The Role of RS and GIS for Agriculture in Mongolia

G.Sarantuya
Research Institute of Animal Husbandry,
Zaisan-53, Ulaanbaatar-210153, Mongolia
g_sarantuya@yahoo.com

D.Amarsaikhan
Institute of Informatics and RS, Mongolian Academy of Sciences,
av.Enkhtaivan-54B, Ulaanbaatar-51, Mongolia
amar64@arvis.ac.mn

D.Uuganbayar
Mongolian State University of Agriculture,
Zaisan-53, Ulaanbaatar-210153, Mongolia
uuganbayard@yahoo.com

Abstract: At present, RS and GIS techniques are being widely used for monitoring and management of different agricultural resources. Basically, Mongolia is an agricultural country and the agriculture is considered to be the backbone of the country's economy. Agricultural sector in Mongolia includes about 45% of the total labor force and produces about 20% of the country's gross domestic product (GDP). Mongolian agriculture is divided into two main sub-sectors: livestock and crops. The livestock sector occupies about 81% and the crops constitute about 19%. The livestock sector is based on nomadic pastoral husbandry with its tradition of herding five kinds of livestock species such as sheep, goat, cattle, horse and camel. The main crops which are prominent in Mongolia's agricultural production are wheat, barley, potato, oat, vegetables and fodder crops. As Mongolia has a very large area in comparison with its over 2 million inhabitants, the country has a great potential to use a wide range of RS and GIS techniques. This paper describes a general overview and some methodologies to use RS and GIS techniques for improvement of the present agriculture in Mongolia.
Keywords: Mongolian Agriculture, Livestock, Crops, RS and GIS.

1. Introduction

Agricultural sector in Mongolia includes about 45% of the total labor force and produces about 20% of the country's GDP. Generally, Mongolian agriculture is divided into two main sub-sectors: livestock and crops. The livestock sector occupies about 81% and the crops constitute about 19% [6]. The main productions produced in the livestock sector are the meat, milk, wool, cashmere, leather, skin and hide and every year in the country a large amount of these products are processed. The present agricultural exports mostly consist of raw materials of different animal origins. The main agricultural crops used for crops sector are the wheat, barley, potato, oat and vegetables. In general, the agriculture in Mongolia provides the food and fodder and it also provides raw materials for such major industries as textile, cashmere, wool, skin, hide, meat and some other industries, which in total account for about 31% of the overall value of the industrial production.

In recent years, due to rapid development in space, communication and information technologies, RS and GIS techniques and technologies have been greatly improved. As Mongolia has a very large area in comparison with its over 2 million inhabitants, the country has a great potential to use a wide range of different RS and GIS techniques. This paper describes a general overview of Mongolian agriculture and some methodologies to use RS and GIS techniques for improvement of the present agriculture in Mongolia.

2. RS and GIS for Agriculture in Mongolia

Livestock sector

Mongolia's livestock production plays an important role in the national economy. For example, in 2003 the animal husbandry of Mongolia was responsible for 86.6% of the national agricultural production in Mongolia. Nowadays, the livestock production contributes about 33% to the total export earnings of the country and it has reached a high standard, supplying meat and meat products for both domestic and foreign markets. Mongolian animal husbandry is very much dependant on the pasture quality as well as weather conditions. In Mongolia, the pastoral nomadic production system is still very common. There are about 117 million ha of pasturelands distributed throughout the country and the most productive pasturelands are stretched from the northwestern region through the central part of the country and north of the Khangai range [2]. Of the land capable of supporting agricultural

activities, 68% is used as rangeland for livestock production (27% is utilized as grazing land, 1.6% is used for hay production, and 1% is used as cropland, including fallow for soil fertility recharge). However, in recent years the Mongolian pasture has been seriously deteriorated and there have been different natural and socio-economic reasons on this. The severe droughts for the last few years and the growing number of livestock have been the main factors for the increasing pasture degradation in many parts of the country.

Over the years, RS methods have been widely used for monitoring and management of pasture resources. In years past, in Mongolia NOAA AVHRR data sets have been extensively used for monitoring of pasture as well as other environmental resources at a national scale. For example, NDVI and biomass estimation using NOAA AVHRR data have been successfully carried out for many years. However, monitoring at a regional scale lacks a detailed study and this gap can be fulfilled by the usage of high resolution satellite data sets such as Landsat TM, Landsat ETM+ and SPOT. When the high resolution satellite data are used for the thematic information extraction (including a land cover map and NDVI), the results can easily be integrated with other thematic information of a regional scale stored within a GIS and can be more reliably used for further spatial decision-making than the data sets of a national scale [1]. Nevertheless, data sets from both national and regional scales integrated with other thematic and statistical information could be efficiently used for different purposes and improve environmental as well as socio-economic decision-making processes.

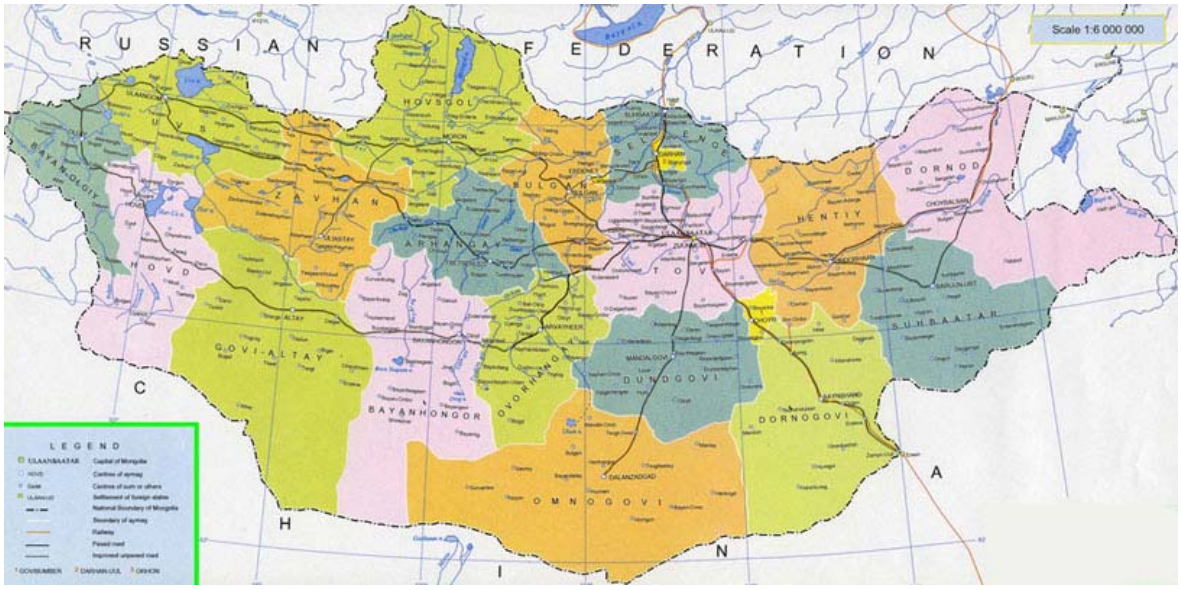

Fig. 1. The administrative map of Mongolia.

The crops sector

Mongolia has a very large area in comparison with its population but the area for agriculture is limited. The agricultural land of the country covers 1,301,700 hectares. The lands in Selenge and Tuv aimags located in central and northern regions account for more than 50% of the total cropped area of the country. The administrative map of Mongolia is shown in Fig.1. In Mongolia, the most prominent agricultural crops used are wheat, barley, potato, oat, vegetables and fodder crops. The crop sector contributes about 13.4% to the total agricultural output of the country. Generally, crop yields in Mongolia are very low compared to the international standards. There are many reasons for this, but the main reasons for the decline in the productivity of agricultural productions are the inefficient use of fallow land, inadequate production technologies, lack of economic incentives, inadequacy of input supplies and limited availability of short-term loans. Moreover, one of the most striking problems of the crop sector is that it needs to rise the crops under the harsh climatic condition and there is a need for crop protection. Any changes in agricultural productivity may bring a significant change in the whole production system. Nevertheless, there are good possibilities to expand the cultivated areas and improve the yield per unit area for various crops [3-6].

Based on our research and observation, we have found that the factors that contribute to the increase of crop yields are the development of high yielding crop varieties, improvement of tillage practices, improved irrigation techniques, better seed rate and modern mechanization of the agricultural sector. In addition, to use the full potential of crop production, the above mentioned constraints have to be seriously addressed and further research activities

using RS and GIS should be intensified. For example, high resolution (ie, Landsat ETM+ and SPOT) and very high resolution (ie, IKONOS and Quickbird) satellite data sets acquired in visible and near infrared range of the electro-magnetic spectrum integrated with other ancillary and attribute information stored within a GIS can be successfully used for checking of the maturity of different vegetation as well as monitoring and management of other crops.

Constrains of Mongolian Agriculture

The main constrains of the Mongolia's agricultural production are the short growing seasons, low precipitation and high evapotranspiration. The continental climate is characterized by sharply defined seasons, high annual diurnal temperature fluctuations, and low rainfall. Soil erosion is also another constraining factor for the Mongolian agriculture. Wind and water are the main sources of the soil erosion. Wind erosion results in the loss of the upper productive soil. It has been particularly damaging in rain fed areas and depleted the natural vegetation. The excessive tillage has also caused a problem. Fragile soils influenced by strong winds during the early growing season result in serious wind erosion. Crop production depends on the conservation of soil fertility and soil moisture in arid or semi-arid conditions [7,8]. To overcome these constrains, different thematic information of varying scales should be integrated within a GIS and different spatial analysis as well as land evaluation should be conducted.

3. Future Scenario of Mongolian Agriculture

At present, medium and small-scale enterprises in agriculture production, marketing and food processing are emerging and they are operating successfully. The former idea that sloganed as "the country has an eternal vast and growing steppe, suitable for an ever increasing agricultural production" is now being replaced by a new political, economic and social concept which recognizes, that livestock and crop productions have to be intensified in those fertile areas, suitable for the production. However, as the country has a limited market, a few of the privatized large-scale crop enterprises may work successfully. Current developments and the demands of the market dictate integration of intensified livestock and crop production near regional centers. Meanwhile, the food and agriculture policy and regional development concept of the Government encourage the breeding high productivity animals, rational use of the pasture resources and planting more vegetables. In addition, it is important to use advanced RS and GIS techniques for monitoring and management in both livestock and crop sectors. For the future improvement of the Mongolian agriculture the following main points may be considered:

- To increase research activities to develop the high productivity animals, specifically, cattle and goats.
- To rationally use pasture resources and follow the traditional system of grazing rotation between four seasons.
- To increase research activities to develop new resistant varieties of different crops and improve quality of crops,
- To adopt sophisticated new technologies, including bio-technology for raising productivity per unit land.
- To reorganize the wheat industry, for example, the wheat seed industry which is the top priority for the breeding of new varieties and maintenance of existing varieties should be done by the State Seed Stations, while the seed multiplication should be done by the private seed companies.
- To increase land utilization and reduce fallow areas as well as to maintain soil fertility and protect it from erosion, wider variety of alternative species including annual and perennial leguminous crop, food and fodder crops and industrial crops should be introduced.
- To create favorable conditions for supplying the urban population's demand for the meat products that can conform the veterinary and sanitary requirements.
- To create the specialized meat markets with refrigerators that can supply continuous cool chain, thus increasing the service from manufacturers to consumers.
- To encourage the foreign investments to the Mongolian agricultural sectors: both livestock and crops.
- To apply advanced RS and GIS techniques for monitoring and management in Mongolian agriculture.

4. Conclusions

The overall idea of this paper was to describe the present condition of Mongolian agriculture, the main constrains of agricultural production in Mongolia and the future scenario of Mongolian agriculture and highlight the potential to use RS and GIS techniques in Mongolian agriculture. It is seen that to improve the current conditions in livestock sector research activities to develop the high productivity animals as well as rational use of pasture should be increased, whereas for the improvement of the current conditions in crops sector such main points as improved research activities to develop new resistant varieties of different crops, usage of sophisticated new technologies for raising productivity per unit land, reorganization of the wheat industry, maintenance of soil fertility and its protection from erosion and further application of the advanced RS and GIS techniques and technologies to the Mongolian agricultural sectors should be taken into account.

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