

REPUBLIC OF SOUTH AFRICA



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CERTIFICATE

In accordance with section 44 (1) of the Patents Act, No. 57 of 1978, it is hereby certified that:

XINJIANG INSTITUTE OF ECOLOGY AND GEOGRAPHY CHINESE ACADEMY OF SCIENCES

Has been granted a patent in respect of an invention described and claimed in complete specification deposited at the Patent Office under the number

2022/01218

A copy of the complete specification is annexed, together with the relevant Form P2.

In testimony thereof, the seal of the Patent Office has been affixed at Pretoria with effect from the **30th** day of **March 2022**

A handwritten signature in black ink, appearing to be 'D. H.', written over a dotted line.

Registrar of Patents



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FORM P2

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54 | ECOLOGICAL RESTORATION AND SUSTAINABLE MANAGEMENT METHOD FOR SHRUB-ENCROACHED GRASSLAND

ECOLOGICAL RESTORATION AND SUSTAINABLE MANAGEMENT METHOD FOR SHRUB-ENCROACHED GRASSLAND

TECHNICAL FIELD

[01] The present disclosure belongs to the technical field of a restoration of a grassland ecosystem, and particularly relates to an ecological restoration and sustainable management method of a shrub-encroached grassland.

BACKGROUND ART

[02] A shrub encroachment refers to increases in a plant density, a coverage, and a biomass of shrubs/woody plants in a grassland ecosystem in arid and semiarid areas, which directly poses a threat to a development of a grassland and a livestock husbandry production, and seriously affects a structure and a function of a grassland ecosystem and a biodiversity of a pasture, resulting in influences on local sustainable livelihoods and live styles. Approx. a population of 2.4 billion worldwide live in arid and semi-arid areas, which cover 41% of a global land area, and nearly 10% to 20% of the arid and semi-arid areas are experiencing the shrub encroachment (Reynolds et al., 2007). This phenomenon has spread to Inner Mongolia, South Africa, North American desert zones, Australia, and Mediterranean basins, and thus, it has become an important ecological problem with which the global arid and semi-arid areas should be confronted.

[03] Up to now, a Chinese patent (CN 1784943 A、CN 106305029 A) discloses a governance method for a grassland desertification and a natural grassland degeneration, in this method, an enclosure, a grazing prohibition, or a rotational grazing in any area to be governed is not involved with a shrub-encroached grassland; and a Chinese patent (CN 1415803 A) discloses a standard mode of a desertification governance by industrialized soil formation, which proposes an intensive raising-based desertification governance mode. Feasible ecological restoration and sustainable management measures haven't been found yet on the shrub-encroached grassland in the prior art.

SUMMARY

[04] The present disclosure aims to provide an ecological restoration and sustainable management method for a shrub-encroached grassland, by which a grassland ecosystem can achieve shrub removal and recycling, and a balance between forage and animals, and meanwhile, a sustainable development of local livelihoods can also be achieved.

[05] The present disclosure provides the ecological restoration and sustainable management method for the shrub-encroached grassland, which includes the following steps:

[06] 1) removing shrubs on a grassland;

[07] 2) conducting a partitioned enclosure on the grassland in which the shrubs are removed;

[08] 3) developing a rotational grazing plan according to a variety and a quantity of livestock in a local community, and conducting a rotational grazing on the grassland which is subjected to the partitioned enclosure;

[09] 4) in a rainy season, planting forage grass on a flat grassland, and harvesting the forage grass for supplementing the livestock forage in a dry season or a cold season.

[10] Preferably, the method for removing the shrubs in the step 1) includes steps of cutting down the shrubs at a position which is flush with a ground, and incinerating roots until the roots are died or are unable to tiller.

[11] Preferably, purposes of the removed shrubs in the step 1) depend on a trunk diameter, that is, the shrubs with the diameters being larger than or equal to 4 cm are used for charking; and the shrubs with the diameters being smaller than 4 cm are used for a fencing of a grassland partition or a wood burning of a family.

[12] Preferably, the removed shrubs in the step 1) are shrubs or woody plants that aren't eaten by the livestock, but are fast-growing and highly tillering, resulting in a reduction in a grassland productivity.

[13] Preferably, an area of a single area where an enclosure is implemented in the step 2) ranges from 10 to 20 ha.

[14] Preferably, time of the enclosure in the step 2) ranges from 4 to 5 months.

[15] Preferably, a rotational grazing is conducted for 4 to 5 d on each area where the enclosure is implemented in the step 3).

[16] Preferably, the method for planting the forage grass in the step 4) includes steps of ploughing or harrowing a surface layer of the flat grassland, uniformly mixing multiple forage grass seeds that are preferred by the livestock, sowing to the surface layer of the grassland, harrowing, and implementing the enclosure for harvesting, without other managements.

[17] The present disclosure provides the ecological restoration and sustainable management method for the shrub-encroached grassland. 1) Shrub removal and recycling: the invaded shrubs, which are thorny and poor in palatability for the livestock, can't be used as edible feeds. Based on a characteristic of high tillering for the shrubs in the grassland, removing the shrubs can provide an enabling environment for a growth of the forage grass.

[18] 2) Enclosure and rotational grazing: based on a community, the grassland is fenced for the enclosure by the shrubs that are cut down, and an appropriate rest grazing and rotational grazing plan is developed according to a variety and a quantity of the livestock in the local community, which should be implemented strictly. The grassland is partitioned according to different seasons, so that the grassland has a chance to rehabilitate, thereby enhancing the grassland productivity.

[19] 3) A combination of grazing and raising: it is necessary to encourage the community to expand a planting area of forage grass for harvesting materials or planting and harvesting ensilage on the flat land in the rainy season in order to cope with an insufficiency in the feeds in the dry season or the winter season and coordinate with a rest grazing and rotational grazing system. In addition, a large amount of the forage grass is planted and harvested in a fence enclosure area, and is distributed intensively after being aired as a basic guarantee of the livestock husbandry feeds in the dry season or the winter season.

[20] 4) Sustainable development: an economic benefit arising from the recycling of the

shrubs as fences for the partitioning management of the grassland, that is, the harvested forage, can overcome a predicament of the insufficient forage in the dry season or the winter season, which not only can expand the area of the edible grassland for the livestock, but can also improve the grassland productivity to make the shrub-encroached grassland rehabilitate. In addition, the community can make up an economic loss arising from reduction in the livestock and increase incomes of local residents by the charking and the planting of the forage grass, thereby achieving the sustainable livelihoods in the severe shrub-encroached area.

[21] In the present disclosure, the method has the following characteristics: (1) as one of innovation points, the shrubs of the grassland are recycled after being cut down, which eliminates the influence of shrub encroachment on the grassland, but can also recycle the shrubs to increase the incomes; (2) the shrub-encroached grassland is subjected to a partitioned enclosure and rotational grazing system, which is conducive to make the grassland rehabilitate, and improve the grassland productivity, thereby making the livestock husbandry of the local community achieve the sustainable development and the balance between the forage and the animals; and (3) with a technical means of the combination of grazing and raising, a shortage of the forage in the dry season or the winter season can be made up, and meanwhile, the forage can be sold to increase the incomes of the residents, thereby ensuring the sustainable livelihoods of the local residents.

[22] Based on a severe shrub-encroached area where the shrubs grow rapidly and encroach on the grassland severely, resulting in influence on local livestock husbandry development due to incapability for the livestock to enter the grassland and reduction in the edible grassland, an ecological restoration and sustainable management mode of the shrub-encroached grassland, which integrates "shrub removal for breeding the grassland, enclosure and rotational grazing, combination of grazing and raising, and sustainable development", is proposed, in which there are 3 technologies that can solve problems of reduction in a grass yield of the grassland, over-grazing, reduction in the livestock, and difficulty in maintaining the livelihoods arising from the shrub invasion in the shrubby-laden area fundamentally to achieve a management mode of shrub removal and recycling, the ecological restoration of the grassland, and the sustainable livelihoods. A practice has proved that with a monitoring of the enclosure of a project demonstration area only for 4 months, a vegetation coverage, a grass height, and a hay yield of the fence enclosure area of the pasture are up to 97.67%, 75.38 cm, and 2,953 kg respectively, the vegetation coverage, the grass height, and the hay yield of a non-enclosure area are 60% 46.64 cm respectively, and 879.1 kg, and the vegetation coverage, the grass height, and the hay yield of the fence enclosure area of the pasture are 62.78%, 61.66%, and 235.57% higher than those of the non-enclosure area respectively.

BRIEF DESCRIPTION OF THE DRAWINGS

[23] Fig. 1 is a demonstration area of an enclosure in the present disclosure;

[24] Fig. 2 is a charcoal to be sold after being fired.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[25] The present disclosure provides the ecological restoration and sustainable management method for the shrub-encroached grassland, which includes the following steps:

[26] 1) removing shrubs on a grassland;

[27] 2) conducting a partitioned enclosure on the grassland in which the shrubs are removed;

[28] 3) developing a rotational grazing plan according to a variety and a quantity of livestock in a local community, and conducting a rotational grazing on the grassland which is subjected to the partitioned enclosure;

[29] 4) In a rainy season, planting forage grass on the flat grassland, harvesting for supplementing livestock forage.

[30] In the present disclosure, the shrubs are removed on the grassland. Preferably, the method for removing the shrubs includes steps that the shrubs are cut down at a position which is flush with a ground, and roots are incinerated until the roots are died. Preferably, the removed shrubs are fast-growing plants that aren't eaten by the livestock. Preferably, purposes of the removed shrubs depend on a trunk diameter, that is, the shrubs with the diameters being larger than or equal to 4 cm are used for the charking (see Fig. 2). In a charking method, the shrubs are filled in a pit that is excavated and are buried and covered hermetically with soil quickly for 2 to 3 days after being ignited, and charcoals are obtained. The shrubs with the diameters being smaller than 4 cm are used for a fencing of a partition or a wood burning of a family. By cutting down and recycling the shrubs, the shrub invasion of the grassland is eliminated, and meanwhile, the shrubs are utilized effectively. As the charcoal is a local main fuel for cooking and making coffee, the shrubs are used as a raw material for charking, that is, each 8 kg of shrubs can be used for burning 1 kg of charcoals, which improves a per capita income of the community.

[31] Upon the removal of the shrubs, the grassland in which the shrubs are removed is subjected to the partitioned enclosure. An area of the partitioned enclosure should not be too large, and the area of a single enclosure area ranges from 10 to 20 ha preferably (see Fig. 1). Preferably, time of the enclosure ranges from 4 to 5 months. After the enclosure is implemented, the grassland is partitioned according to different seasons, so that the forage grass has a chance to rehabilitate, thereby enhancing the grassland productivity. Preferably, the shrubs with the diameters being smaller than 4 cm or shrub branches are used as the fencing of the partition.

[32] Upon the partitioned enclosure, a rotational grazing plan is developed according to the variety and the quantity of the livestock in the local community, and rotational grazing is conducted on the grassland which is subjected to the partitioned enclosure. Preferably, the rotational grazing plan refers to days of the rotational grazing in each enclosure area according to the variety and the quantity of the livestock in each community, for example, 600 to 800 livestock is subjected to the rotational grazing for 4 to 5 d on the partitioned grassland with the area of 10 to 20 ha. The variety of the livestock includes cattle and sheep.

[33] In the rainy season, the forage grass is planted on the flat grassland, and is harvested for supplementing the livestock forage. Preferably, in the method for planting the forage grass, a surface layer of the flat grassland is ploughed, forage grass seeds are uniformly sowed to the surface layer of the grassland, and the land is harrowed for 2 times, during which the management is not required. In the present disclosure, it is necessary to encourage the community to expand a planting area of the forage grass for harvesting materials or planting and harvesting ensilage on the flat ground in the rainy season in order to cope with an insufficiency in feeds in the dry season or the winter season and coordinate with a rest grazing and rotational grazing system. In addition, a large amount of the forage grass is planted and harvested in a fence enclosure area, and is distributed intensively after being aired as a basic guarantee of the livestock husbandry feeds in the dry season or the winter season.

[34] The following describes the ecological restoration and sustainable management method for the shrub-encroached grassland provided by the present disclosure with reference to the embodiments detailedly, which should not be construed as a limit to the scope of protection of the present disclosure.

Embodiment 1

[35] In Ethiopia, a livestock husbandry ranks the second in the world. Its low-altitude area (below 1,500 meters above sea level) accounts for 61% of a land area throughout the country, and 12% populations (or 5 million populations) and 26% livestock (or 21 million) live in such area, with a main living source deriving from a development of the livestock husbandry. Especially, in a Borana Region (south of Ethiopia) of Ethiopia, 82.8% grassland has been invaded by shrubs, in which 24.1% grassland has been invaded by the shrubs totally. As it affects a structure and a function of a grassland ecosystem in the low-altitude area severely, reduces a grassland productivity and a grazing area of the grassland, and reduces a grazing capacity significantly, the development of the local livestock husbandry is affected seriously, making a local community get into troubles.

[36] In the present disclosure, an ecological restoration and a sustainable management of the grassland are implemented in the Borana Region of Ethiopia:

[37] 1) Shrub removal: nearly 200 persons in the local community are organized to cut down the shrubs or remove the shrubs by a brush cutter, with a removal area up to 200 ha; and varieties of the shrubs to be removed are *Acacia drepanolobium* Harms ex Sjoestedt, *Acacia etbaica* Schweinf., *Acacia mellifera* (Vahl.) Benth, and the like of *Albizia Durazz*. After the shrubs are cut down, some persons put a charcoal at a cut of each shrub for burning out; and other persons screen shrub branches, in which those that are thick are used as raw materials of the charcoals, while those that are thin are used as enclosure fences after being collected;

[38] 2) Shrub utilization: the collected thick shrub branches are filled in a pit that is excavated and are buried and covered hermetically with soil quickly for 2 to 3 days after being ignited, and the shrubs can be taken out for selling as charcoals;

[39] 3) Partitioned enclosure: the grassland in which the shrubs are removed is divided into 10 zones averagely, with each zone occupying 20 ha. The cut-down shrub branches are collected for the enclosure, making the grassland not affected by grazing, thereby restoring the productivity naturally;

[40] 4) Rotational grazing: upon the enclosure for 4 months, a system for the 4-day rotational grazing in each zone is developed strictly according to a grassland quality of each enclosure zone and a quantity of varieties (mainly cattle and sheep) of livestock in the Borana Region;

[41] 5) A combination of grazing and raising: a local farm cattle pulls a plow harrow to plow a surface layer of the grassland lightly in the local flat grassland in a rainy season, forage grass seeds are sowed to the surface layer of the grassland uniformly, and meanwhile, the grassland is harrowed with a wooden rake, during which any management isn't required. The harvested forage grass is aired or used as ensilage.

Comparative Example 1

[42] A shrub-encroached grassland with an area of 200 ha is selected as a control grassland

for a non-enclosure management, that is, the conventional grazing, in the Borana Region.

[43] With a monitoring of the enclosure of a project demonstration area only for 4 months, a vegetation coverage, a grass height, and a hay yield of a fence enclosure area of a pasture in the embodiment 1 are up to 97.67%, 75.38 cm, and 2,953 kg respectively, the vegetation coverage, the grass height, and the hay yield of a non-enclosure area in the comparative example 1 are 60% 46.64 cm, and 879.1 kg respectively, and the vegetation coverage, the grass height, and the hay yield of the fence enclosure area of the pasture are 62.78%, 61.66%, and 235.57% higher than those of the non-enclosure area respectively. It can be seen that the restoration and management of the shrub-encroached grassland in the method provided by the present disclosure is conducive to maintaining a healthy ecological balance, thereby solving troubles of local herdsman, and fulfilling a sustainable development objective.

[44] The above descriptions are only preferred embodiments of the present disclosure, and it should be noted that a person of ordinary skill in the art can further make several improvements and modifications without departing from the principle of the disclosure, and those improvements and modifications should be included in the protection scope of the present disclosure,

WHAT IS CLAIMED IS:

1. An ecological restoration and sustainable management method for a shrub-encroached grassland, characterized in that it comprises the following steps:

1) removing shrubs on a grassland;

2) conducting a partitioned enclosure on the grassland in which the shrubs are removed;

3) developing a rotational grazing plan according to a variety and a quantity of livestock in a local community, and conducting a rotational grazing on the grassland which is subjected to the partitioned enclosure;

4) In a rainy season, planting forage grass on the flat grassland, harvesting for supplementing livestock forage.

2. The method according to claim 1, characterized in that, the method for removing the shrubs in the step 1) comprises steps of cutting down the shrubs at a position which is flush with a ground, and incinerating roots until the roots are died or are unable to tiller.

3. The method according to claim 1, characterized in that, purposes of the removed shrubs in the step 1) depend on a trunk diameter, that is, the shrubs with the diameters being larger than or equal to 4 cm are used for charking; and the shrubs with the diameters being smaller than 4 cm are used for a fencing of a partition or a wood burning of a family.

4. The method according to claim 1 or 2, characterized in that, the removed shrubs in the step 1) are plants that aren't eaten by the livestock, but are fast-growing and highly tillering.

5. The method according to claim 1, characterized in that, an area of a single enclosure area in the step 2) ranges from 10 to 20 ha.

6. The method according to claim 1, characterized in that, time for the enclosure in the step 2) ranges from 4 to 5 months.

7. The method according to claim 1, characterized in that, a rotational grazing is conducted for 4 to 5 d on each area where the enclosure is implemented in the step 3).

8. The method according to claim 1, characterized in that, the method for planting the forage grass in the step 4) comprises steps of ploughing or harrowing a surface layer of the flat grassland after a first rainfall in a local rainy season, uniformly mixing multiple local forage grass seeds that are preferred by the livestock, sowing to the surface layer of the ploughed grassland, harrowing, and implementing the enclosure for harvesting, without other managements.



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Drawings



FIG.1



FIG.2

ABSTRACT OF THE DISCLOSURE

The present disclosure provides an ecological restoration and sustainable management method for a shrub-encroached grassland, and belongs to the technical field of a restoration of a grassland ecosystem. Based on a severe shrub-encroached area where shrubs grow rapidly and encroach on the grassland severely, resulting in influence on local livestock husbandry development due to incapability for livestock to enter the grassland and reduction in the edible grassland, an ecological restoration and sustainable management method for the shrub-encroached grassland, which integrates "shrub removal for breeding the grassland, enclosure and rotational grazing, combination of grazing and raising, and sustainable development", is proposed. Problems of reduction in grassland productivity, overgrazing, less livestock, and difficulty in maintaining livelihoods, arising from shrub invasion to the shrub-encroached grassland, are solved, and objectives of shrub removal and recycling, ecological restoration of grassland, and sustainable management of livelihoods are fulfilled.

ABSTRACT DRAWING

