approach to ecosystem services and bioenergy generation. Int. cont. Engg. Tech.Innov. 2020: 1-7. Doi: 10.1109/ICE/ITMC 49519. 2020. 9198647.

Beleyea, R.L., Steevens. B., Garner, G., Whittier, J.C. and Sewell, H. 1993. Using NDF and ADF to balance dets. https://extension. Missouri.edu. (Publ. No. G-3161).

Bourquin, L.D., Titgemeyer, E.C., van Milgen, J. and Fahey, G.C. 1994. Forage level and particle size effects on orchadgrass digestion by steers-II. Ruminal digestion kinetics of cell wall components. *J. Anim. Scie*. 72: 759-767.

Cherney, D.J.R., Cherney, J.H. and Lucey R.F. 1993. In Vitro Digestion Kinetics and Quality of Perennial Grasses as Influenced by Forage Maturity. *J. Dairy Sci.* 76:790-797.

Distel, R.A., Didoné, N.G. and Moretto, A.S. 2005. Variations in chemical composition associated with tissue aging in palatable and unpalatable grasses native to central Argentina. *J. Arid Environ.* 62:351-357.

Dittberner, P.L and M.L. Olson, 1983. The Plant Information Network (PIN) Data Base: Colorado, Montana, North Dakota, Utah.

Dixit, A., Singh, M.K., Roy, A.K, Reddy, B.S. and Singh, N. 2015. Trends and contribution of grazing resources to livestock in different states of India. Range Managm. Agroforestry 36 (2): 204-210.

Francois, H. 2004. Letouris medurable use organization dutourisme enmilieurural. *Rev. d’Economie Regionale Urbaine vol. fevrier:* 57-80.

He, L., Teng, L., Tang, Long, W., Wang, Z., Wu, Y. and Liao, L. 2021. Agro-morphological and metabolomics analysis of nitrogen stress response in *Axonopus compressus*. AoBPlants 13(4), pbab 022.

Jagdish, 2019. Ground cover plants - Types, List, Advantages. https://gardentips.In (last updated on 30.10.2019)

Linn, J.G. and Martin, N.P. 1989. Forage quality tests and interpretation. University of Minnesota. pp. 1-5. https://hdl.handle.net/1.1299/207442 (AGFO-2637)

Radford, A. 1986. Fundamentals of Plant Systematics. Harper & Row Publ. Inc., USA.

Rahim, I. R., Sultan, J. I., Yaqoob, M., Nawaz, H.. Javed I. and Hameed M. 2008. Mineral profile, palatability and digestibility of marginal land grasses of trans-himalayan grasslands of Pakistan. *Pakistan J. Bot*. 40(1):237-248

Sullivan, J.J., Williams, P.A., Timmins, and Smale, M.C. 2009. Distribution ad spread of environmental Weeds along New Zealand roadsides. New Zealendes *J. Ecol.* 33(2): 190-204.

van Soest, P. J., Robertson B. and Lewis, B. A. 1991. Method for dietary fiber, neutral detergent fiber and non-starch polysaccharides in relation to animal nutrition. *J. Dairy Sci.* 74:3583-3597.