Technical Specifications for Natural Grassland Improvement of Karst Area in Guizhou

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Abstract. In order to strengthen the protection of ecological environment in Guizhou, speed up the development of ecological animal husbandry, and improve the standardized production level of natural grassland in Guizhou, based on the summary of practical production and scientific research achievements, this paper stipulates the methods and measures of natural grassland improvement in Guizhou karst mountainous areas, as well as their application scope and operation steps. Specific requirements are put forward for forage sowing, field management and utilization of improved grassland in the process of natural grassland improvement. The formulation of this technical regulation has practical significance for scientifically guiding the standardization, standardized development and utilization of natural grassland in Guizhou karst mountainous areas.

1. Introduction
Guizhou Province, located on the eastern slope of Yunnan-Guizhou Plateau, is a transitional zone from western plateau mountain to eastern hilly plain. It has warm climate, abundant rainfall, long frost-free period (210-300 days), average annual temperature above 10°C and annual precipitation of 1000-1300 mm, which provides good natural conditions for the growth of forage grass. According to the first general survey of grassland resources in China, there are 4.28 million hectares of natural grassland in Guizhou, which can provide sufficient forage sources for herbivorous livestock and has great potential for developing grassland animal husbandry (Su 1987; Zhao 2006). At the same time, Guizhou is the core area of karst landform in East Asia, with wide karst landform distribution, large area, fragile ecological environment, less cultivated land per capita, serious soil erosion and poor agricultural production conditions. It is one of the areas with the most concentrated poverty population and the deepest poverty degree in China. The state and province attach great importance to the development of grassland ecological animal husbandry (Liu 2006; Du 2006). In recent years, with the continuous expansion of grassland ecological animal husbandry, the development and utilization of natural grassland has become the inevitable trend and requirement of sustainable development of grassland...
animal husbandry in Guizhou. In order to speed up the development of ecological animal husbandry, improve the standardized production level of natural grassland in Guizhou, and provide technical guidance for the development and utilization of natural grassland, the technical regulations of natural grassland improvement in Guizhou Karst mountainous area are formulated in combination with production experience and scientific research achievements.

2. Range
This standard specifies the terms and definitions, improvement methods and measures, sowing, field management and utilization requirements of natural grassland improvement technology in Guizhou karst mountainous areas.

This standard is applicable to the improvement of natural grassland in Guizhou karst mountain area.

3. Normative Citation Documents
The following documents become the clauses of this specification through the reference of this standard. All subsequent revisions or modification orders of dated reference documents are not applicable to this standard; The latest versions of undated reference documents are applicable to this standard.

- GB 19377-2003 Parameters for degradation, sandification and salification of rangelands
- GB 6141-2008 Quality grading of legume seeds
- GB 6142-2008 Quality grading of the grass seeds
- NY/T 1343-2007 Technical rule for rangeland rotational

4. Terms and Definitions
The following terms and definitions are applicable to this regulation.

4.1. Natural grassland
Wild herbaceous plants with surface coverage ≥5% or the coverage of shrubs communities ≤40% or the coverage of tree canopy ≤10% can be used for livestock production (Wu 1980).

4.2. Grassland improvement
Under the condition of little or no damage to the native vegetation, through agronomic measures, the habitat of natural grass groups was changed, and local wild species, bred species or domesticated species were introduced to change the composition of natural grass groups, increase the dominance of fine grass and improve the primary productivity of grassland (Sun 2000).

4.3. Improvement of pasture by intense night stocking
Ground treatment was carried out by high-density grazing and trampling of herds, and then fine grass was sown to build improved or artificial grassland (Jiang et al. 1996).

5. Improvement Methods and Measures

5.1. Improvement of agricultural measures

5.1.1. Shallow tillage improvement. Applicable object: natural grassland with moderate degradation or above (refer to GB 19377 for classification of degradation degree).

Scope of application: gentle open area with slope ≤ 15, with soil layer thickness above 30 cm, free of high and large weeds and gravel.

Technical measures: the grassland is restored by mechanical operations such as shallow harrowing or rotary tillage (15-20 cm) → land leveling → mechanical drilling or artificial sowing → rolling.
5.1.2. **No-tillage and direct seeding improvement.** Applicable object: natural grassland with moderate degradation and below.

Scope of application: It is suitable for all-terrain areas where natural grassland is improved. In the gentle open area with slope ≤ 15, it is improved by using no-tillage direct seeding machine or artificial sowing. When sowing, the suitable width is 15-20 cm, the sowing depth is 1-2 cm, and the shallow soil is covered and suppressed; The slope is 15-25, and it is sown by machines or manpower; The slope is ≥ 25, and a supplementary sowing belt (0.5-1 m) with high outside and low inside is arranged at a certain distance (1.5-2 m) along the contour line according to the topographic characteristics for sowing or hole sowing.

Technical measures: do not turn over the soil, remove the surface plants by shallow tillage, stubble removal and other physical methods, and then use no-tillage direct seeding machinery or artificial sowing.

5.1.3. **Improvement of chemical herbicide.** Applicable object: natural grassland containing poisonous and harmful weeds.

Scope of application: It is suitable for all-terrain areas where natural grassland is improved.

Technical measures: in the vigorous growth period of weeds (July-August), choose sunny and windless weather, refer to GB/T 8321.9, spray the killing herbicide or select the herbicide to kill all or part of the original vegetation, check the spraying effect in time after 5-7 days, and make up spraying in time if there is little or no application. Manually remove the vegetation and stones on the ground, and select the appropriate sowing method according to the environmental conditions.

5.1.4. **Improvement of pasture by intense night stocking.** Applicable objects: There are a large number of shrubs, tall and large herbaceous plants, or sparse woodland which are difficult for domestic animals to use in the native vegetation.

Scope of application: land parcels that are difficult to be ground treated mechanically or manually.

Technical measures: adopt the combination of fixed and mobile fences, remove the surface vegetation through the high-density eating, trampling and excreting behaviors of livestock during camping, and after reaching the conditions of reseeding, reseeding the livestock 1-2 days before the group transfer.

5.1.5. **Shrub grassland improvement.** Applicable objects: Moderately degraded and above shrub grassland with shrub coverage ≤40%.

Scope of application: All terrain area suitable for natural grassland improvement.

Technical measures: after stubble removal by mechanical shallow tillage or manual weed removal, replant forage or plant woody forage plants with high feeding value.

5.1.6. **Savanna improvement.** Applicable object: in woodland with canopy density less than 10%.

Scope of application: suitable for forest grassland in all terrain areas.

Technical measures: adopt semi-cultivation or mowing to clear weeds, and then replant shade-tolerant grass to build artificial grassland.

5.2. **Improvement of rotational grazing and grazing cessation**

Mild degradation and the following natural grassland, enclosure, grazing and mowing are prohibited. Rotation of grazing should comply with NY/T 1343.

5.3. **Fertilization improvement**

The natural grassland with moderate degradation and below can be applied with nitrogen 75-150 kg/hm² and phosphorus pentoxide 150-300 kg/hm².
6. Sowing

6.1. Sowing time
Sow 2-3 days before rainfall, and choose early spring or autumn for cold-season forage, with autumn as the main one; Warm-season herbage is selected in late spring and early summer.

6.2. Seed selection
The selection of grass seeds must adapt to the local soil and climatic conditions of fine forage grass (see Table 1), take into account the quality characteristics and utilization purposes, and adopt the qualified seeds inspected by the forage seed inspection department. Grass seeds should meet the requirements of GB 6141 and GB 6142.

Table 1. Recommend forages for grassland reseeding in Guizhou

| Regions                  | Forage Species (Latin Name)                                                                 |
|--------------------------|-------------------------------------------------------------------------------------------|
| Low-altitude             | *Lolium multiflorum* Lamk., *Dactylis glomerata* L., *Trifolium repens* Linn., *Medicago sativa* Linn., *Stylosanthes guianensis* (Aubl.) Sw., *Paspalum wettsteinii* Hack., *Paspalum dilatatum* Poir., *Pennisetum americanum* × *P. purpureum*, *Sorghum bicolor* cv. Dochna, *Sorghum sudanense* (Piper), *Bromus catharticus* Vahl., *Cynodon dactylon* (L.) Pers., *Hemarthria sibirica* Ohwi., *Brachiaria eruciformis* (J. E. Smith) Griseb., etc. |
| ≤ 800 m                  |                                                                                           |
| Mid-altitude             | *Lolium multiflorum* Lamk., *Festuca arundinacea* Schreb., *Dactylis glomerata* L., *Trifolium repens* Linn., *Trifolium pratense* Linn., *Medicago sativa* Linn., *Sorghum bicolor* cv. Dochna, *Sorghum sudanense* (Piper), *Bromus catharticus* Vahl., *Hemarthria sibirica* Ohwi., *Paspalum wettsteinii* Hack., *Paspalum dilatatum* Poir., *Pennisetum americanum* × *P. purpureum*, *Cichorium intybus* L., etc. |
| 800 m ~ 1200 m           |                                                                                           |
| Mid-to-high altitude     | *Lolium multiflorum* Lamk., *Lolium perenne* L., *Festuca arundinacea* Schreb., *Dactylis glomerata* L., *Trifolium repens* Linn., *Trifolium pratense* Linn., *Vicia sativa* Linn., *Medicago sativa* Linn., etc. |
| 1200 m ~ 1600 m          |                                                                                           |
| High-altitude            | *Lolium perenne* L., *Festuca arundinacea* Schreb., *Dactylis glomerata* L., *Trifolium repens* Linn., *Trifolium pratense* Linn., *Medicago sativa* Linn., *Vicia sativa* Linn., *Brassica napobrassica* cv., etc. |

6.3. Seed treatment

6.3.1. Hard seed treatment. Remove some seed coats of hard seeds by physical grinding, acid and alkali corrosion and other methods.

6.3.2. Inoculation of beneficial bacteria. Leguminosae seeds should be inoculated with matching rhizobia (see Table 2).

6.3.3. Seed dressing. Before sowing, mix the seeds with calcium magnesium phosphate fertilizer (750 kg/hm²).

6.3.4. Coating. Manual or mechanized coating.
Table 2. Corresponding of common legumes and rhizobia agents

| Rhizobia agents of Legumes (Latin Name) | Rhizobia agents of Legumes (Latin Name) |
|----------------------------------------|----------------------------------------|
| Astragalus Linn.                        | Astragalus laxmannii Pall., Astragalus dahuricus (Pall.) DC., Astragalus membranaceus (Fisch.) Bunge, Astragalus melilotoides Pall., Astragalus sinicus Linn. |
| Medicago sativa Linn.                  | Medicago Linn., Trigonella Linn., Melilotus Mill. |
| Trifolium Linn.                         | Trifolium Linn. |
| Lotus corniculatus Linn.                | Lotus Linn. |
| Onobrychis vicifolia Scop.              | Onobrychis Mill. |
| Coronilla varia Linn.                   | Coronilla Linn. |
| Pisum sativum Linn.                    | Vicia Linn., Pisum Linn., Lathyrus Linn., Lens Mill. |
| Stylosanthes Sw., Lespedeza Michx., Pueraria DC., Arachis Linn., Vigna unguiculata (Linn.) Walp. | Crotalaria Linn., Ornokarpum Beauv., Erythrina Linn., Desmanthus Willd., Indigofera Linn., Vigna Savi. |

6.4. Seeding rate
For unicast, refer to Table 3 for seeding rate. In mixed sowing, the sowing amount of each grass seed is 60%-70% of that in unicast.

Table 3. Seeding rate of common forages in Guizhou

| Family | Forage Species | Seeding rate (kg/hm²) |
|--------|----------------|-----------------------|
| Gramineae | Lolium perenne L. | 15 - 22.5 |
|         | Lolium multiflorum Lamk. | 15 - 22.5 |
|         | Dactylis glomerata L. | 7.5 - 15 |
|         | Festuca arundinacea Schrebp. | 15 - 30 |
|         | Festuca rubra L. | 7.5 - 15 |
|         | Bromus catharticus Vahl. | 22.5 - 30 |
|         | Phalaris arundinacea Linn. | 7.5 - 15 |
|         | Paspalum dilatatum Poir. | 15 - 22.5 |
|         | Pennisetum americanum × P.purpureum | 30000 - 45000 (Seedlings/hm²) |
|         | Hemarthria compressa (Linn. f.) R. | 60000 – 75000 (Seedlings/hm²) |
| Leguminosae | Trifolium repens Linn. | 3.75 - 7.5 |
|           | Trifolium pratense Linn. | 9 - 15 |
|           | Trifolium incarnatum Linn. | 12 - 19.5 |
|           | Trifolium hybridum Linn. | 6 - 7.5 |
|           | Lotus corniculatus Linn. | 6 - 12 |
|           | Pueraria lobata (Willd.) Ohwi | 3.75 - 4.5 |
|           | Medicago sativa Linn. | 15 - 22.5 |
|           | Medicago polymorpha Linn. | 15 - 22.5 |
|           | Astragalus sinicus Linn. | 30 - 60 |
|           | Stylosanthes guianensis (Aubl.) Sw. | 6 - 9 |
|           | Lathyrus quinqueervius (Miq.) Litv. | 60 - 75 |
|           | Coronilla varia Linn. | 4.5 - 7.5 |
|           | Kummerowia striata (Thunb.) Schindl. | 7.5 - 15 |
|           | Lupinus luteus Linn. | 150 - 200 |
6.5. Basic fertilizer
Before sowing, animal manure or compound fertilizer such as decomposed manure and compost is used as basic fertilizer, and the application amount of farm manure is 15000-30000 kg/hm$^2$. The application rate of compound fertilizer is 450-750 kg/hm$^2$.

6.6. Sowing method
Sowing with strips, broadcast or hole.

6.7. Sowing depth
3-5 times of seed size, 1-2 cm for small seeds and 2-3 cm for large seeds.

6.8. Post-broadcast repression
After replanting grassland, rolling it in time by branches, brooms, etc. to make good contact between seeds and soil.

7. Field Management and Harvest Utilization

7.1. Field management

7.1.1. Seedling management. Seedling growth is slow, so weed control should be strengthened and seedling fertilizer should be applied in time.

7.1.2. Water and fertilizer management. When the grass grows in drought, flood irrigation or sprinkler irrigation is used to irrigate the grass with saturating top-soil 20 cm. In grassland dominated by Gramineae, 150-225 kg/hm$^2$ compound fertilizer should be applied in spring and 120-200 kg/hm$^2$ compound fertilizer should be applied in autumn. In the grassland dominated by Leguminosae, phosphorus pentoxide 150-225 kg/hm$^2$ and potassium oxide 90-150 kg/hm$^2$ were applied in spring and autumn. Fertilization should be coordinated with irrigation and intertillage.

7.2. Utilization

7.2.1. Grazing. According to the principle of balance between grass and livestock, the grassland is divided into different communities with fences, and a reasonable rotational grazing plan is made for grazing.

7.2.2. Cut. Mechanical or manual mowing is adopted, stubble height is 5-8 cm, and after mowing, it is used for fresh feeding of livestock, making hay, silage, etc.

8. Summary
On the basis of summarizing the practical production and scientific research achievements, this paper puts forward the improvement methods and measures of natural grassland in Guizhou karst mountainous area, and stipulates the applicable scope of different improvement measures. Terms involved in natural grassland improvement technology were explained, and specific requirements were put forward for forage sowing, field management and utilization involved in the improvement process, which provided scientific guidance for standardization of development and utilization of natural grassland in Guizhou karst mountainous area, and was of great significance for ecological environment protection and ecological animal husbandry development in Guizhou.

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