BIOLOGICAL REHABILITATION IN THE DEGRADED LAND, A CASE STUDY OF SHARIINGOL SOUM OF SELENGE AIMAG IN MONGOLIA

B. Khishigjargal*, N. Khishigsuren, Sh. Dolgormaa, Ya. Baasandorj

Institute of Geography-Geoecology, Mongolian Academy of Sciences

*-Corresponding author, E-mail: khishigjargal_b@yahoo.com

ABSTRACT

Land is degraded and abandoned by intensive usages from mining and agriculture activities in the northern part of Mongolia. Especially agriculture land usage without rotation is one of the reasons of soil fertility loss. Land degradation is not only becoming an ecological degradation, but also decrease of economic benefits.

We have conducted a survey on the planting perennial in the abandoned and degraded land. Planting perennials in the degraded lands is considering a one of the important technologies for plant regeneration (Institute of Geoecology, MAS. 2002). Lands are traditionally used for pasture and animal husbandry, but in recent decades multiple land use has increased rapidly in Mongolia. Especially, the mining activities have been implemented rapidly.

From the result, we can see that, the wintering of Medicago falcata L is 70-76 percent and yield is 12-16.4 centner/ha in the abandoned land, and 80-85 percent for wintering and yield is 2-3.5 centner/ha in the degraded land from mining activities. Due to planting perennial, xerophyte plants increased by 12 percent and mesophyte plants increased by 45 percent in the abandoned land. In contrast, mesophyte plants decreased by 2 percent, and xerophyte plants decreased by 8 percent in the degraded land from mining activities.

KEYWORD: Perennial, seed, canopy cover, yield, land use.

INTRODUCTION

Due to intensive and unsuitable usages from mining and agriculture activities, plant communities have been decreased and also its dominant plants have been changed which becoming a loss of soil fertility. Mongolia has a one of the biggest territory in the world and land is relatively low degraded from human activities. However, in recent decades, the mining activities have been implemented rapidly and pastureland degradation is becoming serious problem in Mongolia. According to some studies, more than 70 percent of natural rangeland has been degraded (Dejidma and Uuganzaya 2014, Alimaa 2014). By the year 2011, total 19002.9 ha areas were disturbed from mining activities in country. Out of this number, the technical recovery was done in the 8212.9 ha area and the biological rehabilitation was done in the 4082.1 ha area. There is a regulation on the rehabilitation of degraded land. Through this

regulation, every year, the rehabilitation should be done more than 80 percent of total disturbed areas from mining activities. But, in reality, the rehabilitation operation was 21.5 percent in the nationwide in 2011(http://www.eic.mn/dlid/). By the survey on the inventory of degraded lands from mining activities which was implemented during 2009 to 2010, total 15 aimag's 56 soums' 3984.46 ha areas have been abandoned by mining activities and have not yet recovered (Institute of Geoecology, MAS. 2010). According to a survey of "The assessment of multiple land use types and its mapping" which was conducted by the Institute of Geoecology during 2010 to 2014, Saikhan soum which is one of the agriculture soums of Mongolia, 69.6 percent of total agriculture soil is degraded. It showed that we need to implement immediately optimal policies on ecosystem restoring and establish sustainable development, immediately. Not only implementing the policies, but also carry out some projects on restoring ecosystems which will be source for rehabilitation technologies and practices in Mongolia.

Nowadays, planting perennials in the degraded lands is considering a one of the important technologies for plant regeneration (Institute of Geoecology, MAS. 2002). Many researches are focusing on planting perennials in Mongolia. During 1948 to 1951, A.V. Kalinina and some researchers conducted several studies: sorting of perennial plants in various nature zones; some issues of agricultural engineering. According to the leguminous plant breeding studies, some sorts of perennials have been established such as according to the Khaisan study, the "Burgaltai" sort was established in 1986; according to Jamyandorj study, the "Khuduu aral" sort was established in 1996. During 1966-1969, Erdenejav and Myadag studied about the technologies of planting perennials. They suggested that appropriate planting amount of seed is 25-35 ha/kg at the Bromus elymus L, 25 ha/kg at the Elymus sibiricus and 10 ha/kg at the Agropyron cristatum (L).p.b (Research Institute of Animal Husbandry of Mongolia. 2011). According to a survey of Institute of Geoecology, Elymus sibirecus is a suitable plant for plant regeneration at the abandoned land from agriculture activities (Avaadorj (Eds), 1997). Planting seeds in the dry and dense surface layer of soil when the soil should be released with 0-22 cm depth, would be give a better result. Considering the planting period, in the steppe zone, starting in May gives better results of products (Dejidmaa and Uuganzaya. 2014).

Climate condition is a one of the limited factors to recovering plant communities for planting perennials in Mongolia. Especially, climate is very harsh in Mongolia and situated in an arid and semi-arid zone in Northeast Asia. Here, the climate is characterized by short dry summer (June to middle of August) and long cold winter (end of November to April). More than half of the annual precipitation is observed during the summer season in Mongolia with annual mean precipitation is 300-400 mm (Batima and Dagvadorj (Eds.). 2000). Depending on location, the temperature ranges between -15° and -30°C in winter time and 10° and 26.7°C in summer time. The average temperature is 0°C in Mongolia. In 2007, K. Ronnenberg, K. Wesche, M. Pietsch, and I. Hensen conducted a survey on seed germination in the mountain steppes of southern Mongolia. According to the study, seeds of *Allium polyrrhizum, Agropyron cristatum, Arenaria meyeri, Artemisia frigida and Artemisia santolinifolia* were germinated best under warm to high temperatures, whereas temperature of $8/4^0$C deferred germination. They conclude that immediate germination is possible, but only under suitable temperature. For restoration purposes, sowing should commence in late spring/early summer, when temperatures and moisture levels are most favorable. Also, Dejidmaa and Uuganzaya (2014) suggested that when perception is favorable for shooting and flowering period of *Bromus inermis* Leyss is giving good result than a year has shortage of perception. According to Katrik Ronnenber et al (2010), mean seed of *Stipa krylovii* varied between more than 90 % at the driest year and 50 % at the wettest year. Seed viability was even negatively affected by increasing precipitation and by irrigation. But further research is needed to implicate.

In this paper, we conducted a survey on the planting perennials at the abandoned land from agriculture usages and degraded land from mining activities. Our research's main objective is to identify changes of vegetation canopy cover and its recovery of plant communities from planting perennials in the various types of land uses.

STUDY AREA AND PLANT SPECIES

The study was conducted from 2012 to 2014 in Selenge aimag, Mongolia. In this study, we chose two areas for planting perennial: (1) a degraded land from mining activities in Shariingol soum; (2) an

abandoned land from agriculture usages in Saikhan soum. Both of study areas are located in the forest-steppe zone of northern Mongolia and brown soil occupies dominantly in this areas. The altitude varies between 800-1200 m above sea. The average air temperature is 21.2^{0}C in July and -26.8 ^{0}C in January. Most of precipitation is falling in summer time 89.4 mm to 94.4 mm, and 13.5-16.8 mm is occupied in winter. Generally, the vegetation period is short: the plant growth starts within middle of the May which is coincides with the onset of rain, and ceases in September/October due to rapidly decreasing temperature in Mongolia. We chose following species: *Medicago falcata* L*, Bromus inermis* Leyss, and *Elymus dahuricus* L.

Medicago falcata L is a perennial herb and widespread in Yakut (Russian federation) to India. Flowering and fruiting season is June to July. Its habitat of growing in steppe meadows and slope, forest fringes, on loam and sandy-loam soils, waterside sands and pebbles, as weed in fields and vegetable gardens. Seeds require scarification, a burial depth of 0.6-1.2 cm, and moist soils for efficient germination. Plant has high nutritional value and green mass grazed excellently by all types of livestock, dry mass grazed well. It is suitable plant for cultivation as forage (J. Undarmaa. 2015).

Elymus dahuricus L is short-lived perennial forage and a very important grass for rangeland rehabilitation in degraded grassland zones. It has wide geographical distribution in most of the arid and semi-arid regions of China and Mongolia (Zhang XingXu., Li ChunJie., and Nan Zhibiao. 2012). It is adapted to sites receiving 12 to 24 inches annual precipitation, but persists longer with higher precipitation and a self-pollinating plant. Flowering and fruiting season is June to July. Burial depth is 1.3-1.9 cm and moist soils for efficient germination (http://plants.usda.gov/plantguide/pdf/pg_elda3.pdf).

Bromus inermis Leyss is perennial valuable forage and a cool season grass. Its ability to tolerate dry conditions has made it a grass. It distributes widely in Europe, Northern America and has been introduced to South America, temperate and tropical Asia. Flowering and fruiting season is June to September. It is better to grow in the loams and sandy loams of the black and black soils zones. Its seedling requires 1 ha/25 kg and 3-4 cm depth (R. Otfinowski, n.C kenkel, and P.M Catling 2006, Dejidma and Uuganzaya 2014).

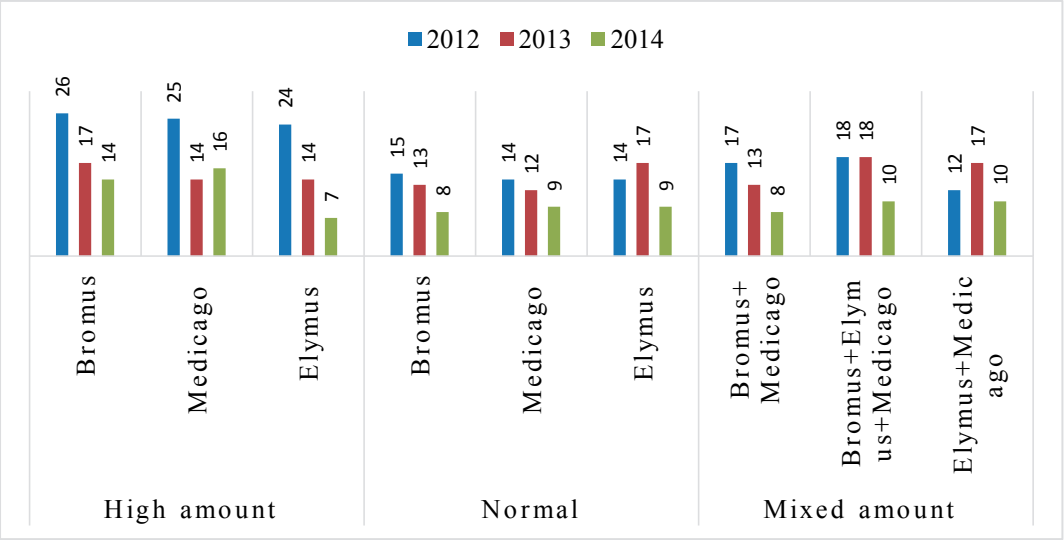
METHODS

The germination experience was carried out in the laboratory. When determining the germination of plant; each of them 50-100 pieces was selected to geminate at the room temperature. The purity of seeds was 70-75.0 percent. From this result, we did field planting. Before planting the perennial, soil treatment was done in the planting fields. Each of planting field is 5м*10м =50м^2 and 1.5 m width between of planting field. We divided volume of seed into three variations a) mixed amount, b) normal, and c) high amount, its amount is 10-35 kg/ha for degraded land from mining activities and 2-70 kg/ha for abandoned land from agriculture usages. Planting period was May 25-30 and June 10-20. Field seedling was determined that the plants' number was accounted in the 1m^2 field and then the number was compared with the number of seeds sown in the lab experiment. Then we determined species richness, canopy cover, and plant functional types in the field and lab.

RESULT

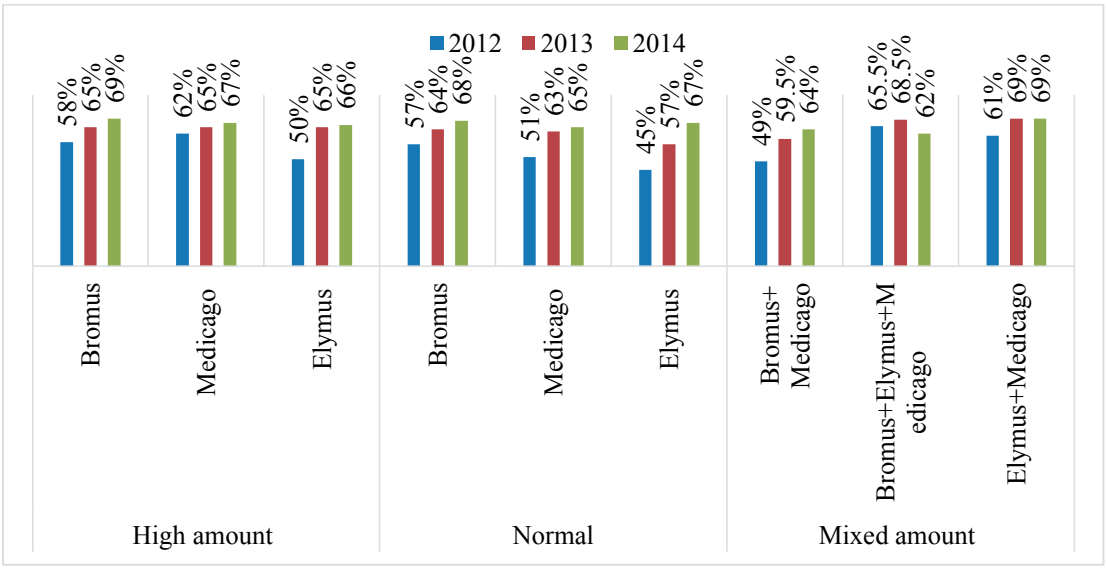
Biological rehabilitation on the abandoned land from mining activities

Comparing with the species richness of 2012 and 2014, weed plants have degreased which was increased at the first year of study, and since 2013 dominant plants have increased such as *Medicago falcata* L*, Bromus inermis* Leyss, and *Elymus dahuricus* L. When we were measuring the plant communities, native plants have intruded to regenerate naturally in the field such as stipa, agropyron, bromus and festucas. Shrub plants were found in the field as a partly (See Pic.1).



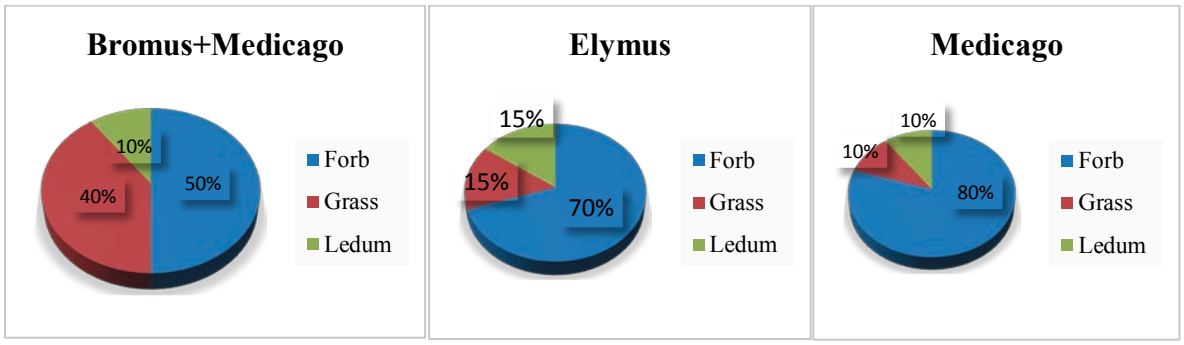
Picture 1. Species richness in the abandoned land

Comparing with the canopy cover of 2012 and 2014, weed plants have degreased and the biomass of *Medicago falcata* L, *Bromus inermis* Leyss, and *Elymus dahuricus* L have been increased as a result of the rehabilitation (See Pic.2).



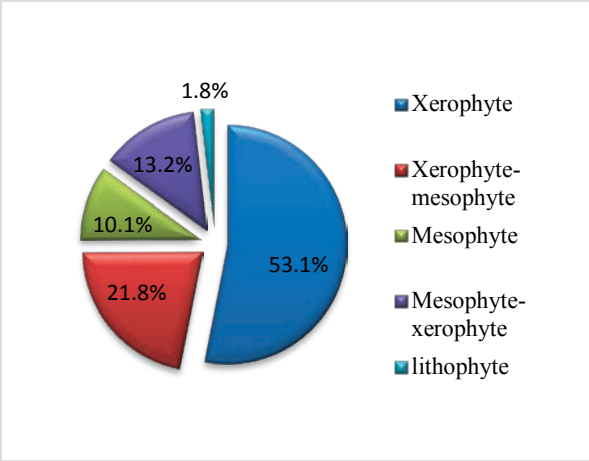
Picture 2. Canopy cover in the abandoned land

Before planting, forb has growth dominantly in the field which is indicated by the current species richness survey in 2012 (See Pic.3).

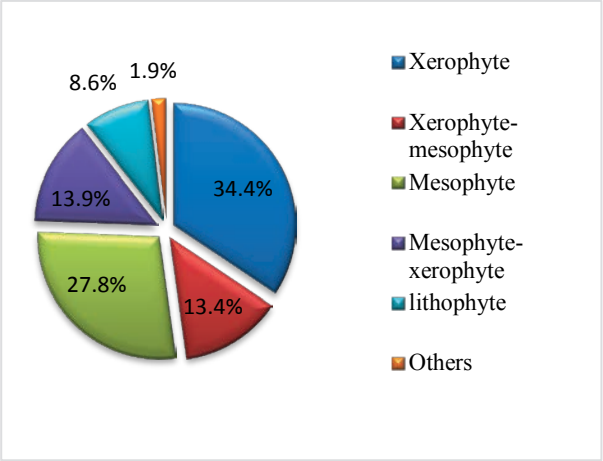


Picture 3. Plant functional types in the abandoned land

When we see from the Pic.4 and 5, because of water shortage and evaporation is higher in the degraded land, xerophyte plants are growing dominantly in this area. Also, we can see that, xerophyte plants have decreased by 18.7 percent and mesophyte plants have increased by 17.7 percent in the field.



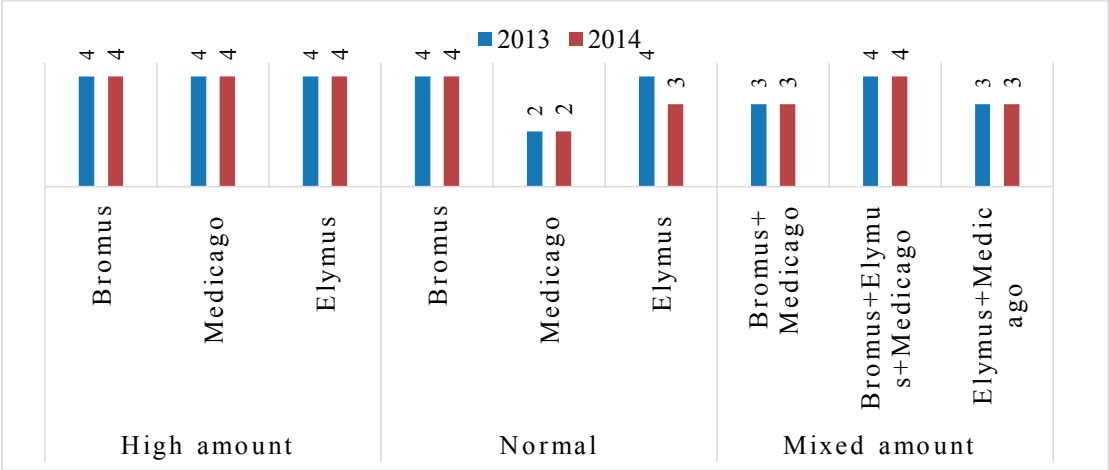
Picture 4. Ecological groups, 2012



Picture 5. Ecological groups, 2014

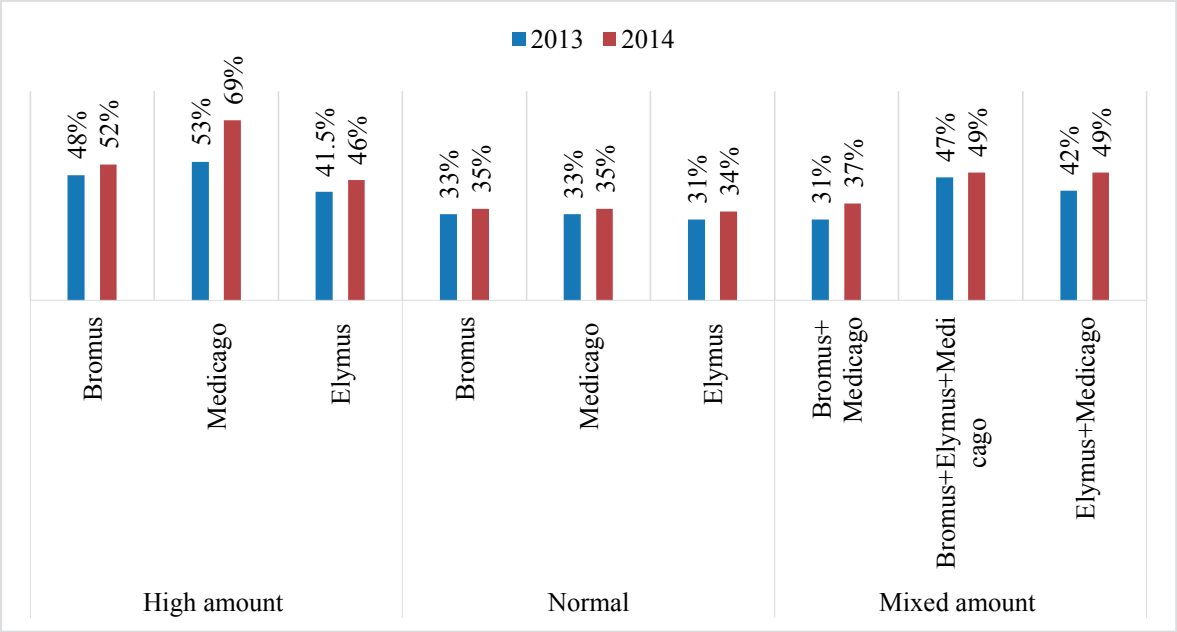
Mining reclamation

The field measurement reveals that weed plants growth relatively low in 2013, and perennial plants have grown dominantly in 2014 (See Pic.6).



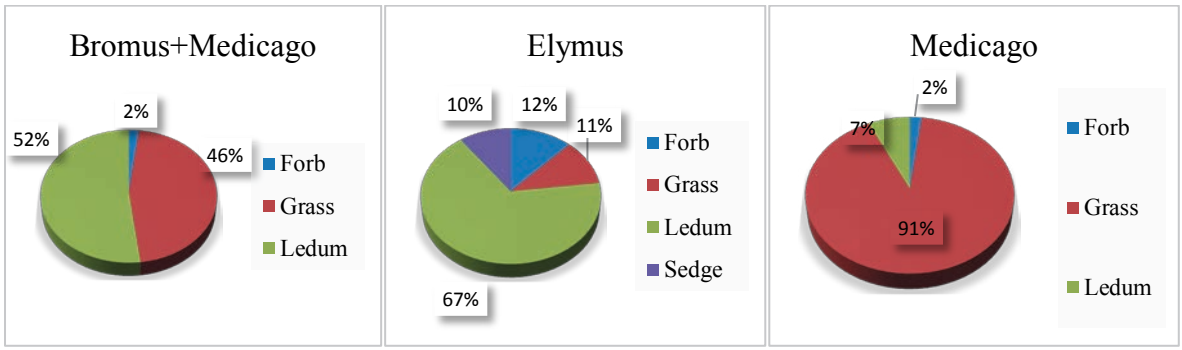
Picture 6. Species richness in the degraded land

Comparing with the canopy cover of 2013 and 2014, 8.1 percent higher at the high amount seedling variation, 2.3 percent higher at the normal seedling variation, and 2 percent higher at the mixed amount seedling variation. When comparing with it, 55.6 percent at the high amount seedling variation, 34.6 percent at the normal seedling variation, 45 percent is at the mixed amount seedling variation (See Pic.7).



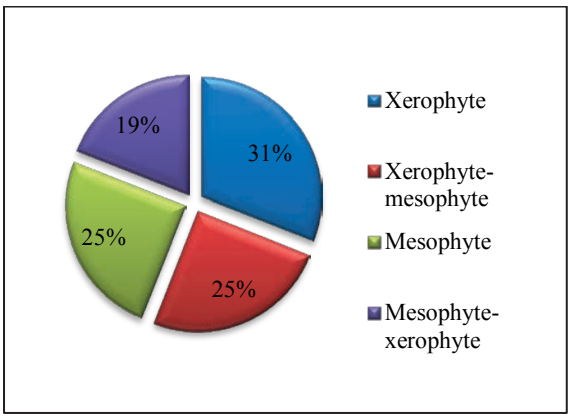
Picture 7. Canopy cover in the degraded land

From the plant functional types, forb's yield is high in the mixed amount variant and also the yield is high in the single account *Elymus dahuricus* L's field. Ford and sedge plant communities is higher in the single account *Medicago falcata* L's field (See Picture 8).

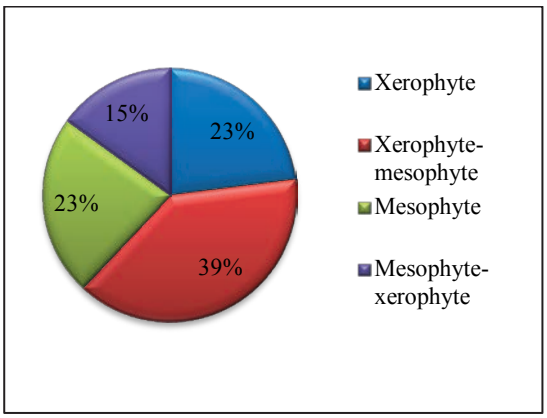


Picture 8. Plant functional types in the degraded land

Pictures 9 and 10, we can see that, plant communities have decreased by gradually such as mesophyte (2 %), meso-xerophyte (4 %), and xerophyte (8 %).



Picture 9. Ecological groups, 2013



Picture 10. Ecological groups, 2014

CONCLUION AND DISCUSION

From this research results, it showed that it is important and effective to evaluate the plant growth to consider with canopy cover, species richness and changes of yield. The wintering of *Medicago falcata* L is 70-76 percent and yield is 12-16.4 centner/ha in the abandoned land, and 80-85 percent for wintering and yield is 2-3.5 centner/ha in the degraded land. Due to planting perennials, xerophyte plants decreased by 18.7 percent and mesophyte plants increased by 17.7 percent in the abandoned land. In contrast, mesophyte plants decreased by 2 percent, and xerophyte plants decreased by 8 percent in the degraded land from mining activities. From third year of study in the abandoned land, when planting only *Elymus dahuricus* L and *Bromus inermis,* grass occupied 70 percent; planting *Medicago falcate* L, grass occupied 5 percent; mixed amount variation, which planted elymus and bromus inermis, grass occupied 40 percent. Depending on the variations, Grass family plants occupied more than half percent in the degraded land from mining activities. For example, planting only *Elymus dahuricus* L and *Bromus inermis* Leyss, grass occupied 80 percent, and planting Medicago *falcate* L, grass occupied 50 percent; mixed variation, grass occupied 65 percent.

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