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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, CAS

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

2022/03534

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 29th day of June 2022



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FORM P2

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TITLE OF INVENTION

54 | Construction method of protective grassland in mountainous area of arid region

Construction method of protective grassland in mountainous area of arid region

TECHNICAL FIELD

The application relates to a technical method for constructing artificial grassland in mountainous areas of arid region, and specifically to technical methods for the construction of artificial grassland in mountainous areas of desert grassland zones on the northern slopes of the Kunlun Mountains in southern Xinjiang, China.

BACKGROUND

Xinjiang is a major province in animal husbandry of China. The desert grassland area in southern Xinjiang, which accounts for 17.45% of the available grassland area in the whole province, is an important local winter pasture and is mainly distributed in the desert grassland zone in the mountainous areas on the northern slopes of the Kunlun Mountains. At present, the surge in population in the oasis and the high price of livestock products have stimulated the livestock industry to make predatory utilization on the biological resources of the desert grasslands, leading to a constant degradation and desertification of grassland ecosystem, which directly affects the local animal husbandry production and the stability of oasis ecosystem, and further aggravates the contradiction between man and land in southern Xinjiang.

As implementing the national Nomads Settlement Project, artificial efficient forage land serves as the most important link in the herdsmen's settlement, and desert grassland in mountainous areas has become the most important area for artificial grassland construction because of its light and heat conditions and geographical location. Efficient artificial pasture can not only provide improved carrying capacity

of grassland, increased output of livestock products and increased the income of herdsmen, but also helps greatly to improve the ecological environment quality of oasis in southern Xinjiang, improve the production and living conditions of poor villages in pastoral areas of southern Xinjiang, as well as improve the backward production methods and accelerate the process of herdsmen's relocation and settlement and new rural construction in pastoral areas.

Due to the special geographical environment in mountainous areas, the wind and sand hazard are important factors affecting the survival and growth of pasture in the desert grassland, where the strong wind is the key factor affecting the survival and yield increase of grass seeds in artificial grassland. Grassland constructed by traditional method faces problem of high seedling mortality and low yield of artificial grassland as in short of protection belts and grassland middle protective barriers. In addition to the high mortality of grass seeds, the influence of strong wind on the growth of grass also makes it difficult to increase the yield of grass in artificial grassland. A lot of manpower, material resources and financial resources have been wasted due to the low efficiency of artificial grassland construction, resulting in a less expected construction performance. Besides, low yield also makes it difficult for the artificial grassland to produce due demonstration effect and economic benefit.

The application draws lessons from the protection effect of oasis protection system so as to provide protection for the survival and growth of excellent pasture through research and develop technology of grassland construction protection in mountainous areas, and improves the survival rate of pasture seedlings and grass yield of grassland,

which therefore realizes the artificial high-efficiency pasture construction in mountainous areas as constructing artificial grassland in arid areas.

SUMMARY

The objective of the present application is to provide a method for constructing protective grassland in mountainous areas of arid region. The method specifically involves the construction of protective belts and protective barriers inside and outside artificial grassland in mountainous areas, the screening of plant species suitable for protective belts in mountainous areas on the basis of orthogonal tests, the determination of the size of protective belts and protective barriers and the layout of species, the use of the barrier effect formed by the construction of protective grassland in mountainous areas, the minimisation of wind and sand damage to the germination and growth of pasture, the improvement of the survival rate of pasture and grass production, and the promotion of the success of the construction of artificial grassland in mountainous areas in arid desert environments.

The application relates to a method for building protective grassland in mountainous areas of arid region, which comprises the following steps:

a. protective belts planting around the grassland: selecting varieties of *Elaeagnus angustifolia*, *Calligonum caput-medusae* Schrenk and *Tamarix ramosissima*, planting them as protective belts around the grassland, wherein the outermost layer of the grassland is *Elaeagnus angustifolia*, the middle layer is *Calligonum caput-medusae* Schrenk, and the inner layer of the grassland is *Tamarix ramosissima*, each band has a bandwidth of 5 m (meter);

- b. protective barrier planting in the middle of grassland: selecting *Caragana polourensis* Franch. and *Calligonum caput-medusae* Schrenk as planting varieties, with each protective barrier of bandwidth of 1.5 m, row spacing of 0.7 m and plant spacing of 1 m;
- c. planting leguminous forage in the open pasture planting area in the middle of the pasture;
- d. arranging drip irrigation belts at the outer protective belt of the grassland with a distance of 1.0 m, arranging drip irrigation belts at the middle protective barrier of the grassland with a distance of 0.7 m, and arranging sprinkler heads at the pasture planting area in the open grassland with a distance of 4.0 m.

Further, the outermost planting layer of the grassland in the protective belt is 2 rows of *Elaeagnus angustifolia* with a row spacing of 1.5 m and a plant spacing of 1.6 m, the middle planting layer is 2 rows of *Calligonum caput-medusae* Schrenk with a row spacing of 1.0 m and a plant spacing of 1.0 m, and the inner planting layer is *Tamarix ramosissima* with a row spacing of 0.7 m and a plant spacing of 1.0 m.

Further, the outermost layer of *Elaeagnus angustifolia* planted in the grassland of the protective belt is planted in staggered rows, specifically, the first row of *Elaeagnus angustifolia* is planted from scratch, the second row of *Elaeagnus angustifolia* is planted 0.8 m back; the middle layer of *Calligonum caput-medusae* Schrenk is planted in staggered rows, that is, the first row of *Calligonum caput-medusae* Schrenk is planted from scratch, the second row of *Calligonum caput-medusae* Schrenk is

planted 0.5 m back, and the inner layer of *Tamarix ramosissima* is planted as conventional.

Further, in step b, *Caragana polourensis* Franch. and *Calligonum caput-medusae* Schrenk planted in protective barrier are planted singly or alternately.

Further, the belt spacing of protective barrier in step b is 16 m.

Further, the direction of the middle protective barrier of grassland is perpendicular to the direction of the prevailing local wind.

Further, in step c, the leguminous grass planted in the open pasture planting area in the middle of the pasture is sainfoin (*Onobrychis*) or alfalfa (*Medicago*) or sweet clover (*Melilotus suaveolens* Ledeb.).

Furthermore, the alfalfa planted is *Medicago sativa* cv.Hetiandaye, vernal alfalfa, Xinmu No.2 or *Medicago sativa* L.cv.Xinjiang Daye.

Compared with the prior art, the construction method of protective grassland in mountainous areas of arid region of the application is characterized in that:

according to the characteristics of mountain environment in arid areas, the drought-tolerant and wind-sand-tolerant plants are selected to establish artificial grassland protective barriers in mountainous areas, and the technical methods of constructing protective grassland in mountainous areas of arid region are formed thereafter.

The protective barrier outside the protective grassland and the protective belt inside the grassland greatly reduce the damage from the wind in mountainous areas to the growth of pasture, and create protective conditions for the survival and growth of

pasture seedlings in artificial grassland. The biological yield of pasture in artificial grassland is hence greatly improved, thereby demonstrating the advantages of artificial pasture construction.

Compared with existing techniques for artificially constructing pastures in mountainous areas, the present invention has a moderately dense planting of trees and shrubs in pasture protective belts and protective barriers. Under the same conditions in mountainous areas, the impact of wind and sand hazards, especially high winds, on the survival and growth of forage seedlings is significantly reduced. By applying this method, the seedling preservation rate and biomass yield of forage is increased greatly, supplementary sowing is reduced so as the sowing cost, in addition to the saving of manpower. As a result, the biological yield is greatly increased as well as the livestock carrying capacity of the artificial grassland, and better economic benefits and demonstration effect are achieved accordingly.

According to the application, the plant species suitable for the mountain environment are selected firstly, protective belts and protective barriers are established in the periphery and the middle of the grassland as constructing the artificial grassland, followed by the planting of pasture, and the artificial grassland is constructed under the protective conditions, thus improving the effectiveness and success rate of the grassland construction.

Different irrigation methods are adopted in the grassland protective belt, protective barrier and pasture planting area, which fully improve the efficiency of water

utilization while targeting the respective spatial structure and biological characteristics of the protective belts and grasslands.

DESCRIPTION OF THE INVENTION

Embodiment 1:

A 200 mu (1 mu = 666.7 m³) experimental demonstration plot of artificial forage land at an altitude of 2,400 m in a herding settlement, Wulukesayi (or Uluksay) Township, Cele County, Hotan District, Xinjiang Province, built in 1 hectare units. The main species planted in the protective areas are *Elaeagnus angustifolia*, *Calligonum caput-medusae* Schrenk and *Tamarix ramosissima*, and the forage is alfalfa (*Medicago sativa* cv. Hetiandaye, vernal alfalfa) and sainfoin.

Land leveling

The planting site is open bare land with gentle slope, flat terrain and small gradient fluctuation in front of mountain area, and the whole land is leveled. Hole-shaped soil preparation method is adopted in the outer protective belt and inside of grassland to create an environment for planting seedlings and artificial settlement, where tree planting holes (tree pits) are 60 cm (centimeter) long, 60 cm wide and 60 cm deep, a plant spacing of 1.6 m and a row spacing of 1.5 m, and shrub planting holes are 40 cm long, 40 cm wide and 40 cm deep.

Irrigation device laying

7 drip irrigation belts are laid in the outer protective belt of grassland, drip pipes are arranged close to tree pits with a row spacing of 1.0 m; 3 drip irrigation belts are laid

in the protective barrier of grassland with a row spacing of 0.7 m; and 2 sprinklers are laid in the open space of grassland with a sprinkling distance of 4 m;

Seedling selection

The main varieties planted in the protective belt and protective barrier are *Elaeagnus angustifolia*, *Calligonum caput-medusae* Schrenk and *Tamarix ramosissima*. The quality of seedlings is an important factor that affects the construction of the protective barrier, so it is important to choose healthy seedlings. Generally, 2-year-old seedlings are used to ensure a certain root length, ground diam and ground height (about 50 cm); the root system should not be damaged or split, unqualified seedlings, seedlings with pests and diseases, and disabled seedlings cannot be used for planting protective barrier.

Planting of protective seedlings

The unsprouted seedlings are placed in the centre of the pit, the roots are straightened out and then the pit is filled with soil; when the soil is filled to half the depth of the pit, the seedlings are lifted upwards to the required depth, then the pit is filled again until the soil is 15 cm from the ground (the mouth of the pit) and finally the pit is covered with sand until it is full, the pit is smoothed and patted down.

Planting

Protective belts are planted around the grassland: at the beginning of March, planting varieties of *Elaeagnus angustifolia*, *Calligonum arborescens* Litv. and *Tamarix ramosissima* are selected and planted as protective belts around the grassland, in which two rows of *Elaeagnus angustifolia* are planted in the outermost layer of the grassland,

with a row spacing of 1.5 m and a plant spacing of 1.6 m, where the plants are planted in staggered rows, that is, the first row of *Elaeagnus angustifolia* is planted from the beginning, the second row of *Elaeagnus angustifolia* is planted 0.8 m back; the middle layer is planted in stagger rows with 2 rows of *Calligonum caput-medusae* Schrenk, that is, the first row of *Calligonum caput-medusae* Schrenk is planted from the beginning, the second row of *Calligonum caput-medusae* Schrenk is planted 0.5 m back; and the inner layer of the grassland is planted with two rows of *Tamarix ramosissima*, with row spacing of 0.7 m, plant spacing of 1.0 m, each protection belt has bandwidth of 5 m.

Protective barriers are planted in the middle of grassland, with *Caragana polourensis* Franch. and *Calligonum caput-medusae* Schrenk as planting varieties; the protective barrier has bandwidth of 1.5 m, row spacing of 0.7 m and plant spacing of 1 m; *Caragana polourensis* Franch. and *Calligonum caput-medusae* Schrenk are planted in separate monocultures, i.e. one belt is entirely planted with *Caragana polourensis* Franch. and the other with *Calligonum caput-medusae* Schrenk, and the spacing between the belts is 16 m;

Leguminous forage sainfoin or alfalfa (*Medicago sativa* cv.Hetiandaye, vernal alfalfa) are planted by method of planting in rows in the open pasture in the middle of the pasture in the middle of April of that same year with row spacing of 15 cm and sowing depth of 2 cm.

Embodiment 2

A 60 mu forage demonstration base at an altitude of 2,200 m in desert grassland in front of the mountain of Yeyike (or Yeyiq) Township, Minfeng County, Hotan District, Xinjiang province, built in a unit of 1 hectare. The main varieties for the protective belts are *Elaeagnus angustifolia*, *Calligonum caput-medusae* Schrenk, *Tamarix ramosissima*, *Caragana polourensis* Franch., and alfalfa (vernal alfalfa, Xinmu No.2, *Medicago sativa* L.cv.Xinjiang Daye) and sweet clover.

Land leveling

The planting site is a flat, open, bare land with low slope gradients in the mountainous foreland, and the whole area is levelled. Hole-shaped soil preparation method is adopted in the outer protective belt and inside of the grassland to create an environment for planting seedlings and artificial settlement. The arbor planting hole (tree pit) is 60 cm long, 60 cm wide and 60 cm deep, with a plant spacing of 1.6 m and a row spacing of 1.5 m, and the shrub planting hole is 40 cm long, 40 cm wide and 40 cm deep.

Irrigation device laying

7 drip irrigation belts are laid in the outer protective belt of grassland, drip pipes are arranged close to tree pits with a row spacing of 1.0 m, 3 drip irrigation belts are laid in the protective barrier of grassland with a row spacing of 0.7 m, and 2 sprinklers are laid in the open space of grassland with a distance of 4 m.

Seedling selection

The main varieties planted in protective barriers are *Elaeagnus angustifolia*, *Calligonum caput-medusae* Schrenk and *Tamarix ramosissima*. Seedling quality is an

important factor affecting the construction of protective barrier, which means it is important to select healthy seedlings. Generally, 2-year-old seedlings are selected to ensure a certain root length, ground diam and ground height (about 50 cm), and the root system is not be damaged or split. Unqualified seedlings, seedlings with pests and diseases, and disabled seedlings cannot be used for protective barrier.

Planting of protective seedlings

The unsprouted seedlings are placed in the centre of the pit, the roots are straightened out and then the pit is filled with soil; when the soil is filled to half the depth of the pit, the seedlings are lifted upwards to the required depth, then the pit is filled again until the soil is 15 cm from the ground (the mouth of the pit) and finally the pit is covered with sand until it is full, the pit is smoothed and patted down.

Planting

Protective belts are planted around the grassland: at the beginning of March, planting varieties of *Elaeagnus angustifolia*, *Calligonum arborescens* Litv and *Tamarix ramosissima* are selected and planted as protective belts around the grassland, in which two rows of *Elaeagnus angustifolia* are planted at the outermost layer of the grassland, with a row spacing of 1.5 m and a plant spacing of 1.6 m, with staggered rows between rows, that is, the first row of *Elaeagnus angustifolia* is planted from the beginning, the second row of *Elaeagnus angustifolia* is planted 0.8 m back; the middle layer is planted with *Calligonum caput-medusae* Schrenk in staggered planting between rows, that is, the first row of *Calligonum caput-medusae* Schrenk is planted from the beginning, the second row of *Calligonum caput-medusae* Schrenk is planted

0.5 m back; and the inner layer of the grassland is planted with two rows of *Tamarix ramosissima*, with row spacing of 0.7 m, plant spacing of 1.0 m, each belt has bandwidth of 5 m.

Protective barriers are planted in the middle of grassland with *Caragana polourensis* Franch. and *Calligonum caput-medusae* Schrenk as planting varieties and bandwidth of 1.5 m, row spacing of 0.7 m, and plant spacing of 1 m; these two kinds of plants are planted alternatively, that is, one belt is entirely planted with *Caragana polourensis* Franch. and the other with *Calligonum caput-medusae* Schrenk, and the spacing between the belts is 16 m;

Leguminous forage alfalfa (vernal alfalfa, Xinmu No.2, *Medicago sativa* L.cv.Xinjiang Daye) and sweet clover are planted in the middle of grassland in mid-April. All seeds are sown in a mixture and are lightly harrowed after sowing and suppressed once at the end of sowing.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS

1. A method for constructing protective grassland in mountainous areas of arid region, characterized by comprising the following steps:

a. protective belts planting around the grassland: selecting varieties of *Elaeagnus angustifolia*, *Calligonum caput-medusae* Schrenk and *Tamarix ramosissima*, planting them as protective belts around the grassland, wherein the outermost layer of the grassland is *Elaeagnus angustifolia*, the middle layer is *Calligonum caput-medusae* Schrenk, and the inner layer of the grassland is *Tamarix ramosissima*, each band has a bandwidth of 5 m (meter);

b. protective barrier planting in the middle of grassland: selecting *Caragana polourensis* Franch. and *Calligonum caput-medusae* Schrenk as planting varieties, with each protective barrier of bandwidth of 1.5 m, row spacing of 0.7 m and plant spacing of 1 m;

c. planting leguminous forage in the open pasture planting area in the middle of the pasture;

d. arranging drip irrigation belts at the outer protective belt of the grassland with a distance of 1.0 m, arranging drip irrigation belts at the middle protective barrier of the grassland with a distance of 0.7 m, and arranging sprinkler heads at the pasture planting area in the open grassland with a distance of 4.0 m.

2. The method according to claim 1, characterized in that there are 2 rows of *Elaeagnus angustifolia* planted in the outermost layer of the protection belt grassland in step a, with a row spacing of 1.5 m and a plant spacing of 1.6 m; there are 2 rows of

Calligonum caput-medusae Schrenk planted in the middle layer with a row spacing of 1.0 m and a plant spacing of 1.0 m; and there are 2 rows of *Tamarix ramosissima* planted in the inner layer with a row spacing of 0.7 m and a plant spacing of 1.0 m.

3. The method according to claim 2, characterized in that the outermost layer of *Elaeagnus angustifolia* planted in step a is planted in staggered rows, that is, the first row of *Elaeagnus angustifolia* is planted from scratch, the second row of *Elaeagnus angustifolia* is planted 0.8 m back, and the middle layer of *Calligonum caput-medusae* Schrenk is planted in staggered rows, that is, the first row of *Calligonum caput-medusae* Schrenk is planted from scratch, the second row of *Calligonum caput-medusae* Schrenk is planted 0.5 m back, and the inner layer of *Tamarix ramosissima* is planted as conventional.

4. The method according to claim 3, characterized in that *Caragana polourensis* Franch. and *Calligonum caput-medusae* Schrenk planted in the protective barrier in step b are planted singly or alternately.

5. The method according to claim 4, characterized in that the belt spacing of the protective barrier in step b is 16 m.

6. The method according to claim 5, characterized in that the leguminous grass planted in the open pasture planting area in the middle of the pasture in step c is sainfoin, alfalfa or sweet clover.

7. The method according to claim 6, characterized in that the leguminous grass planted in the open pasture planting area in the middle of the pasture is sainfoin (*Onobrychis*), alfalfa (*Medicago*) or sweet clover (*Melilotus suaveolens* Ledeb.).

8. The method of claim 7, characterized in that the alfalfa planted is *Medicago sativa* cv.Hetiandaye, vernal alfalfa, Xinmu No.2 or *Medicago sativa* L.cv.Xinjiang Daye.



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ABSTRACT

The application relates to a method for constructing protective grassland in mountainous areas of arid region. The method screens plant species suitable for the characteristics of mountainous environments, constructs protective belts and isolation strips at the periphery of artificial pastures and inside pastures in advance, and designs technical measures such as width of protective belts and protective barriers, species configuration, spatial order (location), planting spacing and irrigation methods through orthogonal tests. It provides protection for the development and growth of forage grasses, minimizes the damage to the germination and growth of forage grasses caused by wind and sand and windy weather, improves the survival rate of forage grasses and grass production, and promotes the development of arid deserts by utilizing peripheral protection belts and internal protective barriers in mountain protective pastures. As one of the best technical mode for grassland construction in mountainous areas of arid region, the method present by this application can greatly increase the survival rate and yield of pasture in the construction of artificial pasture in mountainous areas of arid region.