ABSTRACT

The Study was carried out in the years of 1997 and 2001 as a research project in Southeastern Anatolia Forestry Research Institute and completed in 2002.

Aim of the research is to determine the effect of different soil tillage types and reseedings on soil erosion and forage yield. Experimentation applied as split plot experimental design. 3 repetition x 5 various soil tillages (control + 4 tillages) x 2 reseedings (control + reseeding) treatments were used in this study.

The highest forage yield was measured in moldboard and deep soil tillage parcels. But the highest soil loss was determined in the same parcels. To determine the relationships between soil loss and some soil erosion sensitivity indexes; Dispersion Ratio, Colloid Moisture Equivalent and Erosion Ratio were compared. The best result was achieved from the Erosion Ratio Index.

Keywords: *Rangeland, Soil tillage, Reseeding and Erosion*

I. Introduction

Soil conservation and improvement of the deteriorated soils are very important for human being future. Stockbreeding is going on as ancestral way in Turkey for a long time. Because of the over grazing, most of the rangelands have been under heavy grazing pressure for a long time and are exposed to erosion. If the soil is deteriorated one time, it is quite difficult to rehabilitate it. Reseeding and fertilization are not effective to rehabilitate degraded grasslands in dry climatic conditions. On the other hand; due to over grazing, soil is getting compacted and as a result of this, its infiltration capacity is being decreased. Villagers usually over use the rangelands but they do not do anything to rehabilitate them. Therefore, soil tillage is necessary to increase the aeration, water infiltration ratio and water holding capacity in deteriorated lands. This study had been planned for this purpose. Water holding capacity of the soil generally depends on the amount of humus and carbonate, type of clay minerals, soil depth, stoniness of the soil, soil texture and salinity of the soil (Kantarcı 1989).

Grazing capacity of Turkey's Rangelands is quite low. Dry forage yield varies between 400 – 1200 kg/ha. Most of the forage yield consists of wild grasses (Bakır 1981).

Baer et al. (2000) stated that rehabilitation of degraded rangeland is very important to achieve the human being necessity. To stabilize the soil structure, reduce the erosion and increase the soil productivity, in contrast to his explanations, transformation of the farm lands to pasture have been done. He also said that the farm land which has been cultivated as moldboard and used for agricultural purpose for a long time is exposed to erosion. Due to moldboard cultivation, soil aggregate structure was destructed and the organic carbon was reduced from 60 % to 24 %.

Brady et al. (1994) expressed that people does not have any positive effect on soil texture but positive effect on soil structure by using certain plant and crop rotation managements.

In this paper our purpose is to examine how different soil tillage types and sowing of Sainfoin *(Onobriches sativa)* affect the soil water holding capacity, erosion, productivity and, crop yield.

II. Materials and Methods

Randomized block experimental design was used in the field study of this research. Five different soil cultivation types were applied as main treatments. Two sowing treatments (sown and unsown) with Sainfoin *(Onobriches sativa)*, were applied as the sub-treatments. Sainfoin application was applied as split plots. Applying of sainfoin sowing treatments were; 1.) Moldboard soil tillage at a depth of 30-40 cm with plough (ST1), 2.) Moldboard soil tillage at a depth of 20-30 cm with plough (ST2), 3.) Stripe style soil tillage with chisell (ST3), 4.) Making hole in soil (ST4) with spiked roller, and 5.) No soil tillage (C), applied only soil tillage treatments. Additionally; 1.) Moldboard soil tillage at a depth of 30-40 cm with plough (ST1SW), 2.) Moldboard soil tillage at a depth of 20-30 cm with plough (ST2SW), 3.) Stripe style soil tillage with chisell (ST3SW), 4.) Making hole in soil (ST4SW) with spiked roller, and 5.) No soil tillage (CSW) were applied together with Sainfoin sowing treatments. Sainfoin was sown in March of 1999. The dimensions of the sampling plots were about 10 by 5 m. Soil tillage and sowing treatments were done as simultaneous way. Broadcast seeding was applied by hand after the soil tillage for ST1 and ST2 sampling plots, but before for ST3, ST4 and C sampling plots.

Crop yield was measured as an above ground biomass using 1 by 1 m frame. Above ground biomass was cut on soil level in Jun and their oven-dry weigh were measured after drying in an oven at 65^{o} C for 24 h. Samples were taken two times from each sample plot and average data used for evaluation.

III. Results

Forage yield amount has shown a descending movement while the soil tillge depth decreased (Figure 2). The highest yield was achieved from the ST1 and the least from the C. The amount of forage yield mesured 319, 240, 210, 147 and 126 gr. $sqm.^{-1}$ for the soil tillage types of ST1, ST2, ST3, ST4 and C respectively. Analysis of variance indicated that soil tillage was effective on forage yield at P=0.0089 level.

Measurement of forage yield was taken into account as above ground biomass. Above ground biomasses were found 404, 266, 226, 140, and 123 gr sqm^{-1} for STSW1, STSW2, STSW3, STSW4, and CSW respectively. The biomasses related to ST1, ST2, ST3, ST4, and C were found 233, 214, 194, 128, and 95gr sqm^{-1} respectively. It can be said that decreases in the above ground biomass from ST1 to C treatment was affected by soil tillage types (Figure 1).

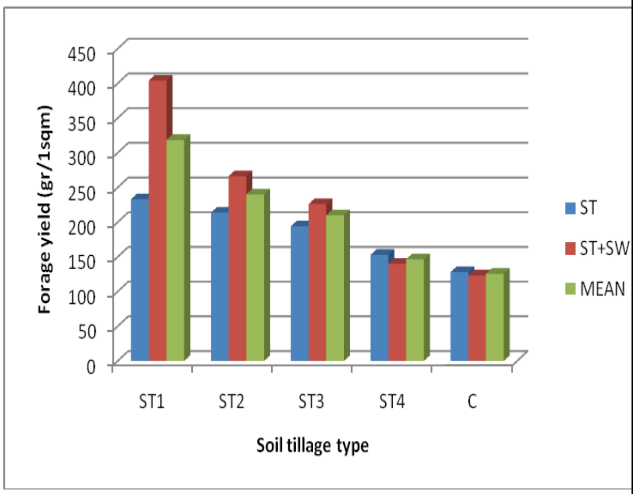

Figure 1. Above ground forage yield according to soil tillage types

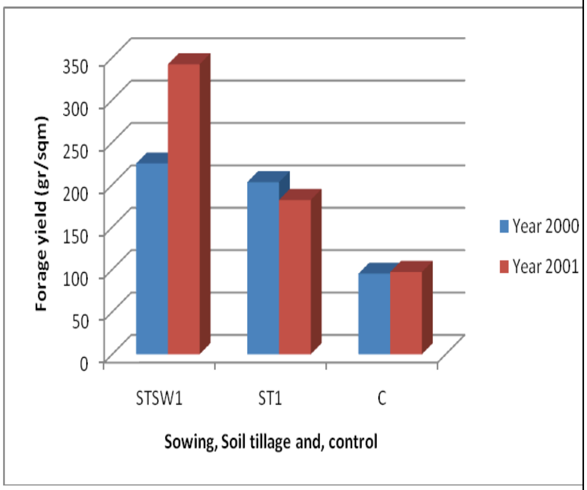

Figure 2. Effect of soil tillage and Sainfoin sowing on aboveground plant biomass

Be able to explain the effect of Sainfoin cultivation on aboveground plant biomass increment, consecutive measurements - after Sainfoin removed from the area - were made in the year of 2000 and 2001. As seen from figure 2, while aboveground plant biomass increased in STSW1, decreased in ST1 and there was no changing in C. Possibly this increment in STSW1 was originated from the increment of soil productivity by means of nitrogen fixation of Sainfoin in soil. The relationship between soil cultivation and the quantity of transported soil is statistically significan at p=0.05 security level. Soil loss was measured for MBT1 = 118, MBT2 = 57, ST = 29, SRT = 12 and NT = 18kgr/53sqm/year (Figure 3).

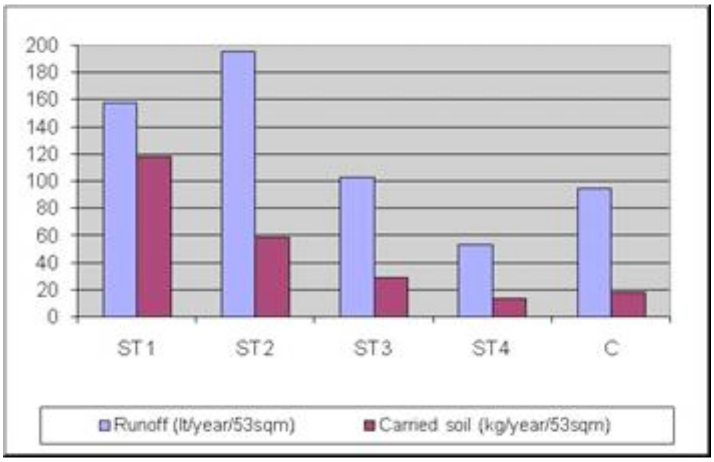

Figure 3. Relationship between soil tillage type and eroded soil (kg/year/53sqm)

IV. Discussion

Experiments proved that leguminosae increases soil productivity as observed that natural vegetation has shown better growth rate when trefoil sowed before such vegetation in the same area (Figure 2). However, a special care should be taken when selecting forage species, which that, in pasture management, more durable trefoil species should be preferred and graminea is to be mixed with trefoil species at a particular rate in order to prevent invasive natural species whose forage value is lower than expected. In addition, several other studies concludes that wheat species expose symbiotic life style with nitrogen found in the roots of leguminosae and make nitrogen nodules and enriches soil with nitrogen and make an increment in crop yield in rotation.

In general it is reported that leguminosae, through their well developed root systems, takes difficultly dissolved nutriented found in deeper horizons of the ground and make use of it for both their own nourishment and circulating nutrients to upper horizons of the ground. The best leguminosae species for such a function are trefoil and trifolium (ULUOCAK, 1984). Particularly in droughty and barren areas trefoil gives better outcomes than other leguminosae species.

Beyond that, several studies conducted at both global and national level prove that leguminosae species have a significant impact on soil reclamation and yield incement. Some of them are summarized below;

According to a research, leguminosae species like trifolium and clover, via their special bacteria, transfer free nitrogen stored their roots to deep soil and make fertilizer and thus enriche, through mobilizing rich phosphate, soil productivity. In addition, they transport nutrients found in deep soil toward upper horizons and increase the yield productivity of the following planted crops at % 30-60 (ANON., 1972).

Trefoil and trifolium increase wheat yields, which that normally fallowed wheat yields 102 kgs per a quater acre (or 1000 square meters), whereas wheat, sowed after three year trefoil rotation, yields 180 kgs per a quater acre and 178 kgs per a quarter acre if sowed following more than three year trifolium rotation. (BAKIR ve AÇIKGÖZ, 1976). Green peas, grown as an organic fertilizer, pea sowed following oaten yields 500 kgs per a quarter acre. And thus, 9,530 kgs nitrogen added to soils and at the end of fallowing period such a leguminosae plant 14,290 kgs nitrogen added to soils in total per a quarter acre; whereas other plant species, other than leguminosae, takes 15,420 kgs nitrogen from soils per a quarter acre (ÇELEBİ ve KARAKAPLAN, 1973). Beyond that leguminosae species, in addition to several advantages in fallowing, have a positive impact on anzimatic activity which raise soil productivity (HAKTANIR, 1973).

According to Tosun (1968), in shallow arid pastures of Eastern Anatolia, trefoil is the species that is oriented best and, with the mixture of wheat, it yields the highest amount of products. Even following stages of the experiment it is observed that crops mixed with trefoil increased its yields and in the last year of the experiment it is found that the mixture of trefoil-blue cloven, trefoil-pasture cloven and trefoil-stringless brom yielded more than (single species) the others in terms of crude protein and forage (TOSUN, 1968).

When analysing the data, several scientific relations are observed between variables. The relationship between soil cultivation and the quantity of soil transported is statistically significan at p=0.05 security level. To investigate the tendency of soil types toward erosion, areas where full site soil cultivation is practiced in ST1 and ST2 coded areas and analysed. As an outcome, the aspects of soil and surface flowage parcels influential for the quantity of transported soils are investigated and concluded that erosion ratio is observed as a satisfactory level. Since the purpose of this study is to search for the impact of various soil cultivation methods on soil erosion, when selecting study areas at the first stage, a special attention is paid the commensuration of the slope of surface flowage parcels. Therefore, the impact on slope on erosion is not taken into account in this study.

With regard to soil analyses, organic material contents vary from % 0.59 to % 1.37 and it is counted very poor (Figure- 3.3). Since organic materials are the sources of humus, it plays a particular role on the colloid and aggreditated soil structure. In here, highest and the most severe erosion (118 kg./ 53 sqm) is observed in parcel ST1 (full site deep soil cultivation made). However, to grow satisfactory level of plants, in soils whose organic material contents are too low, moldboard soil cultivation is necessary (FİDAN, 2002). As a matter of fact ST1 parcels give the highest productivity level. Top soil biomass measurement performed in the third year of feed crop has proved that the highest yield increment occurred in full site and deep soil cultivation parcels. Thus, it might be asserted that such practices might give better results when restrong demolished areas. Studies conducted in this areas have paid a special attention to the referred issue that after increasing nitrogen storage capacity of soils, it becomes easier to grow plant species which need more nitrogen and thus more biomas increment becomes possible. In areas whose nitrogen storage capacities are increased, fertilisation makes plantation easier and thus makes an impact on yield increment. In soils whose nitrogen contents are less, mix plantations of not greedy plants with nitrogen and nitrogen stored species enhance yield productivity and increase plant diversity (CHAMBERS, 1989).

V. Conclusion

Soil cultivation, depending upon the methods and time, might be hazardous or useful for biological activities. Soil cultivation causes an increment on erosion and organic material decomposition. In such a condition, agricultural soils whose organic material contents are below 1% are considered as biologically dead soil (SULLIVAN 1999). Full site soil cultivation with plow and disc aplication following it demolishes soil aggregation and makes it sensitive to wind and water erosion. Deepness in full site soil cultivation with plow is to be 35 cm and topsoil remains as the same depth. Due to oxygen shortage at such a deepness organic material decomposion takes places very weak.

On the other hand, since soil cultivation demolishes topsoil texture and vegetation, it decreases infiltration. It is known that uncultivated soil has a substantial impact on soil protection, water storage and preservation, surface flowage decrement, organic material increment and increment in infiltration capacity. In brief, uncultivated soil method, which creates a typical mulch cover on the surface, plays a protective shield on soil surface. Such a shield functions as a buffer zone for soil protection against extreme drought and pounding effect of raindrops and decrease evaporation from soil surface as well. Vegetation porvides food chain and many other advantageous for living creatures of soil. However, in drought and semi arid regions, it is obliged to increase organic material contents for amelioration of demolished soils via overgrazing and agricultural practices. To increase organic material and nitrogen contents of soils, it is essentail to plant long living leguminosae well oriented to local site conditions and to do that whole site deep soil cultivation is necessary. As a matter of fact, ZORALİOĞLU (1990) states that, in his study about specifying appropriate site preparation methods for arid and semi arid region afforestation activities, the best result is obtained from full site rippering method, but it might have bad side effects if it is not followed rules of how to use it and disc application is to be performed to prevent moisture lost. And all those results verify our findings. To store necessary water in the soil, stripe shaped soil cultivation is performed in Autumn. To keep stored water, it is useful to make full site soil cultivation in Spring in the same field. Not to lose soil during full site soil cultivation, contour furrow is constructed at a critical erosion distance. Thus, the best method for the highest soil moisture protection and forage yield in arid and semi arid regions is the one that best suited for soil loss. Soil cultivation methods via stripe with harrow and narrow spade are specified as causing the least surface flowage and the highest infiltration (Figure 3), but such a soil cultivation method is not preferable in terms of forage yield and soil moisture.