# Effects of Weather Changes in Agriculture of Mongolia

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**Abstract**

*The weather change consequences have began to effect seriously onto industry of agriculture. The appropriate humidity demanded for every stage of growth of corn and vegetable is different. Proper use of changeable technology in agriculture more suited to the climate conditions of the passing year and term of growing allows high amount of grain and vegetable. The changeable technology means an appropriate use of the most suitable versions of agro technology based on the weather anomaly.*

*In the recent years, particularly in 2008-2010, the weather condition did not repeated in the same time during the growth periods of plants. In other words, the most suitable periods with enough moisture and temperature were occurred in the middle and end, or in the beginning and end of growth. In this situation the use of changeable technology worked out by the researchers gave its good results.*

**Key words**

*Extreme warming up, grain, elements of agrotechnics, changeable technology of agriculture*

## Introduction

Before 1970's the understanding of climatic change attracted no special attentions of the pubic. Few scientists were publishing sometimes the results of their work in this area. Conference on nature and environment organized by UN in 1972, international conference on effects of carbon dioxide and other greenhouse gases on climate, held in Austria in 1985, and work of intergovernmental experts team responsible for researching climatic changes, founded in 1988 resulted in becoming it central of the attentions of every nations. At present it has been an urgent issue in not only scientific area, but also in international cooperation.

Although a natural transformation, called climatic change started slowly in Mongolia, which is situated in center of Asia, the largest main land in the world from the end of the past century, tendency of intensification year by year has been observed nowadays. Such intensification is being demonstrated first of all with temperature changes, and distribution, spatial density and rate of precipitation. According to the conclusion of intergovernmental expert team, which consists of leading scientists in various scientific fields, it is probable that

effects of climatic changes will be greater in agriculture, particularly crop sector of Mongolia, which is situated in the bordering areas between subtropical desert and Siberian taiga [3].

**Effect of climate on growth of grain crops**

For only more than 40 years between 1960 and 2003, annual average air temperature in central regions of crop production increased by $1.05^0$C, number of days with more than $30^0$C air temperature reached 7-10 days, as well as period without cold increased by 9-11 days or lasts 109 days in total [4].

Annual total precipitation remains almost unchanged, but precipitation increases during cold season, decreasing from May till cold season. Also rain occurs mostly in the form of heavy shower in stripe areas and such rain water is not absorbed into soil and cause flooding, which results in increased soil erosion. As a consequence crops and pasture plants lack moisture and adverse effects on plant production significantly prevail. Due to effect of overheating (above $30^0$C) pasture plants loss their growth capacity within 5-7 days, while growth of grain crops stops after 7-10 days. Simultaneously the growth fastens and completes during early August, and therefore crop yield is lost. Besides of seed shooting of grain crops such as wheat, barley and oat, 3-5 roots arise and start to penetrate soil. They are called embryonic root or radicle. Radicles are directly vertical in soil and responsible for supplying crop head with nutrients. After emerging seed shoots, at the period of increasing number of leaves to 3 or 4 or after approximately 10-14 days 8-12 tiller roots appear on underground part of the stem or embryionic roots depending on the level of soil moisture. Tiller roots supply leaves on the branch stem and head of the plant with nutrients, and mostly lie not deeply in the soil, but near the surface spreading laterally.

In case of sufficient moisture in the soil, 3-5 kernels in each heads of main stem, 2-3 kernels in heads of lateral stems and yield per unit of area exceeds 26 centner per ha. In other words it means that wheat growth and development takes place normally and potential of the crop variety is fully utilized. If soil lacks moisture, especially in the stages of tillering and stem elongation, lateral stem branches do not appear, number of kernels in each head of main stem decreases sharply, and finally it leads to drop of crop production. According to our study, due to above reason tillering of wheat did not occur, smaller and less number of kernels developed in the head of main stem, development fastened and ripening occurred during early August in 2000, 2001 and 2002, when drought occurred during the first half of crop growth period.

In agronomical science drought is classified into spring, summer and autumn, the latter is related to only winter crops, and therefore it is unnecessary to describe here. Because spring drought is characterized with arid, cold and windy contiditions, it is peculiar that the period from seeding to shooting prolongs and tillering and root firmness weakens. In such condition number of kernels and heads at the top drops and crop production reduces. If soil moisture is sufficient, its consequences are significantly decreased. Although spring drought occurs annually at various level in all crop producing regions, its effect on crop production varies with soil moisture amounts. There is an formerly effective measure for minimizing impacts of spring drought via adjustment of agrotechnical elements, including planting period, seed norm and seeding depth, and the varities in accordance with soil moisture of the period and warm season patterns during late 1980's in some farms of Selenge aimag, and it is still successfully being used by several companies. This convertible technology, the simplest method for adaptation to warming in our country's condition is practicable for any crop farms. Conclusively, a technology for producing certain amount of crops in case of spring drought has been developed.

Summer drought is peculiar with its relatively lower humidity, extreme heat and greater evaporation, and its harms are enormous. Under the impacts of summer drought plant growth ceases or crops dry up. Depending on drought intensity heads, which emerge during tillering, have no kernels or their bases or tips are empty. This phenomenon is called formation of empty heads. Despite empty heads did not occur in above years, heads in the center of top had smaller size and fewer number kernels. Because summer drought occurs when grain crop growth shifts into its middle  period, the possibility of changing plantation period and seed norm depth in other words there is no other ways than lamently seeing dried up crops. However, it is time to solve this problem by our crop farmers, who are responsible for producing foods for all nations, especially crop research institutes and scientists. Although there is a saying that pre-paved ways are impossible for science, it is clear whole society does not exist without foods.

Table 1. Crop production in the central crop regions (center per ha)

| Aimags gelonging to central crop producing region | Years | | |
|---|---|---|---|
| | 2000 | 2001 | 2002 |
| Darkhan-Uul | 5.5 | 6.7 | 2.7 |
| Selenge | 5.9 | 6.1 | 3.6 |
| Òuv | 2.9 | 6.3 | Ç.5 |

Scientists (M.K.Sulemeinov, 1980, A.N.Konovalov, 1984, and others) proved that stems with heads per unit of field account for 50% of total values of wheat production, number of kernels per head for 25%, and weight of 1000 kernels for the remaining part. But, all these 3 parameters, which reveal crop production, dropped in above years. For instance, number of stems with 1 $m^2$ heads decreased to 70-100, number of kernels per head to 6-8 and weight of 1000 kernels to 28-30 g. A tendency of increasing days with temperatures above $30^0$Ñ in July due to global worming impact demonstrates how much the loss to face is.

According to prognosis of international center for study of climatic change, precipitation amount in steppe regions of central Asia and northern America tends to increase by 2-5%, but evaporation increases due to temperature elevation and adverse impacts prevail. In larger scientific centers in highly developed countries, current situations and future tendency of climate is evaluated by using mathematical models expressing interactions of elements of global climatic system. Using these models, our scientists determined climatic patterns in 2010-2039, 2040-2069, and 2070-2099. As compared to those in 1990's summer temperature will increase sharply, while precipitation will not almost change in 2020 (2.0-2.3$^0$C), but also it is probable to decrease according to evaluations by some models [3].

Although annual average air temperature has slight fluctuations year by year in central crop producing regions in our country for the last 60 years, in general term it has been continuously increasing as shown in figure [4].

**Differences of climatic conditions during crop growth period**

As the examples, results of meteorological surveys conducted in Nart teaching and research center at MSUA are mentioned. Air temperature changes by 1.0$^0$C in 2008 and 0.8$^0$C in 2009 are warmer by 0.2-0.4$^0$C than multi-year average in Bornuur and 0.7-0.9$^0$C than Baruunkharaa. Average temperature 15.0-15.4$^0$C during crop growth period or from May through September is around multi-year average. Air temperatures in warm season of years from 2008 to 2010 reveal they were variable in spring, while they were relatively similar in summer and autumn.

Comparison of air temperatures in each month revealed start period of crop growth or April and May in 2008 were relatively cooler, these months were relatively warmer and June, July and September were cooler in 2009, and April and May, 2010 were cooler. With precipitations, humidity differs with these years.

Climadiagram shows third decade of June and first decade of July were humid, while precipitation lacked in remaining periods (figure 2).

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Significantly intensifying occurrence of sudden cold in both ground and air during late spring and early autumn has provided unfavorable conditions for crops.

Table 2. Duration of sudden cold exposures

| Year | Late spring | | | Early autumn | | | Periods without cold /days/ |
|---|---|---|---|---|---|---|---|
| | Date | Intensity ($^0$C) | | Date | Intensity ($^0$C) | | |
| | | Air | Ground | | Air | Ground | |
| 2008 | 29 May | -4.3 | -4.5 | 22 Sept. | -6.8 | -6.8 | 115 |
| 2009 | 28 May | -4.5 | -4.5 | 5 Sept. | -4.3 | -5.3 | 99 |
| 2010 | 10 May | -2.3 | -3.1 | 16 Sept. | -0.3 | -1.3 | 128 |

Days without cold for 3 consecutive years were 99-128 or differences by 16-29 days reveal climatic conditions are very unstable. It is also an evidence that following of the same technology in all crop production practices is impossible.

**Adaptation of crop production to climatic change**

From all above, it is clear that further climatic conditions will be unfavorable for crop production, but stable crop production after 2008, reached the level sufficient for domestic consumption leads to a thought how will be if we consider the issue from different point of view. According to oriental astrology, climatic conditions occur in periods such as 10-12 years' or short term, 20-24 years' or middle term and 60 years' or long term cycle.

Conclusion of Mongolian scientist Sh.Gungaadorj (2009) based on grain crop production in the last 50 years in our country that an explosion (significant change) occurs in every decade can be seen to be consistent with short term cycle in oriental astrology. Therefore, it reveals probably that grain crop production will not drop further, instead it will rnage within certain limits. According to oriental astrology any periodic cycles are categorized into; humid and dry, and humid cycle has favorable summer condition.

Because every nation gives attentions to minimize greenhouse gas, gathered in athmosphere due to adverse impacts of human actions, it is undoubtful positive outcomes will appear in the future. In such case, natural processes will take place in accordance with their principles and it is possible to increase importance of oriental astrology. The earlier

predictions of weather forecasts by people will advance activities tended to increase their own profits or minimize any hazards via making arrangements. We are hopeful you will understand that such our thoughts are not intended to deny work of our meteorologists, but only our little contribution to vitally important issues for minimizing, if possible, terminating climatic changes via our attempts to renormalize natural principles, which have been disturbed by human action.

Besides of talking about aridification and desertification to northern regions, there are also a number of accomplishments, and improvement of crop production technologies, minimal and zero tillage methods, development of new varieties, selection of proper irrigation technology, increase of irrigated fields and afforestation as a result of research by agricultural institutes, stations and branches could not reach the necessary level, but their fundamentals are now being paved. They are as follows:

1. The technology for protection of soil from erosion and striped planting method, which were introduced into production since mid 1970's, have several important advantages. Such measure not only protects soil, but also results in increase of accumulation of moisture and organic matters in the soil; minimize the threats of drough and protection of grain crops from overheating.

2. It is characteristic with that "convertible crop production technology", which is used in spring planting in association with seasonal climatic conditions, ensures full utilization of precipitation and heat reserves during plant growth period. Adjustment of plantation period, seed norm, seeding depth, and varieties of grain crop, and fertilizer types and dosage to climatic conditions can minimize change sof crop productions.

3. As a result of gradual and slight increase of irrigated crop fields it reached 31000 ha by 2009. This is a selected method, producing significant outcomes for shorter period for combating aridification. However it consumes greater costs for construction, and therefore increases of fields area is slower. Production practices show maximal crop production in irrigated conditions in both warmer gobi and steppe regions is 45-50 centner per ha and in central region 20-26 centner per ha.

4. Wheat of a new variety Darkhan -144, developed in teaching and research institute of crop sciences has 16 centner/ha yield in dry years, while wheat of Darkhan -74 variety gives 27.9-34.0 centner per ha products (S.Tserendolgor, 2009). However, it is wise to make clear that above is not maximal potential level for these varieties.

5. Results of studies, conducted worldwide revealed already that afforestation is selected method, which protects both soil and plants from heating, as well as it increases relative

atmospheric humidity and minimizes adverse effects of drought. A country, who has found importance of forest belt from all sides, and is now using it in practice, is our southern neighbor China. There forest is broadly being used for freshening water, cleaning air an dequlibrating ecology. Although afforested areas reached 2000 ha during 1980's in our country, majority of them were destroyed during social transition period and there are 12000 h areas located within natural forest. Most of them were and may be now in the territories of Khuder, Altanbulag and Zelter soums of Selenge aimag, and Erdenbulgan and Tarialan soums of Khuvsgul aimag.

**Conclusions**

1. Thorough study of both beneficial and weak issues to be resulted form climatic changes and implementation of them in further ractions should be main solution for developing crop production.
2. Optimal use of convertible technology based on climatic prognoisis of coming year will allow greater crop production.
3. It has been necessary to pay special attentions on afforestation and establishment of forest belts, and implement promptly the action of establishing green belt, propounded by President of Mongolia Ts.Elbegdorj.

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