The Study of Hilly Loess Lands in Northern of Iran and Applies Soil Conservation Programs to Improve Sustainable Agriculture

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Abstract: Ever-increasing anthropogenic activities coupled with poor management of land and water resources are placing tremendous stress on environment, have resulted in steady increase in massive deforestation, escalating desertification, soil erosion, floods and droughts, urban congestion; extinction of countless species of plants and animals that make the ecosystem and the ubiquitous pollution of land, water and air. Exploding population growth, illiteracy poverty, further compounded by poorly planned developmental projects in developing countries and unsustainable consumption patterns and economic developments in developed countries are contributing directly to the environmental degradation and destruction of the ecosystems all around the world. Remedies for many of these maladies lie in sustainable development of the natural resources.

Some of the most important section of National Research Program (NRP) in Iran is soil conservation, run-off controlling, increasing of ground water resources and decreasing of environmental pollutions. Golestan province is one of the most important agricultural regions in north of Iran and in many locations surface layer of soils is loess and because of that there are so many problems in land behind the dams. In this research after a general evaluation of sensitivity in loess hilly lands to erosion in Goletan province, for two years two different steep farm was chosen (around Kalaleh city, which has affected by sever floods almost in every years) and four below treatments were done:

A. Plowing and planting along the slope direction (Farmer's condition).
B. Sub soiling along the contour line then plowing and planting along the slope direction.
C. Sub soiling, plowing and planting along the contour line.
D. Plowing and planting along the contour line.

Some physicochemical properties of soil (bulk density, soil water storage, etc.) were measured before and after the research work, also yield and yield components of wheat were measured in all of the treatments. After analyzing of these collected data, the order for priority for those treatments is as follow: C > D > B >> A.

Keyword: loess land, sustainable agriculture, soil conservation

1 Preamble

Understanding the natural environment and its relationship with ecological processes is essential pre-requisite for undertaking any developmental planning anywhere in the world. Globally, over the past 50 years, the productivity of more than 1.2 billion hectares of lands has come down. At this rate, it will make even harder the task of providing food for a world population projected to nearly double by the middle of the next century. According to a recent study conducted by the Global Assessment of Soil Degradation (GLOSOD), sponsored by the United Nations Environment Program (UNEP), an area approximately the size of China and India combined has suffered moderate to extreme land degradation caused mainly by bad agricultural practices, deforestation, overgrazing, etc., in the past 45 years.

Golestan province is situated in the northern part of Islamic Republic of Iran; on the southeast cost of Caspian Sea.Golestan province has 497,150 hectares cultivated lands where a total area is 20,380 square kilometers. The weather, which affected by latitude and position in respect to Caspian Sea, is cold in south mountainous land, mild Mediterranean in center and hot arid to hot sub-humid in north of

province. Land elevation and average annual rainfall are decreasing from south (1,000mm) to north (200mm) and also from east to west, therefore most rivers flow from south to north (e.g. Qaraso river) and east to west (e.g. Atrac river) into the Caspian Sea.

Emphasis on governmental assets, lack of local people participation, emphasis on mechanical measures, scattered projects, lack of comprehensive plans are some reasons for failures in achieving the watershed management goals and objectives and unfortunately annually we have flood and drought disasters which are the main constrains for economic development (filling the dams by sediment, destruction of installation, etc.) and affect people's life in the province (as an example, after two days intensive rainfall in our studied area- Kalaleh - at 12th August 2001,more than two hundred peoples were dead, so many buildings and installation were completely destroyed and 50,000 hectares of crop area was affected by occurred flood), but the Iranian government has paid enormous tendency to soil and water conservation in the "*Third Five years Plan for Development*".

Loess of Iran, which intensively covered the northern states of country, are unknown loop of loess chain from Europe to China but except some incomplete reports there is not any study on recognition, potentiality and capability of losses which known as "World Wheat Belt". Major objectives of this study was determination of best possible and practicable management in hilly loess land to sustainable production as well as profitability by farmers and practical extension of soil and water conservation culture for decreasing the erosion damages.

2 Materials and methods

Preliminary studies on reconnaissance and detection of sensitive hilly loess lands in Golestan province were done for finding a suitable farm in viewpoint of physiography, social and cultural position. During of two years experiment two suitable and independent fields in rain fed area were chosen. In first year (1998-1999) field was located at southern slope in Aqqamish village and amount of rainfall was 30% more than long tern average annual rainfall, but in second year (1999—2000) field was located at northern slope in Mirzapank village and amount of rainfall was 42% less than long tern average annual rainfall (drought year). After collection of soil samples and primary soil surveys, four below treatments(as schematically shown in Fig.1) were applied in field:

(1) Control treatment, i.e. farmer's condition[1]: plowing, planting and all other agronomic practices were applied along the slope direction.

(2) Sub soiling (50 cm—60 cm in depth and with 1 m interval space) across the general slope direction; plowing, planting and all other agronomic practices were applied along the slope direction.

(3) Sub soiling (50 cm—60 cm in depth and with 1 m interval space) across the general slope direction, making contour lines with ploughshare based on land slope and special mathematical equation [2], then plowing, planting and all other agronomic operations were applied along the contour lines.

(4) Making contour lines with ploughshare based on land slope and special mathematical equation, and then plowing, planting and all other agronomic operations were applied along the contour lines.

These treatments aim was studied the effect of change in soil permeability and making contour lines directly on the amount of surface runoff, soil erosion, soil moisture storage and indirectly on crop yield. After preparation of investigated field, wheat (var. Zagros) was sowing and in all the treatments care practices (except amount and time of fetililization) were completely same. Because of impossibility of doing this experiment in usual form of statistical designs, four stated treatments were applied and finally 20 randomized plots (with 1m ^{2} area/plot) form each treatment were chosen and yield components (ear high, number of spiklet per ear, number of grain per ear, density, plant high and etc.) were determined then crops of each plot was harvested separately from near the floor and grain yield, straw yield and harvest [3] index was determined. For studying the effect of different treatments on soil moisture storage, 20 samples from each depth (0 cm—30 cm, 30 cm—60 cm, 60 cm—90 cm) of different treatment was

[1] Farmers used fertilizers by conventional methods and without applying potassium fertilizer, but in all other treatments, except control, fertilizers (N, P & K) were used based on soil testing results.

[2] V=S/10 +2, where V is vertical distance between two contours (m) and S is average land slope (%) .

[3] Harvest Index=HI=Grain yield /(Grain + Straw yield).

collected and the amount of soil gravitational moisture was measured. Assuming that the sample means are distributed normally, which assumption is reasonable even when the original population deviates somewhat from the normal, the above ratio may be regarded as a normal deviate. All the results of two different years were analyzed by using the means comparison test (t-Test).

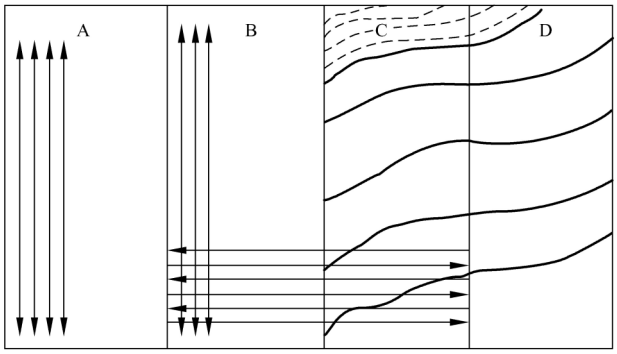

Fig.1 Schematic map of experiment and its treatment distribution

3 Results and discussion

Results of each measured parameter (e.g. grain yield) for two years were aligning and assume that there are forty replication (20 for first and 20 for second year) for each treatment. All the biennial composite results were analyzed by using the test of significance of means and their differences.

The best advisable treatment for hilly loess lands of the studied area is conjugate application of sub soiler across the slope at the end of dry season (September) and making the suitable well designed contour lines for increase the water harvesting and successfully control of run-off at beginning of rainy season (Treatment C). The second priority is making contour lines for harvesting the surface run-off and increase of soil water storage for next crops (Treatment D). If such cases which farmers are not able to do these suggested treatments (because of lack of knowledge, absence of instruments, high and irregular slopes and etc.) they should go for using sub soiler at the end of dry season, because some major parameters (grain and straw yield, soil moisture storage, etc.) will be significantly affected by this treatment (Table 1).

Table 1 Results of biennial composite analysis by t-test between different treatments (A, B, C, D)

Parameters	t Test in paired samples					
	A & B	A & C	A & D	B & C	B & D	C & D
Grain yield	**	**	**	**	**	**
Straw yield	**	**	**	**	**	N.S.
Harvest Index	*	**	N.S.	*	N.S.	**
No. Of spiklet /ear	N.S.	**	**	**	**	N.S.
Ear high	N.S.	*	**	*	**	N.S.
Plant high	N.S.	**	**	**	N.S.	N.S.
No. Of grain / ear	N.S.	**	**	**	**	N.S.
Moisture%(0cm—30cm)	*	**	**	**	**	N.S.
Moisture %(30cm—60cm)	*	**	**	**	**	**
Moisture %(60cm—90cm)	N.S.	**	**	**	**	**

** = Significant at 1 % level of significance

* = Significant at 5 % level of significance

N.S. = Not Significant

4 Conclusion

Application of very simple soil and water conservation management practices in hilly loess lands, will be affected significantly on saliently decreasing of soil erosion, increasing the soil moisture storage as well as soil productivity level and significantly increase of profitability of farmers (Table 2).

Table 2 Economic assessment of applying different treatments

Year of Experiment	Treatment	Yield (kg/ha)	Production charge (Rial*/ha)	Total Income (Rial/ha)**	Net Income (Rial/ha)***	Difference Income with control (Rial/ha)	Difference With control (%)
1998-1999	Control-A	3551.5	600,000	2,841,200	2,241,200	0.0	0.0
“	B	4013.5	675,000	3,210,800	2,535,800	294,600	13.15
“	C	5021	855,000	4,016,800	3,161,800	920,600	41.07
“	D	4597	780,000	3,677,600	2,897,600	656,400	29.29
1999-2000	Control-A	2165	600,000	1,732,000	1,132,000	0.0	0.0
“	B	2800	675,000	2,240,000	1,565,000	433,000	38.25
“	C	3522	855,000	2,817,600	1,962,600	830,600	73.37
“	D	2935	780,000	2,348,000	1,568,000	436,000	38.52
Mean	Control-A	2858	600,000	2,286,400	1,686,400	0.0	0.0
“	B	3407	675,000	2,725,600	2,050,600	364,200	21.61
“	C	4272	855,000	3,417,600	2,562,600	876,200	51.95
“	D	3766	780,000	3,012,800	2,232,800	546,400	32.4

*=Plowing, sub soiling, making of contour lines, etc. (8000 Rials=1US$)

** =Yield × Price of wheat (800 Rials/kg)

*** = Net Income = Total Income - Production charge

The effects of conservation program on profitability of farming was much more significant in second year which drought condition was occurred (Table 2). Hopefully with providence of all responsible governmental organizations and applying precision and serious programs, which are: preparation of watershed management master plans, conservation of critical areas, investments in the hill slopes and etc. on soil and water conservation, it will observed that the improvement of production and productivity level, rupturing of a importing the agricultural productions, decrease in environmental pollution and efflorescence of Iranian agriculture.

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