**Abstract:**

In Azerbaijan, 1.36 mln ha of irrigated land suffers from different level of soil salinization. Saline soils are observed mainly along the central regions of the country (Kura-Aras lowland). Here, 30-35% of areas are supplied with a very little amount of water and this leads to limited crop rotation and creation of monocultures. This fact has also led to decrease in soil organic matter content due to severe hot weather conditions and removal of plant residues completely after harvest for forage and fuel purposes. As a result of the studies carried out by AIM, it was revealed that application of conservation agriculture (CA) system in farms is an effective approach in terms of soil fertility improvement (management) and achievement of sustainable stable yield. The farming system through CA application is based upon reduction of soil tillage or zero tillage. The results obtained from the laboratory analyses indicate that the amount of humus (2.8310-2.6759=0.1551) under CA areas increased by 5.5% during 3 years. Water consumption reduced approximately by 20-30% and seed usage by 35-40% (in some crops by 50%), costs saved by 35-40%. Fuel consumption per ha decreased by 3.3 times (70%). Compared to ordinary row sowing, bed planting method increases productivity for 5-8 centner per ha depending on varieties.

**Key Terms:** fertility, conservation agriculture, erosion, productivity, bed planting, laser level

**Introduction:**

Recent reports show that in Azerbaijan, 1.36 mln ha of irrigated lands suffer from different level of soil salinization. Saline soils are observed mainly along the central regions of the country called Kura-Aras lowland. It should be also mentioned that more than half of the arable lands of the mentioned areas are irrigated. Due to frequently observed water shortage, 30-35% of areas are supplied with a very little amount of water and this leads to limited crop rotation and even creation of monocultures. Creation of monoculture practices caused decrease in soil organic content in its turn.

Global warming contributes to the on-going soil degradation, as well. During the previous 15 years, high temperatures occurred very frequently that this caused soil desertification and degradation as a result of decrease in rainfall and increase in evaporation. This deprived of many farmers from use of the significant part of cropping areas and backyard areas.

Previously the peasants used to cultivate their land areas with the simplest methods during the period with low level scientific-technical progress. Tools of the people who were engaged in agricultural activities were very primitive. Over time, people started to invent more advanced agricultural tools. During that period of time, tractors, combine harvesters, big ploughs and other mechanised tools invented. The revolutions happened in the realm of technology provided an opportunity to implement cultivation along larger areas.

As a result of agrarian refors in late 90s, land areas in our country have been privatized and presented to the full authorization of farmers. Though some farmer households have little amount of land plots (3-5 ha), they cultivate those areas with heavy (10 tons) agricultural machineries. And this fact causes soil compaction and degradation for long years. One of the more harmful factors is the fact of application of too much of deep plowing. There are such kind of soils that their arable layer is considered 20-25cm. It is not advisable to carry out 30-35 cm deep ploughing in those soils. Its reason lies under the fact that, as a result, the undernourished layer of soils which adversely affects plant growth, is turned and appeared
on the surface, and plants couldn’t grow and bear poor yields.

Although soil ploughing is an important agrotechnical measure, improper implementation of this action may sometimes cause severe complications. No tillage as one of the main principles of Conservation Agriculture can be one of the solution ways of the soil quality degradation.

**Conservation Agriculture for Sustainable Farm Development:** Recent reports show that in Azerbaijan, 1.36 mln ha of irrigated lands suffer from different level of soil salinization. Saline soils are observed mainly along the central regions of the country called Kura-Aras lowland. Soils of Agjabedi, Beylagan, Zardab regions, including Lachin Winter Ground of Agjabedi which are included into the main activity areas of Agro Information Centre have exposed to high level of salinization.

It should be also mentioned that more than half of the arable lands of the mentioned areas are irrigated. Due to frequently observed water shortage, 30-35% of areas are supplied with a very little amount of water and this leads to limited crop rotation and even creation of monocultures. Creation of monoculture practices caused decrease in soil organic content in its turn. Besides, this fact has also led to decrease in soil organic matter content due to severe hot weather conditions and also removal of plant residues completely after harvest for forage and fuel purposes.

Moreover, apart from the collector-dranaige network and non-functional irrigation services, improper use water and soil resources by the population also led to increased soil salinity and as a result, total soil degradation increased. Unequal areas caused due to the lack of the financial means, appropriate equipments and skilled workers leads to high production costs, decrease of efficiency of water irrigation and loss of yields.

For example, application of extra 1000 m³ water is required for the area changed between 10 cm from the highest point of microtopography to the lowest point so that the highest parts can be drenched on the same level. In order to compensate such changeable microtopography in the fields, farmers use a lot of water and as a result, the areas in lower part tend to stay under muddy water. To fight against increasing soil salinization, farmers implement washing of soils away from salt in the limited area, however, taking into account that non-operation or poor operation of collector-drainage network, it has very poor effect.

Global warming contributes to the on-going soil degradation, as well. During the previous 15 years, high temperatures occured very frequently that this caused soil desertification and degradation as a result of decrease in rainfall and increase in evaporation. This deprived of many farmers from use of the significant part of cropping areas and backyard areas.

People used to cultivate their land areas with the simplest methods during the period with low level scientific-technical progress. Tools of the people who engaged in agricultural activities were very primitive. Over time, people started to invent more advanced agricultural tools. During that period of time, tractors, combine harvesters, big ploughs and other mechanised tools invented. The revolutions happened in the realm of technology provided an opportunity to implement cultivation along larger areas. Big agricultural tools were started to be used in big farmer households.

Nowadays, land areas in our country have been privatized and presented to the full authorization of farmers. Though some farmer households have little amount of land plots, they cultivate those areas with heavy (10 tons) agricultural machineries. And this fact causes soil compaction and degradation for long years. One of the more harmful factors is the fact of application of too much of deep plowing. There are such kind of soils that their arable layer is considered 20-25cm. It is not advisable to carry out 30-35 cm deep ploughing in those soils. Its reason lies under the fact that, as a result, the undernourished layer of soils which adversely affects plant growth, is
turned and appeared on the surface, and plants couldn’t grow and bear poor yields.

**Which activities cause soil quality decrease?**

**Ploughing**: This process is one of the important components in the preparation of soil. Sometimes, farmers plough their very little land plots with heavy tractors combined ploughs. Due to ploughing through heavy machinery, soil gets so compacted that any plant planted in this area can not grow normally.

Disadvantage of deep ploughing: Here biological cycle is disturbed, apart from biodiversity, soil organic matter is also decreased. Mineralization gets accelerated, the soil remains uncovered. As a result of all those factors, wind and water erosion is occurred, and these facts leads to decrease of soil nutrients through wind or water.

What is observed during soil compaction? Soil aeration takes place poorly in the cropping layer of compacted soil. Performance of microorganisms which increase soil fertility significantly decreases as a result. Water conducting ability of soil weakens. During the disturbance of aeration and humidity regime, mineralization of organic matters get worsened.

It gets clear from all those opinions that though soil ploughing is an important agrotechnical measure, improper implementation of this action may sometimes cause severe complications. What about no-till cropping, is it possible in this situation? Based on the results achieved so far, we can say that yes, it’s possible. No tillage is characterized as Conservation Agriculture (CA) in the world.

CA is not only a technical method, but a kind of approach. CA is also called no-till or direct sowing. The cropping system aiming environmental protection through CA is based on the reduction of soil tillage or zero-tillage. With this new technology, crop residues retained on the surface after harvesting, are cut and mixed with soil during cropping. As a result, soil surface is covered with small plant residues and this plays the role of mulching. During this process, not only the improvement of soil fertility, but also the decrease of greenhouse gas (water steam, carbon dioxide, methane) emissions to the atmosphere and soil carbon sequestration (C) are observed. At the same time, those activities should be carried out through application of crop rotation. Thus, CA is an innovation system that not consists of just one part. The objective is to replace the traditional plant growing practices with the use of the relevant CA machineries and appropriate crop rotation system. Less labour consumption, less fuel, machinery costs, constant yield, sustainable increase of soil fertility, decrease of washing of soil nutrients, avoidance from wind erosion, decrease of climate change impacts, reduction in the amount of carbon emissions, protection of biodiversity and application of crop rotation method are the advantages of conservation agriculture.

**Economic factors during conversion to CA**: At the beginning, machinery use increases, herbicide costs get higher, more time is needed for increase of soil fertility and decrease of weeds, the ratio of diseases gets changed.

**The integration of CA with biological agriculture**: Integrated management of biological resources, minimizing the soil cultivation with machineries, efficient use of pesticides and fertilizers, efficient crop rotation, integration of biodiversity, animal-husbandry and cropping, plant nutrition through biological methods and biological protection of pests should be ensured through integrated system of fight.

Retention of crop residues on soil surface. In the area under CA application, crop residues are retained on the surface after harvesting. The crop residues retained on the soil surface are cut through a special crop residue chopper machinery during or after the harvesting.

**Application of no-tillage**: Site selection. Taking into account of the field relief, its low productivity, inclination to salinization, exposure to various kinds of erosions, different obstacles faced during irrigation, land areas with water problem, etc., firstly the area for no-tillage should be selected. The first step is to plough the field so that leveling can be
applied. After the ploughing process, surface leveling should be carried out along the field. In case that no-till cropping is started with sowing of winter cereal grains, the sowing will be carried out directly by the bed-planter machine. But, in case that this process is implemented in spring, firstly beds will be made through bed-planting machine, then the seeds of spring crops will be sown into those beds with pneumatic sowing machine.

Laser-leveling of the field. During the conversion into no-till cultivation, it’s important to carefully level the land plot at the beginning.

Laser level carries out the site leveling work more accurately and ensures the soil to remain level for 4-5 years. And, this in turn, prevents extra water loss and washing away of soil nutrient and provides significant profit. At this time, soil erosion and other adverse factors reduces.

Importance of laser level in conservation agriculture. Less water waste is observed in the area under laser level, but also the water distribution along the field is very easy and efficient.

Practices has shown that in the fields leveled with laser level method, seed germination and growth occur at the same level, water is distributed equally on the soil surface during the irrigation, soil is not eroded and the seed is not carried from one part of the field to another by water. As a result, the crop density becomes normal in the field. This, in turn, means higher productivity. It is possible to level the field with laser level through defining zero or slopeness degree to the field.

Zero degree. In this case, field length should be taken into account. The best indicator during zero-degree leveling of the field is the implementation of surface leveling activities in zero degree slopeness land areas with slopeness as much as the planting layer. The field length shouldn’t exceed 100-150 m. In case of 0.30 cm slopeness in the field, we divide it into two parts and can level that area in 0° slope while carrying 0.15 cm from one part to other one.

Slope degree leveling of the field is carried out taking into account the field relief. While mapping the area, its degree of slopeness is defined. This is carried out by a laser level. Taking into consideration the slopeness degree during the leveling of the field, the area can be leveled through applying various slopeness degrees.

Secondary ploughing or leveling of the field. While laser leveling of the area for no-till, soil top layer gets compacted to some extent due to the over use of the tractor or the fact that the surface becomes pointed. At this time, the field is needed to be leveled through gear-level or re-leveling should be done. This case is mainly observed during the zero degree leveling of the field. For that reason, after the laser-leveling of such fields, it’s possible to start the next sowing or preparation of beds while carrying out the field ploughing and leveling.

Bed planting of winter crops. After the area to be applied under no-till is ready for sowing, seeds of winter cereal grains are sown on the field.

In the bed planting method, seed sowing machine, in its one move, makes both beds for seeds and also carries out sowing in 3 or 4 rows with 10-12cm distance between them. Seeds of the winter cereal grains are recommended to be planted into 4-5 cm depth in the soils with light mechanical composition and 3-4 cm depth in soils with medium and heavy structure.

Preparation of beds for sowing of spring crops. Unlike the autumn sowing, in order to carry out no-till planting of spring-sown crops, firstly the area is leveled through a laser level or heavy gear-level, then beds are prepared for carrying out this sowing process.

Bed planting. The advatages of the bed planting method are the following:

- Sowing norm is reduced by 30-40%
- Irrigation water is saved and labour consumption of water user is decreased
- Number of productive stems increases thanks to strong shrubing in crops
- Weight of seeds increases, productivity and quality improved
- Irrigation is carried out between beds.

Optimum sowing norm of autumn wheat in the bed planting method was carried out by 130-160 kg per ha and higher productivity was achieved.

Transition to no-tillage cropping: Application of rotation cropping in CA. The following crop rotation can be applied in no-till fields based on the soil-climate conditions: Wheat - Wheat - Maze - Wheat - Barley - Alfalfa. Rotation of the crops of various botanical families should be implemented based on essential principles of cropotation.

Ratio of legume should prevail in crop rotation, because: they concentrate nitrogen and humus in the soil, contribute to soil structure improvement, and handle function of soil microorganisms. Ratio of root crops should be minimized, because: they digest humus intensively, accommodate development of diseases and pests (e.g., potato cyst nematode), require hard work.

“Intermediate” crops should be included into crop rotation, because: they are additional source of nutrition, enrich the soil with nitrogen, generate additional root mass, act as live mulch, reserve technical preparation of the soil, prevent “wash away” of the nutrition from the soil.

Agro Information Center – the pioneer in promotion & application of conservation agriculture in Azerbaijan:

AIM has been implementing about 40 long-term projects on rural development via extension, information and support services. The project “Improving the adaptive and mitigating potential of the rural population via sustainable farming systems” implemented within 2010-2012 was the first large scale project on agro-ecological field. “Conservation agriculture” program was also implemented within the project. The major objective of the project was that the farmers integrate CA technologies in their farming practices. Over 1500 farmers in Aghjabedi, Beylagan and Zerdab districts have acquired theoretical-practical knowledge and experience in CA. CA experiments are being applied in 880 thousand m² of low fertile plots in 91 farms covering 18 communities, inclusive of 29 farmers doing winter grain crops in 2010, 42 farmers doing technical and legume (maze, sunflower, sorgo and beans) in summer season of 2011, and 20 farmers doing grains as winter crops. Other interested farmers applied to join the project at further phases.

A survey was carried out with farmers regarding advantages of CA and the reasons for their interest were learnt. The farmers mentioned the essential advantages of the CA as bed planting method, efficiency of irrigation water and labor consumption, use of intermediate crops, as well as seeds, technique in the crop rotation, minimizing of fuel costs besides fertility of the soils. The aforementioned advantages were observed in the fields during the past period. Let’s present some of them in detail:

The results of the lab analyses show that, the humus content of the soil over 3 years increased by (2.8310-2.6759= 0.1551) 5.5% in the CA fields. The impacts of leaving crop residues on the mentioned fields were initially observed via visual observations. It was revealed that the crop residues start to gradually decompose and this also leads to increase of small living beings in the soil (especially useful earthworms) and improvement of their function. Water consumption decreased approximately by 20-30%, seed use by 35-40% (50% in some crops), costs went down by 35-40%. Fuel consumption lowered by 3.3 times (70%) per hectare.

Regarding the impact of CA on environment, it was accounted that the volume of CO₂ left on the field of 41 ha of land was 421 tons and 306 kg (this figure is expected to increase). Besides direct impact of fuel consumption on cost saving, less entry of heavy agricultural machinery into the plots leads to smaller compaction of the soil and also labor was saved. However the biggest impact on environment was the reduced emission of toxic gases into atmosphere from less use of the...
machinery. Thus, the initial calculations showed that the average amount of fuel consumption in CA reduced by 71.2% per hectare during the term compared to conventional fields. So, amount of CO₂ emission to atmosphere per 100 ha of plot reduced by 14.874 tons. Of course, besides all these advantages the farmers are more interested in economic revenues. the farmers are aware of higher efficiency of the CA after 3-5 (as the soil fertility grows) years of its application. Besides, the results of reduced costs for two years show increase of revenues from CA field compared to conventional fields:

Growth of average income per 1 ha of crops:

- Wheat – 30.8%
- Maze – 40.8%
- Sunflower – 25.3%
- Beans – 20%
- Sorgo – 73%
- Winter bean – 21.6%

These crops were cultivated via no-till and bed planting method which is characteristic to the transition period to CA. Especially, the income from no-till plot was significantly different from the income from others. Thus, the income from bean product cropped this way was 4.6 times (78%) higher. As it is apparent, the conservation agriculture contributes to growth of farmer revenues besides improvement of the soils.

Therefore, we can say that CA is a favorable system for continuous development of farms under the conditions of changing climate.

Conclusions:

Three years ago, low fertile, in some places even soils that inclined to salinization were selected for the application of conservation agriculture in the central region of Azerbaijan. The results obtained from the laboratory analyses indicate that the amount of humus (2.8310-2.6759=0.1551) under CA areas increased by 5.5% during 3 years. Moreover, farmer income was increased by a few times thanks to both of the reduction of production costs and increased productivity. Water consumption reduced approximately by 20-30% and seed usage by 35-40% (in some crops by 50%), costs saved by 35-40%. Fuel consumption decreased by 3.3 times (70%) per ha.

With regard to the positive impact of CA on the environment, apart from the fact that reduction of costs directly affects decreased fuel consumption, soil compaction by the impact of machinery was less and labour force saved due to very little use of heavy machinery in the field. However, the greatest environmental impact observed on this regard, is the reduction of harmful gas emissions to the atmosphere thanks to less use of machineries. Thus, according to the primary calculations, in CA, average amount of fuel used for 1 ha wheat field during the season was decreased by 71.2% compared to the traditional growing. Due to just less use of machinery, the amount of carbon dioxide (CO₂) released to the atmosphere was 14.874 tons per 100 ha. Bed planting method provides better results within CA. In comparison with the ordinary sowing, grain productivity in the sowing applied just with this method increases between 5-8 s/ha depending upon varieties.

Farmers are also recommended to grow field protecting forest strips around the field under CA application. Field protective forest stripes contribute to improvement of microclimate in the field and consequently crop productivity increases. Therefore, it is important for every farmer to set planned forest stripes of locally adaptable, fast growing and disease-pest resistant trees and bushes around their private farmlands.

References

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