



LE GOUVERNEMENT  
DU GRAND-DUCHÉ DE LUXEMBOURG  
Ministère de l'Économie

Le Ministre de l'Économie,

Vu la loi du 20 juillet 1992 portant modification du régime des brevets d'invention, telle que modifiée ;

Vu le règlement grand-ducal du 17 novembre 1997 concernant la procédure et les formalités administratives en matière de brevets d'invention ;

Vu le dépôt de la demande de brevet luxembourgeois daté du : **11/01/2023** ;

Arrête :

**Art. 1er.-** Il est délivré à la (aux) personne(s) mentionnée(s) sur le tableau des données bibliographiques attaché au présent arrêté, sous le numéro de code 73, un

### **BREVET D'INVENTION N° LU503332**

pour : MIXED PLANTING METHOD OF GRASS AND SHRUBS FOR LOAM SLOPE PROTECTION IN DESERT REGION OF NORTHERN XINJIANG

tel que décrit dans les duplicata des pièces techniques joints en annexe.

**Art. 2.-** Le brevet est délivré sans examen préalable de la brevetabilité de l'invention, sans garantie de l'exactitude de la description et aux risques et périls des demandeurs.

**Art. 3.-** Le présent arrêté, qui constitue le titre de protection, est expédié au(x) mandataire(s) agréé(s), mentionné(s) sur le tableau des données bibliographiques attaché au présent arrêté, sous le numéro de code 74 ou, à défaut, à la (aux) personne(s) visées(s) à l'article 1er, pour servir de document probant à celle(s)-ci.

Luxembourg, le **11/07/2023**

Pour le Ministre de l'Économie,

  
Corinne Müller  
Attachée

Office de la propriété intellectuelle





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**MIXED PLANTING METHOD OF GRASS AND SHRUBS FOR LOAM SLOPE PROTECTION IN DESERT REGION OF NORTHERN XINJIANG.**

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The invention relates to a mixed planting method of grass and shrubs for loam slope protection in desert region of northern Xinjiang, using drought-resistant perennial grass seeds and the shrubs widely distributed in northern Xinjiang, such as *Artemisia ordosica* Krasch., *Stipa capillata* L., *Salsola ruthenica* and *Nitraria sibirica* Pall., and including sowing date, preparation before sowing, grass seed sowing, shrub planting and later management. The invention greatly improves protection effects of the loam slopes in the desert region, realizes growth of the grass and the shrubs of in the desert region with annual precipitation of 100 - 200 mm only using snow in winter and limited rainfall in spring and summer, overcomes technical problems of difficult vegetation restoration in the loam slope in the desert region under existing technical conditions.



FIG. 1

## **MIXED PLANTING METHOD OF GRASS AND SHRUBS FOR LOAM SLOPE PROTECTION IN DESERT REGION OF NORTHERN XINJIANG**

### **TECHNICAL FIELD**

The invention relates to a mixed planting method of grass and shrubs for loam slope protection in desert region of northern Xinjiang, which is suitable for ecological protection of water conservancy projects, traffic engineering and flood control embankment in the desert region of northern Xinjiang with annual precipitation >100 millimeter (mm) under no irrigation.

### **BACKGROUND**

In desert region of northern Xinjiang, in order to ensure the safe operation of large-scale water conservancy projects and traffic engineering, loam slope is built beside the engineering subgrade. The loam slope has a relatively large gradient (about 30°), and is eroded by freezing and thawing floods and storm in spring and summer due to the lack of vegetation coverage. Therefore, the loam slope and dam surface in some sections suffer from serious water and soil loss, sediment flows into canals, roads are blocked, and flood dikes are destroyed. Although the engineering management department has been repairing the unstable slope year after year, but the slope is still not stable enough. Conventional slope engineering protection technologies are not only expensive, but also affects the environment and ecological landscape of the main canal, so vegetation coverage is becoming an effective way to control erosion and stabilize the slope. In addition, rodent pest in some sections of water diversion projects, the blockage of the channels caused by silt mixed with flood, the harm of malignant weeds to the channel seepage control systems and the harm of wind sand along the way all pose a serious threat to the safe and operation of the water diversion projects.

At present, loam slope protection methods mainly include traditional loam slope-engineering, loam slope protection with vegetation and loam slope protection

combining engineering with vegetation. The traditional loam slope-engineering adopts cement skeleton, has the advantages of rapid construction and obvious short-term effect, but has the disadvantages of high cost, high follow-up management cost and a short service life. The loam slope protection with vegetation is low cost, environmental and sustainable, but not obvious and inefficient in the short term. The loam slope protection combining engineering with vegetation combines the advantages of both the traditional loam slope-engineering and the loam slope protection with vegetation, as well as overcomes the disadvantages of each other, is a commonly used loam slope protection method at present.

Many vegetation loam slope protection technologies at home and abroad usually adopt gramineous grass species which are drought-resistant, barren-resistant, strong in soil fixation ability, developed in root system and good in protection effect. For example, the grass species used in loess slope on both sides of Huangling-Yan'an highway in China include *Bromus inermis* Leyss., *Agropyron cristatum* (L.) Gaertn., *Sedum sarmentosum* Bunge, *Onobrychis viciifolia* Scop. and *Coronilla varia* L., etc; according to the local climate characteristics and soil conditions, the loam slope on both sides of Xibaipo-Shanxi section of the National Highway 207 uses *Lolium perenne* L., *Trifolium repens* L., *Festuca arundinacea* Schreb., *Eragrostis curvula* (Schrad.) Nees., *Macroptilium lathyroides* (Linn.) Urban, *Festuca elata* Keng ex E. Alexeev and other grass species, by adjusting the proportion of the grass species with different advantages, and four plant species formulas are obtained, as well as achieve good loam slope protection effect. However, the above plants are only suitable for regions with annual rainfall >400 mm. Even grass seeds of relatively drought-resistant *Sedum sarmentosum* Bunge and *Poa annua* L. become withered after emergence, or even can't emerge under no irrigation in northern Xinjiang, and in brief they can't adapt to the arid climate in northern Xinjiang. In recent years, the planting technologies of herbaceous plants for loam slope protection in northern Xinjiang uses annual herbaceous plants, such as *Halogeton glomeratus* (Bieb.) C. A. Mey., *Kochia scoparia*, *Salsola brachiata*, and *Ceratocarpus arenarius* L., which may grow normally in arid region under no irrigation

and effectively protect the loam slope. However, after two years, due to the characteristics of annual herbs, the overall loam slope protection effect is not stable, and some sections are poorly developed or even undeveloped.

## SUMMARY

An objective of the invention is to provide a mixed planting method of grass and shrubs for loam slope protection in desert region of northern Xinjiang, including sowing date, preparation before sowing, grass seed sowing, shrub planting and later management, which uses drought-resistant perennial grass seeds and the shrubs widely distributed in northern Xinjiang combined with a construction method suitable for the loam slopes, thereby greatly improving protection effects of the loam slopes in the desert region, and realizing growth of the grass and the shrubs of in the desert region with annual precipitation of 100 – 200 mm only using snow in winter and limited rainfall in spring and summer.

According to the invention, a mixed planting method of grass and shrubs for loam slope protection in desert region of northern Xinjiang, including:

- a: sowing date: from late October to early November before soil freezing in autumn;
- b: preparation before sowing: selecting sandy loam, gray-brown desert, or gray-desert soil, then preparing soil on loam slope before sowing, and uniformly raking the slope surface by using a rake to loosen surface soil with a rake depth of 2 – 5 centimeter (cm); mixing seeds of *Artemisia ordosica* Krasch., *Stipa capillata* L. and *Salsola ruthenica* at a volume ratio of 2:1:1 to obtain mixed seeds, and mixing the mixed seeds with wet soil at a volume ratio of 1:1 to obtain mixed seed soil;
- c: grass seed sowing: uniformly sowing the mixed seed soil of the *Artemisia ordosica* Krasch., the *Stipa capillata* L. and the *Salsola ruthenica* according to 3 – 5 kilogramm per mu (kg/mu, 1 mu=666.666666667 square meters) on the raked slope surface, then uniformly raking the mixed seed soil with the rake, and finally beating the slope surface with a shovel for compacting the slope surface;
- d: shrub planting: digging small fish scale pits with a pit width  $\geq 20$  cm and a pit depth  $\geq 20$  cm on the loam slope according to spacing in the rows and spacing between rows of

2×1 meter (m), putting root system of 1-year-old *Nitraria sibirica* Pall. seedlings with root length >15 cm vertically and extended into the fish scale pits, covering the root system with the soil, lift the seedlings, flattening the soil, then burying the soil to base stem of the seedlings, and flattening the soil again;

e: later management: levelling erosion ditches or washed-out sections in the autumn and reseeding grass seeds and plant the seedlings, in the year when grass seeds are sown, if the erosion ditches on the loam slope are large or flood banks of the loam slope are washed away.

The invention has the following technical effects.

The mixed planting method of the invention uses the drought-resistant and saline-alkali tolerant creeping shrubs, strictly controls the sowing date, and fully utilizes characteristics of grass seed development in arid and semi-arid region, so that they may survive and grow under no irrigation, and vegetation coverage in the first year reaches >20% and gradually reaches >30% after the second year, thus effectively protecting the loam slope in the desert region.

## **BRIEF DESCRIPTION OF THE FIGURES**

FIG. 1 shows a picture for tidying up loam slope of the present invention; and

FIG. 2 shows a picture for loam slope vegetation after recovery for 2 years.

## **DESCRIPTION OF THE INVENTION**

The invention is further explained in detail with embodiments.

The invention provides a mixed planting method of grass and shrubs for loam slope protection in desert region of northern Xinjiang, implemented on the loam slope of Huangqiba section of Yin-er-ji-ke water conservancy project in Karamay, with a region of 50 mu. Seeds were collected from September to October, 2014, and sown in early November, an average height of seedlings was 30 cm in September, 2015, and vegetation coverage was >20%. As the emergence effect in some sections was not good, more grass seeds were planted, seedlings of *Nitraria sibirica* Pall. were planted in April, 2015, and overall vegetation coverage was >30% in August, 2016.

## Embodiments

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## Seed harvest and storage:

Harvest time: harvesting seeds of *Artemisia ordosica* Krasch., *Stipa capillata* L., *Salsola ruthenica* and the *Nitraria sibirica* Pall. during July to October when the seeds are fully mature.

## Maturity characteristics:

*Artemisia ordosica* Krasch., a semi shrub of *Asteraceae Artemisia*, with a fruit period from August to October, where a mature period of the *Artemisia ordosica* Krasch. distributed around Gurbantunggut Desert is from late August to mid-October, and the mature period of the *Artemisia ordosica* Krasch. distributed in the north of Karamay is later, from the middle of October to the middle of November, and 1000-grain weight of about 0.8 - 0.9 gram (g), and the mature seeds of the *Artemisia ordosica* Krasch. are brown and with a seed germination rate of about 50%;

*Stipa capillata* L., perennial herb of *Gramineae Stipa*, with a fruit period from July to August, 1000-grain weight of about 1.0 g, a seed germination rate of 30 - 50%, and fusiform caryopsis;

*Salsola ruthenica*, annual herb of *Chenopodiaceae Salsola*, with a fruit period from September to October, 1000-grain weight of about 0.5 - 0.6 g and a seed germination rate of 70 - 80%; when the seeds of the *Salsola ruthenica* are mature, the part above the flower dorsal wings hardens to be leathery, and the winged perianth and seeds easily fall off from the mother and spread to far places by the wind.

*Nitraria sibirica* Pall., a shrub of *Nitraria* L., with a fruit period from July to September, dried fruits 1000-grain weight of about 30 – 40 g, a seed germination rate of about 70%; when mature, fruits are dark red, fruit juice is dark blue-purple, tastes sweet and slightly salty, and stones are ovate and apex acute, 5 - 6 mm long and 3 mm wide in bases.

## Harvesting method:

For the ripe seeds of the *Artemisia ordosica* Krasch., putting on gloves and gently stroking branches with the ripe seeds, so that the ripe seeds fall off, or laying a cloth bag under *Artemisia ordosica* Krasch. cluster and gently tapping with a small stick to obtain the ripe seeds; for the ripe seeds of the *Stipa capillata* L.: tapping with the small stick to

obtain the ripe seeds, or putting on the cloth gloves and gently rubbing part of the *Stipa*<sup>503332</sup> *capillata* L. with the ripe seeds to obtain seeds; for the ripe seeds of the *Salsola ruthenica*: as the ripe seeds are easy to fall off, gently tapping with the small stick to obtain the ripe seeds with leaves and wings; and for the ripe seeds of the *Nitraria sibirica* Pall.: holding branches with fruits by hand, shaking the branches back and forth to make the fruits fall and then picking off fruits that have not fallen;

Seed storage: as the collected seeds of the *Artemisia ordosica* Krasch. and the *Stipa capillata* L contain a little water, spreading them out for drying; spreading the seeds with the seed scales of the *Salsola ruthenica* out and completely drying (under no irrigation, the seed scales are conducive to preserving the water around the seeds, so the sowing effect is better); for the *Nitraria sibirica* Pall. fruits with pulp, soaking the fruits in warm water for 2 h, gently rubbing after the pulp becomes soft, separating the pulp from the seeds, taking out the seeds, spreading them out and completely drying;

The seeds of the above *Artemisia ordosica* Krasch., the *Stipa capillata* L., the *Salsola ruthenica* and the *Nitraria sibirica* Pall. shall be dried outdoors without wind for 2 - 3 days, and not exposed to the sun, so as to avoid being burned at high temperature, thus affecting the seed germination rate; moreover, the dried seeds shall be packed in cloth bags and placed in a ventilated and dry room.

Sowing principle: according to biological characteristics and seed germination characteristics of above four desert plants, the seeds of the *Artemisia ordosica* Krasch., the *Stipa capillata* L. and the *Salsola ruthenica* are directly sowed, and the seeds of the *Nitraria sibirica* Pall. are planted after seedling;

Sowing date: sowing the seeds from late October to early November before soil freezing in autumn according to the seed germination characteristics of the desert plants, which is conducive to seed germination in the coming year.

Preparation before sowing: selecting sandy loam, gray-brown desert, gypsum gray-brown calcic soil, or gray-desert soil, then preparing soil on loam slope before sowing, and uniformly raking slope surface of the gray-brown desert, the gypsum gray-brown calcic soil or the sulfated meadow by using a rake with a rake depth of 2 – 5 cm to loosen surface soil for better implantation of the seeds;



Mixing seeds of *Artemisia ordosica* Krasch., *Stipa capillata* L. and *Salsola ruthenica* at a volume ratio of 2:1:1 to obtain mixed seeds, and mixing the mixed seeds with wet soil at a volume ratio of 1:1 to obtain mixed seed soil; in this way, when sowing the mixed seed soil, the seeds are not scattered with the wind because they are too small and light, resulting in uneven sowing; in addition, the seeds are fully mixed with the soil due to sticky effect of water, which is conducive to improving the emergence rate.

Grass seed sowing: uniformly sowing the mixed seed soil according to 3 – 5 kg/mu on the raked slope surface, then uniformly raking the mixed seed soil with the rake, and finally beating the slope surface with a shovel for compacting the slope surface, where the compacting the slope surface is very important and can't be omitted, because in northern Xinjiang, there are different degrees of windy weather in autumn, winter and spring, if the slope surface is not compacted, the loose surface seed soil may be blown away a lot, and soil moisture of the loose surface soil is greatly affected by the external weather, which is affect the emergence rate in spring.

Shrub planting: digging small fish scale pits with a pit width  $\geq 20$  cm and a pit depth  $\geq 20$  cm on the loam slope according to spacing in the rows and spacing between rows of 2×1 m, putting root system of 1-year-old *Nitraria sibirica* Pall. seedlings with root length  $> 15$  cm vertically and extended into the fish scale pits, covering the root system with the soil, lift the seedlings, flatting the soil, then burying the soil to base stem of the seedlings, and flatting the soil again.

Later management:

1) in the year when grass seeds are sown, under influence of snowmelt flood in spring and heavy rainfall in summer, if erosion has little impact on the loam slope, there is no need to level the erosion ditches and to reseed the grass seeds, but if the erosion ditches on the loam slope are large or flood banks of the loam slope are washed away, erosion ditches or washed-out sections shall be levelled in the autumn, the grass seeds are reseeded and more the seedlings are planted; and

2) in region where both the grass seeds and *Nitraria sibirica* Pall. shrubs are planted, under good water conditions, herbaceous plants grow faster than the seedlings of the *Nitraria sibirica* Pall., and the seedlings of the *Nitraria sibirica* Pall. can't compete with the

herbaceous plants and gradually turn yellow and die; in this case, there is no need to replant the seedlings of the *Nitraria sibirica* Pall.; under bad water conditions, the grass seeds grow less than the seedlings of the *Nitraria sibirica* Pall. or even does not grow, the seedlings of the *Nitraria sibirica* Pall. gradually grow instead of the herbaceous plants for the loam slope protection because of their deeper roots and better drought resistance than that of the grass seeds.

**CLAIMS**

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1. A mixed planting method of grass and shrubs for loam slope protection in desert region of northern Xinjiang, characterized by comprising:

a: sowing date: from late october to early november before soil freezing in autumn;

b: preparation before sowing: selecting sandy loam, gray-brown desert soil, or gray-desert soil, then preparing soil on loam slope before sowing, and uniformly raking the slope surface by using a rake with a rake depth of 2 – 5 centimeter (cm) to loosen surface soil; mixing seeds of *Artemisia ordosica* Krasch, *Stipa capillata* L and *Salsola ruthenica* at a volume ratio of 2:1:1 to obtain mixed seeds, and mixing the mixed seeds with wet soil at a volume ratio of 1:1 to obtain mixed seed soil;

c: grass seed sowing: uniformly sowing the mixed seed soil of the *Artemisia ordosica* Krasch, the *Stipa capillata* L and the *Salsola ruthenica* according to 3 – 5 kilogramm per mu (kg/mu, 1 mu=666.666666667 square meters) on the raked slope surface, then uniformly raking the mixed seed soil with the rake, and finally beating the slope surface with a shovel for compacting the slope surface;

d: shrub planting: digging small fish scale pits with a pit width  $\geq 20$  cm and a pit depth  $\geq 20$  cm on the loam slope according to spacing in the rows and spacing between rows of 2×1 meter (m), putting root system of 1-year-old *Nitraria sibirica* Pall; seedlings with root length  $> 15$  cm vertically and extended into the fish scale pits, covering the root system with the soil, lifting the seedlings, flatting the soil, then burying the soil to stem base of the seedlings, and flatting the soil again;

e: later management: levelling erosion ditches or washed-out sections in the autumn and reseeding grass seeds and plant the seedlings, in the year when grass seeds are sown, if the erosion ditches on the loam slope are large or flood bank of the loam slope is washed away.

**PATENTANSPRÜCHE**

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1. Ein gemischtes Anpflanzungsverfahren von Gräsern und Sträuchern zum Schutz von Lehmland in der Wüstenregion von Nord-Xinjiang, dadurch gekennzeichnet, dass es umfasst:

- a: Aussaat-Termin: Ende Oktober bis Anfang November vor dem Bodenfrost im Herbst;
- b: Vorbereitung vor der Aussaat: Auswahl von sandigem Lehm, grau-braunem Wüstenboden oder grauem Wüstenboden, dann Vorbereitung des Bodens am Lehmland vor der Aussaat und gleichmäßiges Harken der Hangoberfläche mit einer Harke mit einer Harkentiefe von 2 - 5 Zentimetern (cm), um den Oberflächenboden zu lockern; Mischen der Samen von *Artemisia ordosica* Krasch, *Stipa capillata* L und *Salsola ruthenica* in einem Volumenverhältnis von 2:1:1, um gemischte Samen zu erhalten, und Mischen der gemischten Samen mit feuchter Erde in einem Volumenverhältnis von 1:1, um gemischte Saaterde zu erhalten;
- c: Aussaat von Grassamen: gleichmäßige Aussaat der gemischten Saaterde von *Artemisia ordosica* Krasch, *Stipa capillata* L und *Salsola ruthenica* in einer Menge von 3 - 5 Kilogramm pro mu (kg/mu, 1 mu=666,666666667 Quadratmeter) auf die geharkte Hangoberfläche, dann gleichmäßiges Harken der gemischten Saaterde mit der Harke und abschließendes Schlagen der Hangoberfläche mit einer Schaufel zur Verdichtung der Hangoberfläche;
- d: Anpflanzung von Sträuchern: Ausheben von kleinen Fischebengruben mit einer Grubenbreite  $\geq 20$  cm und einer Grubentiefe  $\geq 20$  cm auf dem Lehmland gemäß einem Reihenabstand und einem Abstand zwischen den Reihen von 2×1 Meter (m), Setzen von Wurzelsystem von 1-jährigen *Nitraria sibirica* Pall; Sämlingen mit einer Wurzellänge von mehr als 15 cm vertikal und ausgestreckt in die Fischebengruben, Bedecken vom Wurzelsystem mit Erde, Anheben der Sämlinge, Abflachen des Bodens, dann Eingraben des Bodens bis zum Halmansatz der Sämlinge und erneutes Abflachen des Bodens;



e: spätere Bewirtschaftung: Einebnen von Erosionsgräben oder ausgewaschenen Abschnitten im Herbst und erneute Aussaat von Grassamen und Auspflanzung der Sämlinge, im Jahr, in dem die Grassamen gesät werden, wenn die Erosionsgräben am Lehmhang groß sind oder der Schutzwall des Lehmhanges weggespült wird.



FIG. 1



FIG. 2