DOI: https://doi.org/10.5564/mjas.v27i02.1284

Some results of evaluating the level of sustainable development of agricultural production in Mongolia

Solongo Kh[1]., Guo Xiao Chuan[1], Batkhishig I.[2*]

1-School of Economy and Management, University of Inner Mongolia, Hohhot, Inner Mongolia, China
2-School of Agroecology and Business, Mongolian University of Life Sciences, Darkhan, Mongolia

*Corresponding author: batkhishig@sab.edu.mn

ABSTRACT

In this research work, we evaluated the level of the sustainable agricultural development of Mongolia by a criteria consisting of 3 sub-systems and 14 indicators with a multi-index comprehensive evaluation method by using the data of 2005-2017. According to the research, the sustainable agricultural development level has reached 55.53%, where the economic sub-system has the highest impact and the social sub-system has the lowest impact but the development tendency of the environmental sub-system is at the same level as the general level and the level of sustainable agricultural development strongly depends on the environmental and climatic conditions.

KEYWORD: Economy, society, environment, evaluation, multi-indicator general evaluation method, level of sustainable development

INTRODUCTION

Sustainable agricultural development is a form of agricultural development, which is oriented on supplying the current and future generation with enough and accessible agricultural products through conservation the natural resources and introducing effective agricultural production technology, and which rationally uses and protects the land, water, animal and plant resources, does not deteriorate the environment, technologically effective, economically beneficial and commonly accepted in the society [1]. Recently, the agricultural production of Mongolia has been making progresses, however, the size of planted field has increased by 48.3% and 72.0% of total agricultural field has been over cropped [2] for the last 20 years as well domestic demand of some agricultural products depends on imports (as of 2017, 52% of the demand calculated by total agricultural products was supplied by domestic production) due to such factors as climate changes, irrational crop cultivation technology, soil fertility degradation and many others, which shows that we are at risk of leaving no agricultural production resources to the next generation as well risk of inability to supply the demands of current population. Therefore, by evaluating the level of current agricultural sustainable development and by determining the actual problems we can identify how to provide the sustainable agricultural development.

METHODS

Many countries of the world are using the multi-index comprehensive evaluation method, data envelope analysis, outcomes of agricultural scientific technology and comparative methods in evaluating the agricultural sustainable development. Among these methods, the multi-index comprehensive evaluation method has several advantages as relatively standardized calculation process, accurate

results, easy application and systematized, therefore, we have chosen this method for evaluating the sustainable agricultural development of Mongolia.

In the framework of economic, environmental and social sub-systems – the three main components of the sustainable development – we selected 6 economic sub-system indicators such as unit weight of agricultural products to the GDP, total investment to the agricultural sector and labor productivity of agricultural sector; 4 social sub-system indicators such as unit weight of the workers engaged in the agricultural sector and level of labor earnings; and 7 environmental sub-system indicators such as cultivation field per capita, coefficient of irrigated field and fertilizers applied per ha. Properly selecting the criteria of sustainable development, which can represent every sub-system, is very important to the evaluation results, therefore, we selected the above 14 indicators after using and comparing the sustainable agricultural development indicators proposed by A.Bakei, L.Nyambat, B.Purev and G.Gantulga [2] and "Analysis and evaluation on assessment index system of agriculture sustainable development" by Meng Su Ying [3].

Research methods and model

The mathematical expression of the Multi-index comprehensive evaluation model method:

$$AT_i = \sum_{i=1}^{n} W_i B_i \; i = 1, 2, \dots \dots, n \quad (1)$$

$$B_i = \sum_{j=1}^{m} W_{ij} C_{ij} \quad j = 1, 2, \dots \dots, \quad (2)$$

$AT_i -$ Comprehensive index of sustainable development of Mongolia's plant production sector

$W_i -$Weight of guidelines layer

$B_i -$Comprehensive index of guidelines layer

$n -$Number of guidelines layer

$C_{ij} -$Normalized value

$W_{ij} -$Weight of index layer index

$m -$Number of index layer

There is difference in sustainable development measurement unit and size, so we should normalize transfer them into same measure. To do this, we use extremum standardization and normalize the indicators.

Negative index:

$$Z_{ij} = \frac{X_{ij} - \min(X_j)}{\max(X_j) - min(X_j)} \quad (3)$$

Positive index:

$$Z_{ij} = \frac{min(X_j) - X_{ij}}{max(X_j) - min(X_j)} \quad (4)$$

To account the weight of index for the standard values use standard deviation coefficient.

$$V_j = \frac{\delta_j}{\bar{Z}_j} (j = 1, 2, \dots, m) \quad (5)$$

$$W_j = \frac{V_j}{\sum_{j=1}^{m} V_j} (j = 1, 2, \dots, m) \quad (6)$$

$V_j -$Standard deviation coefficient

δ_j- The standard deviation of each parameter

$\bar{Z}_j$- Average of standard values of each indicator

W_j- The weight coefficient of each index

RESULTS

Sustainable development level was calculated by using the dynamics of the sub-system indicators for the years of 2005-2017 (Table 1).

Table 1

System for agricultural sustainable development evaluation indexes of Mongolia

Guidelines layer		Index layer		Computing method
Index X_i	Weight W_i	Index X_{ij}	Weight W_{ij}	
Economic	0.3751	Unit weight of agricultural products to GDP	0.1509	GDP/agricultural total production
		Agricultural products per capita, MNT (as of 2010)	0.1625	Total agricultural production/Total population

Social	0.2633	Total investment to agricultural sector	0.1673	By amount of total investment to agricultural sector
		Labor productivity of agricultural sector, MNT thousand (as of 2010)	0.2208	Value added cost of agricultural sector/agricultural workers
		Land productivity, ha/c	0.1455	Wheat harvest yield per ha
		Level of domestic demand supply	0.1529	Domestic demand of agricultural products/amount of domestic production
		Unit weight of workers engaged in agricultural sector	0.2077	Workers in agricultural sector/total employed
		Level of labor earnings, MNT thousand (as of 2010)	0.2540	Average monthly wage
		Average life expectancy of the population	0.2633	Statistical data
		Average annual population growth, %	0.2750	Population in reported period/population in baseline year
Environmental	0.3616	Cultivation field per capita, ha	0.1143	Total cultivation field/total population
		Level of forest cover	0.2479	Forest fund/total territory
		Coefficient of irrigated field	0.1295	Irrigated field/total cultivated field
		Fertilizers per ha, MNT (as of 2010)	0.1287	Fertilizers used a year/cultivated field
		Average annual temperature^{0}C	0.1092	Statistical data
		Average annual precipitation RR(mm)	0.1564	Statistical data
		Eroded and damaged agricultural field, thousand ha	0.1140	Field unable for further cultivation

Note: Total investment to agricultural sector, labor productivity of agricultural sector and Labor earnings were represented by agricultural indicators and level of fertilizers per ha was represented by nitrogen fertilizer.

Level of agricultural sustainable development of Mongolia gradually increased between 2008-2012 and in 2012, it reached the highest level of 55,53%. It is the result of the "Virgin Land Campaign" by the Government of Mongolia since 2008 and the average growth speed of sustainable development was 21.26% during these years (Table 2).

Table 2

Coefficient of level of sustainable agricultural development

Year	Economic development coefficient	Social development coefficient	Environmental development coefficient	General level coefficient of sustainable development of agricultural sector
2005	0.3045	0.5660	0.3126	0.3763
2006	0.3790	0.3540	0.2318	0.3192
2007	0.1980	0.4360	0.1653	0.2489
2008	0.4067	0.5075	0.4448	0.4470
2009	0.4248	0.4170	0.2731	0.3679
2010	0.4722	0.4180	0.3125	0.4002
2011	0.5948	0.3676	0.3990	0.4642
2012	0.6953	0.3617	0.5511	0.5553
2013	0.6082	0.2213	0.5795	0.4960
2014	0.7566	0.3259	0.4108	0.5182
2015	0.4875	0.2971	0.4335	0.4178

2016	0.7315	0.3490	0.4977	0.5462
2017	0.4765	0.3357	0.5011	0.4483

The sustainable development level was much fluctuatingbetween 2013-2017, which strongly depended on the crop plantation , weather and climate conditions like dryness and drought and other factors in 2013 and 2015, much amount of harvest was lost during these periods, which led to sharp decrease of total production during these years and total agricultural production decreased by 11% in 2013 and by 28.8% in 2015 compared to the previous year, which led to decrease of the sustainable development coefficient. In other words, agricultural sustainable development strongly depends on the climatic conditions. It can be seen from the fact that the general coefficient of the agricultural sustainable development and the dynamics of the environmental sub-system coefficient are same in other years except 2013-2015. (Figure 1)

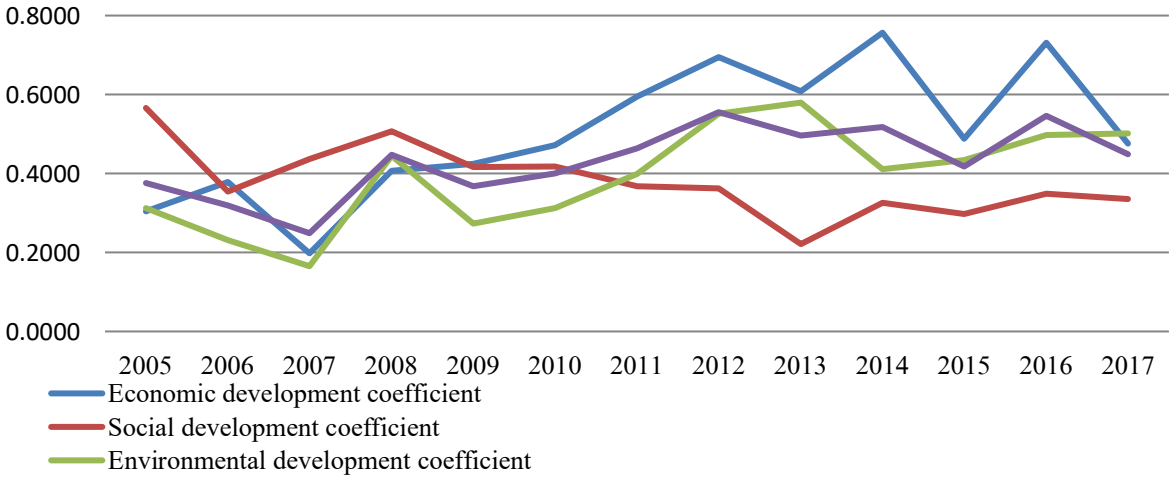

Figure 1. General level coefficient of sustainable development of agricultural sector

The agricultural sustainable development sub-systems in Figure 1 show that the agricultural economic development level is higher than the general sustainable development level since 2009, which shows strong impact to the agricultural sustainable development. In particular, in 2009 it was higher than the general level by 5.68% and in 2014 the highest or 23.84%. But, labor productivity of agricultural sector, total investment and growth of the agricultural products per capita leaded to the economic sub-system development. It is the result of the Government efforts in renovating and modernizing the agricultural machineries of the agricultural entities through investments.

Social sub-system coefficient of the sustainable agricultural development is the lowest, which shows that the agricultural social development level is weak as well it must be addressed much stronger. In particular, number of workforce in this sector is low (up to 10% of total workers are engaged in this sector) as well it shows that the agricultural production must be intensified and increased in order to supply the additional demands caused by lack of professional workforce, average life expectancy of the population and population growth.

Environmental sub-system development level has been increasing continuously since 2010 and in 2013 it reached 57.95%, although it has been gradually increasing in the following years, it hasn't reached the above level yet. Amount of irrigated field has been increasing slowly and has reached about 10% of total agricultural field, amount of eroded and damaged agricultural field has been decreasing continuously and in 2017 it reached 70.9 thousand hectares, which had a strong impact to the development of the environmental sub-system.

DISCUSSION

According to the "Agricultural sustainable development state of Mongolia, scientific backgrounds" by A.Bakei et.al shows that the agricultural system dynamics is same as the environmental sub-system dynamics, which considers that the agricultural sector much depends on the weather and climate conditions. Arable farming or soil tillage is an important indicator of the agricultural sector, therefore, this principle was also observed in our research.The level economic sub-system development was higher than the general level, which also proves this principle. Although agriculture strongly depends on the environmental and climatic conditions, mitigating this impact is the precondition for the agricultural sustainable development.

CONCLUSION

1. The agricultural sustainable development level of Mongolia was evaluated by 3 sub-systems of economic, social and environmental and 14 indicators by using the multi-indicator general evaluation method.
2. Economic sub-system has the highest impact to the agricultural sustainable development and the social sub-system has the lowest impact. Further, it is necessary to pay more attention to the social development indicators in agricultural sector.
3. Environmental sub-system development tendency of the agricultural sustainable development is same as the general development tendency.
4. The level of the Agricultural sustainable development of Mongolia gradually increased during the "Virgin land campaign-3" or between 2008-2012 and reached 55.53% but the level fluctuated between 40-55% for last 5 years. During the years with unfavorable climatic conditions the level decreased on average by 7.5%, which proves that the level of the agricultural sustainable development still depends on the climatic conditions.

REFERNECES

[1] Wang L.C, "Theory and practice of agricultural sustainable development", Beijing, 2014, pp.13-14.

[2] A.Bakei, L.Nyambat, B.Purev, G.Gantulga "Sustainable developing status of Mongolian Agriculture, scientific basis" in Scientific Developing level of Mongolian Agriculture and its future goals,UB, 2018, pp.127-145.

[3] MENG Suying, CUI Jiansheng, ZHANG Ruihua,"Analysis and evaluation on assessment index system of agriculture sustainable development", Journal of Hebei University of Science and Technology, vol.35, no.5, October 2014, doi:10.7535/hbkd.2014yx05013

[4] ZHONG Xia, ZHONG Huai-jun, "Multi-criteria Estimation:Its Application as a Method", Journal of Inner Mongolia University (Humanities and Social Sciences), vol.36, pp.107-111, Jul.2004.

[5] ZHANG Jinhua, "Research on comprehensive benefit evaluation of the modern agricultural sustainable development-Take GUIZHOU province as an example", Chinese Journal of Agriculture Resources and Regional Planning, vol.37, no.6, June 2016, doi:10.7621/cjarrp.1005-9121.20160630

[6] FANG Xing-ming, WEI Jing, GUO Li-li. "Reflection and reconstruction of sustainable development theory", Economist, vol. F112.1, 2017,doi:10.16158/j.cnki.511312/f.2017.03.005

[7] Mongolian University of Life Sciences, "Scientific Developing level of Agriculture and its future goals", UB, 2018.