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Rainfall harvesting on slopes using contour furrows with plastic-covered transverse ridges for growing *Caragana korshinskii* in the semiarid region of China

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ABSTRACT

A rainwater harvesting system on slopes using contour furrows with plastic-covered transverse ridges designed to be used in small rainfall dominated areas of the semiarid loess region of China has been tested from 2001 to 2004. The system consisted of constructing contour furrows on the loess slope at a distance of 5 m with plastic-covered transverse ridges built in the furrows between shrubs of *Caragana korshinskii*. There were three treatments in the study: (1) plastic-covered ridge with gravel-mulched furrows (T1), (2) plastic-covered ridge with bare furrows (T2), and (3) control (no ridge and no contour furrow) (T3).

The experimental results indicated that runoff from the natural loess slope was small and variable, and only produced from a few rainfall events with high intensity. Runoff efficiency averaged 13.8, 4.5, 1.4, and 0.4% in 2001, 2002, 2003, and 2004, respectively. However, the plastic-covered ridges accumulated runoff from most rainfall events, particularly from the light rains less than 5 mm. So the natural loess slope between the furrows and the plastic-covered ridges in the furrows can complement each other, i.e., the plastic-covered ridges induce runoff from small rainfall to the planted area, and the natural loess slope between the furrows concentrate runoff from heavy rainfall, thus improving rain use efficiency. The total runoff collected from both the natural loess slope and the plastic-covered ridges to the planted area in the furrows was 231, 143, 88, and 59 mm in 2001, 2002, 2003, and 2004, respectively. Soil moisture storage in the 200-cm deep soil layer was obviously higher for T1 and T2 than for T3, and *C. korshinskii* showed a significant improvement in growth for the T1 and T2 treatments. Therefore the combination of contour furrows and plastic-covered ridges as rainwater harvesting system may have a great potential development in the small rainfall dominated arid regions of China.

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1. Introduction

Caragana korshinskii is a drought resistant shrub, which is widely used for vegetation rehabilitation in arid and semiarid regions of China, for its high ecological and economic value, including: (i) the key role in vegetation succession from shifting dune to sandy grassland, (ii) the restoration of degraded land by fixing atmospheric nitrogen, (iii) the formation of a shrub shelterbelt for crops or artificial grassland, and (iv) supplemental livestock forage (Hansson et al., 1995; Ren et al., 2002). However, the establishment and growth of *C. korshinskii* is often limited by water shortage.

Water harvesting is a method of collecting surface runoff from a catchment area and storing it in surface reservoirs or in the root zone of a cultivated area (Reij et al., 1988). It can be a source of water for supplying drinking water for people, livestock, and wildlife as well as for providing supplemental water for growing food and fiber crops (Frasier, 1980). Microcatchment water harvesting (MCWH) which collects runoff from short slopes is especially useful in arid and semiarid regions (Boers et al., 1986; National Academy of Sciences, 1974). The basic MCWH system consists of two parts: the catchment area and infiltration basin. The catchment collects rainfall from a small area cleared of or lacking vegetation. The concentrated runoff is stored in the soil profile of the infiltration basin irrigating trees and crops (Renner and Frasier, 1995). The major advantages of MCWH are that it is simple, cheap, replicable, efficient and adaptable (Reij et al., 1988). MCWH can improve soil moisture storage, prolong the period of moisture availability, and enhance growth of agricultural, horticultural and forest crops (Evenari et al., 1968; Sharma et al., 1982; Boers et al., 1986; Crichley, 1987; Reij et al., 1988; Carter and Miller, 1991; Oweis et al., 1999; Ojasvi et al., 1999). The ridge and furrow method of MCWH was found to be more effective on tree growth and crop production (Vashistha et al., 1980). Gupta (1994, 1995) reported that the bare ridge and furrow method for rainwater harvesting can significantly improve the tree growth of *Azadirachta indica*, *Tecomella undulata* and *Prosopis cineraria* in the Indian Desert area. Lal et al. (1984) found that the adoption of a 'W'-form in situ rainwater harvesting system demonstrated effective results on crop production in Brazil, and Li et al. (2001) found that the plastic-covered ridge and furrow rainfall harvesting (PRFRH) system combined with mulches significantly improved water use efficiency and yield of corn in the loess region of China. In recent years, the PRFRH methods have been successfully tested for various crops (e.g., wheat, potato and alfalfa) in the semiarid regions of China (Tian et al., 2003; Li et al., 2007). However, PRFRH was usually used in the flat dry farmland; few efforts were made to test it on the slope partly due to complexibility of the terrain and the high labor cost.

For the hillslope, rainfall is still mostly stored in the soil using terraces, bunds and bare contour ridges. The infiltration characteristics of the soil and the climatic conditions limit the efficiency of these methods (Abu-Zreig et al., 2000). In the loess plateau of China, the contour furrow method for rainwater harvesting was traditionally used to grow trees on the loess slope; however, this method always fails due to small amounts of runoff and high evaporation (Li et al., 2000). In this study, we attempted to construct plastic-covered transverse ridges between the trees in the furrows to induce more runoff to the root area of the trees and reduce soil evaporation. The objective of the study was to investigate runoff characteristics, soil water storage and growth of *C. korshinskii* with this rainfall harvesting system.

2. Materials and methods

2.1. Field site

This study was conducted between May and September from 2001 to 2004 at the Gaolan Research Station of Ecology and Agriculture, Cold and Arid Regions Environmental and Engineering Research Institute, Chinese Academy of Sciences. The station is located in the transitional zone between the arid and semiarid regions (Gaolan County, Lanzhou, Gansu Province, 36°13′N, 103°47′E) at an altitude of approximately 1780 m. Mean annual precipitation is 263 mm, with nearly 70% falling between May and September. Mean annual temperature is

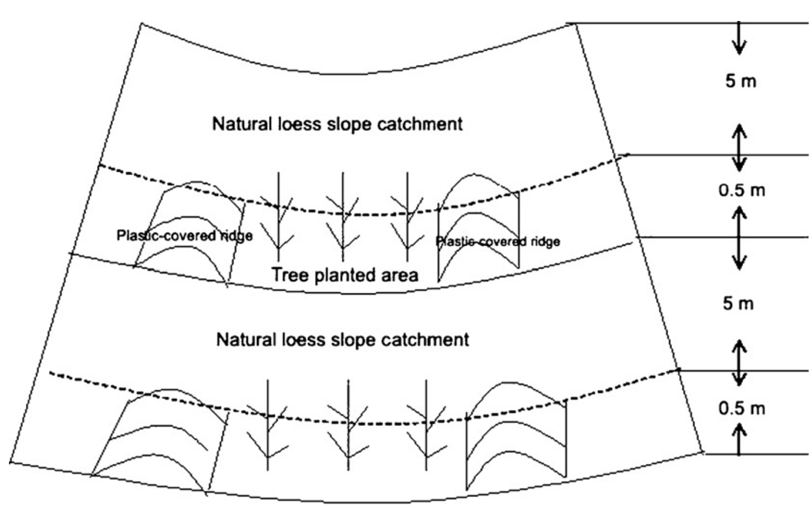

Fig. 1 – Schematic diagram of the experimental arrangement showing a cross section of loess catchment, contour furrow, and plastic-covered ridges.