ISSN 2181-9408

Scientific and technical journal

Sustainable Agriculture

№3(7).2020

Founder: Tashkent Institute of Irrigation and Agricultural Mechanization Engineers
Our address: 39, Kari-Niyaziy str., Tashkent 100000 Uzbekistan , www. sa.tiiame.uz

The journal "Sustainable Agriculture" is registered in the Press Agency of Uzbekistan on the 12th of February in 2018 (license № 0957).

In 2019, the journal is included in the list of recommended scientific publications by the Higher Attestation Commission of the Republic of Uzbekistan.

ARCHITECTURE. LANDSCAPE ARCHITECTURE

A.N. Inamov, O.S. Abdisamatov
Introduction of automated local accounting system ModelBuilder.....4

ECONOMY. ECONOMIC SCIENCE. OTHER BRANCHES OF THE ECONOMY

M.R. Li, A. Etenesh, I. Rudenko, F. Saydullaeva
Food Security risks and the Covid-19 pandemic in the republic of Uzbekistan.....8

A.E. Primov
The patterns and extent of crop diversification: evidence from different agro-ecological regions of Uzbekistan.....10

Sh.M. Murodov
Main directions for developing food security.....15

G.D. Dusmuratov, I.O. Yunusov
Opportunities for public-private partnerships in the field of aquaculture.....21

U.Z. Alimov
Experiences on watermelon and melon cultivation and their export: in case of Spain.....26

U.K. Akhmedov, S.Kh. Kholmatov
Possibilities of attracting foreign investment in the economy of the republic of Uzbekistan.....29

U.K. Akhmedov, A.G. Tuychiev, K.K. Mamadaliev
Issues of enhancing the transfer of innovations to small business.....31

S.T. Iskandarov
Development challenges of fruit and vegetable sector of Uzbekistan.....34

HIGHER EDUCATION. PEDAGOGY

S.T. Kalandarova , O.A. Kulmamatov
Teaching methods and ways of developing communicative competences of students.....37

M.H. Primova
Big data technologies in Learning Management System.....40

ENVIRONMENTAL PROTECTION. WATER MANAGEMENT, HYDROLOGY

Ramesh Raj Pant, Nanu Babu Khanal, Khadka Bahadur Pal, Lal Bahadur Thapa, Richa Galaju, Satyam Kumar Chaudhari, Buddha Bahadur Basnet, Namraj Dhami, Khaydar Durdiev, Kiran Bishwakarma
Hydrochemical characteristics and macrophytes in the Betana Lake, Eastern Nepal.....44

M.M. Babadjanova
A review of climate change impacts on wheat crop in Uzbekistan.....52

S. Musayev, I. Musaev
Hexavalent chromium removal from aqueous solution and natural attenuation in soil by adsorption 56

S.M. Kodirov, S.R. Mansurov
Assessment of water content in hydrologic time series by using difference integral curves (in the example of Pskem River).....60

INTRODUCTION OF AUTOMATED LOCAL ACCOUNTING SYSTEM MODELBUILDER

A.N. Inamov - associate professor, O.S. Abdisamatov - independent researcher
Tashkent Institute of Irrigation and Agricultural Mechanization Engineers

Abstract

In the world computer industry, previously developed programs are being improved, and in our country, along with the developed countries of the world, there is a gradual transition to work on the basis of modern programs. ArcGIS software products based on the latest computer technologies meet all open standards, which allows them to be used in many practical areas and at different levels of work organization (individual, server and mobile).

Key words. Modelbuilder, ArcGIS software, Data base.

Introduction. ArcGIS software has a clear model of working with data, especially spatial data, and this model is called a geodata. The geodatabase serves as the basis for storing all types of data used in the process of working with ArcGIS applications, i.e. the geospatial acts as a warehouse for storing various data. Using a geodata helps not only to effectively manage data stored locally or on a server, but also to create complex models when working with different industries and projects.

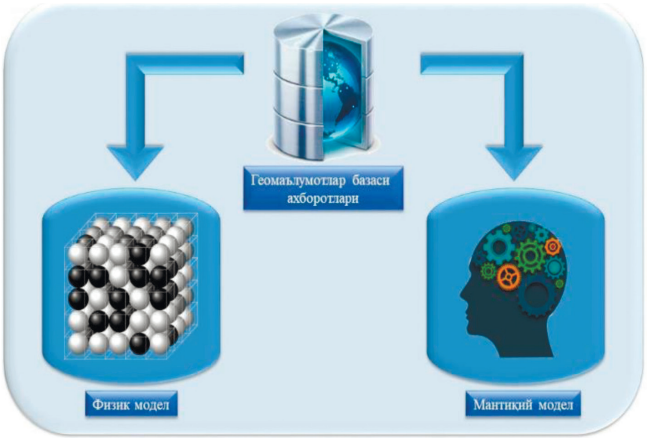

Figure 1. Geospatial models

Relevance of the topic. Today, when working with a geodatabase, users will be able to work with two different models at the same time. These are physical and logical models. This not only ensures that the objects are geometrically related, but also allows them to be linked at the object level.

Object and methods of research. In a geodata, data can be stored locally, i.e. on users of PCs or on a server. The following geospatial storage options are available:

- file geodatabase - file folders on disk;
- personal geodata - a database in a Microsoft Access (.mdb) file;
- MBBS (Database Management System - Oracle, SQL Server, Informix, DB2 or PostgreSQL).

When modeling a geodatabase, users can introduce some rules to be able to avoid mistakes and inaccuracies that may occur in the future. It is also possible to correct deficiencies in data entry using special verification tools.

In a geodatabase, users can not only work with simple dots, lines, and polygons whose data is stored in tables, but also rely on real-world objects. For example, they have the ability to work with transformers instead of points, and with pipes instead of lines.

Although there are many different scripting languages in the GAT software market, we can distinguish three programs that are recognized by many: VBScript, JScript, and Python. VBScript and JScript are considered by many programmers to be simple programming languages. These programs are also designed to run in a Windows environment, such as the C programming language. Python programming language is an easy to learn language similar to C programming language. In addition, Python can run on UNIX, Linux, Windows, and more, regardless of the operating system.

Python is a standalone open platform programming language. It is widely used because it is a fast, powerful and easy to learn programming language.

Python has been used in script writing for geoprocessing since ArcGIS version 10.0. Each edition of Python is expanding its capabilities and making it easier to use.

Python programming language is introduced into the whole ArcGIS system, it is a language for automation of analysis, data modification, cartographic work processes, which increases the productivity of work.

Geoprocessing using the Python programming language is done with the ArcPy site-package mechanism in ArcGIS software. ArcPy provides access to additional features, classes, and modules that allow you to quickly organize simple and complex workflows in geoprocessing tools as well.

It is possible to store large amounts of data in a geodata. For example, sheets of topographic maps can be stored as a common thematic layer of multiple sheets, rather than as a whole. In doing so, most operators can refer to layers of such themed cards and edit them at the same time. ArcGIS also has the ability to create additional modules using the visual programming language ModelBuilder or by writing a script in a text programming language. Scripting in ArcGIS is an effective method that can be used to perform large and complex processes, from simple processes. It is also notable for allowing scripts to be reused.

Everyone who uses ArcGIS is required to write their

own scripts to automate the workflow. Even someone unfamiliar with the programming language or its terminology should be able to visually create a model of personal tools using the ModelBuilder model.

ModelBuilder is a sequence of algorithms used to create, edit, and manage models. The models are linked to each other in a sequence of geoprocess tools. In his research, the author used ModelBuilder as a visual programming language to create workflows.

In this model, a number of process algorithms were performed using the Studyarea polygon, such as soil analysis, new field addition, layer shearing, calculation of new area value, and geostatistical analysis.

ModelBuilder is very useful in creating simple and complex workflows and implementing automated systems, providing you with additional methods for ArcGIS functionality, which allows you to create and share specific models as a tool.

ModelBuilder provides great convenience in creating and executing less complex workflows, as well as providing additional methods for the functionality of ArcGIS, which allows you to create and share specific models as a panel. In addition, ModelBuilder allows ArcGIS to be integrated with other applications (Figures 2, 3, and 4).

In the ArcMap application, algorithmic work is carried out using the ModelBuilder panel for quality management of agricultural lands and modulation of the automated system. When performing algorithmic work, the sequence of commands is determined by the rules of the program and modulated based on the use of thematic layers and tools in the ArcToolbox panel.

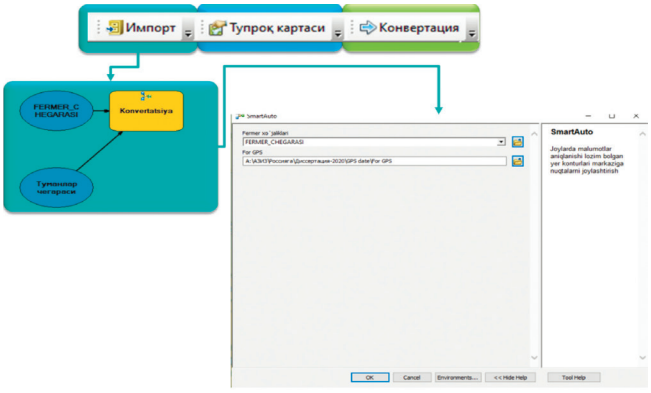

Figure 2. Algorithm for automating the system of conversion of field research into geodata in ModelBuilder

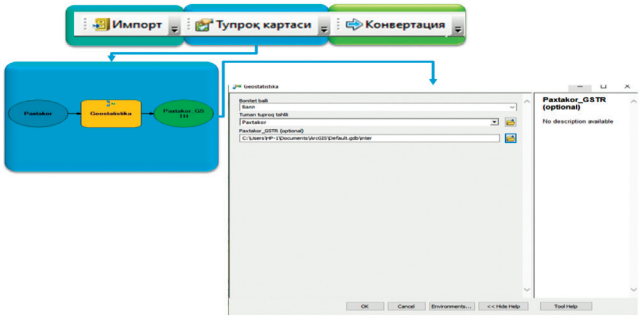

Figure 3. Algorithm for automating the system of visualization of soil differences in geodata in ModelBuilder

In order to implement the modulation, it is first necessary to automate the field research system. Electronic digital maps created in ArcGIS software, which belongs to the family of geographic information systems, serve as a basis for automating field research.

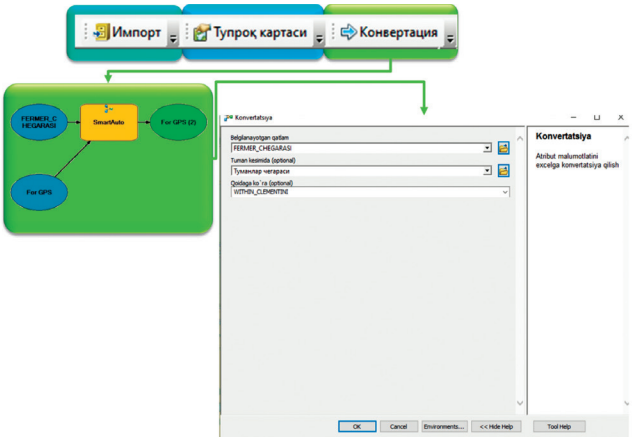

Figure 4. Algorithm for automating the system of exporting the analysis performed in ModelBuilder to tabular form

Stages of automation:

1. Export of electronic digital data with geographical location;
2. Integration of geodata database of field research results through GSM network;
3. Carry out geostatistical analysis based on the results of field research.

The thematic layers of electronic digital cards created in the ArcMap application of ArcGIS are the object of modulation.

Uploading the results of field research using a GPS device to the ArcGIS formula and performing geostatistical analysis is carried out in the following order (Figure 5):

- Mobile Mapper Office software is installed on the computer;
- administrative-territorial boundaries of the selected territory are downloaded;
- the Open line is activated via the file menu;
- the generated Open window displays the address of the results of field research on the GPS device;
- MMJ format unit GPS device files are selected and the Open button is pressed;
- otkrыt dannyx A window will appear under the name GIS and the coordinate system and attribute columns will be viewed;
- When the open button is pressed, the data of the vector layer in the form of a dot of the GPS device is visualized on the desktop;
- exported to * .Shape ArcGIS format unit via file menu;
- Vector layers in * .Shape format are imported into the ArcMap application of ArcGIS;
- the geographical location of vector layers in the form of points is considered;
- Qualitative analysis of the results of field research through the geostatistical analysis panel;
- the appropriate information column is selected for the analysis of the vector layer in the form of a dot;
- the process of sectoring is carried out using the method of quality colors;

- according to the results of the analysis, the errors are equalized;
- Colors describing the quality of lands are standardized at the stage of classification;
- in the standardization of classifications are brought into a single unit with non-natural numbers;
- Possibilities of color visualization of soil color are considered;
- the classification is memorized and combined with an electronic digital card using RGB spectral colors;

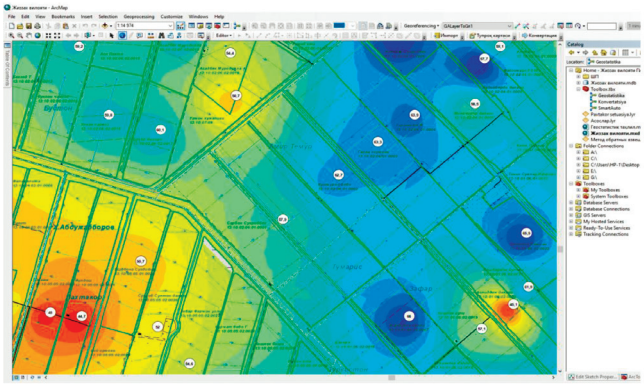

Figure 5. The interface of the ArcGIS program, which visualizes land users, land contours and soil quality points

- Land users and land contours are activated and the information of the attribute data columns is visualized.
- Automation and modulation of quality management of agricultural lands is carried out in the following order (picture 6):
- A new ArcToolbox toolbar will be created in the ArcCatalog window of the ArcMap application;
- A module is created through a new line from the ArcToolbox toolbar;
- the resulting module window is schematized by the algorithmic sequence;
- the required tools are downloaded from the ArcToolbox toolbar;
- schematic algorithms are interconnected;
- Several Toolbox tools can be interconnected in the development of algorithms;
- it is possible to ensure the participation of the required vector layers in the loading and algorithmic process by the add command;
- In the algorithm it is possible to make corrections to instruments;
- or amendments may be made;
- enters the toolbox to provide rules and explanations to the interfaces in modulation;
- The completed module is started and checked. Successfully completed module schemes are automatically visualized with unique colors;
- module interfaces can be checked and modified;
- Algorithm of the module created for automatic implementation of geostatistical analysis;
- Algorithm of the module for identifying land users in the relevant area and exporting attribute data to an Excel spreadsheet;
- Algorithm of the export module to create a vector layer in the form of a dot from the ground users to the center of the land area and upload it to the GPS device.

Figure 6. Automation and modulation of quality management of agricultural lands

The role of integration is important in the management of agricultural land accounting and the modulation of automated systems. An electronic digital map created in ArcGIS software to perform field research results on a GPS device is loaded with vector data in the form of dots placed in the centers of the field according to land users and their geographical location. Based on the loaded vector data, the GPS device examines the total land area of land users, crop types, irrigation networks, and similar objects.

To investigate soil quality and classifications, point-view vector layers mounted on the center of common land areas of land users are loaded into a GPS device. Soil analyzes are taken from the points along the defined threshold according to the loaded layers. The soil obtained under field conditions is analyzed and the results are sent to the geodata database via the GSM network. The results are imported into the ArcGIS program and analyzed by the geostatistics module. The analysis results in the automatic creation of RGB spectrum classifications and visualization of soil differences using the quality color method according to the value of soil score quality. These studies show that to date, soil separation is carried out mechanically by the Center for Soil Composition and Repository, Quality Analysis. Drawing of land allotments in mechanical works is time-consuming and poses considerable problems for regional land surveyors in deriving normative value estimates to land users. In particular, we can cite the fall of several soil separations in a single land contour. In the automated system recommended by the author, the software module performs the drawing of soil separations automatically. Provides the ability to determine the normative value estimates on the land contour at the general regional, district or provincial level using algorithm codes.

Research results and discussions. As a result of scientific research, the means of spatial analysis of data and their geographical processing have been expanded. Algorithms in Model Builder for export of attribute data, creation of vector-shaped layers in the center of land plots and geostatistical analysis of spatial data, creation of statistically accurate surfaces and automatic visualization of soil separations for land users to conduct qualitative field research developed.

Conclusions, suggestions and recommendations.

The analysis of the development of algorithms for modulation and data integration in the automated system of quality indicators of land accounting was

analyzed and the following conclusions were drawn.

Field research results ESRI individual products belonging to the ArcGIS family have been integrated into common architecture and interface basic applications such as ArcMap, ArcCatalog and ArcToolbox, and their functions, geographic processing and spatial analysis tools have increased.

Currently, the above work is being continued and it is planned to implement it in other regions of the country in 2020-2025.

References:

1. Abdullayev T.M., Inamov A.N. Diagnosis of spatial photo errors in geophysical connection //O`zbekiston zamini jurnali – Toshkent 2020, 1-son, 23-26 б
2. Inamov A.N., Abdisamatov O.S., Mamatkulov Z.Yu. Application of modern innovative technologies in accounting for water consumption // Geographic Society. Tashkent 2018.201-204 p.
3. Inamov A.N., Ashiralieva G.M. The role and importance of unmanned technologies in agriculture // Innovative approaches to the rational use of land resources: Republican scientific and practical conference on problems and creative solutions. Tashkent 2019.322-325 p.
4. Inamov A.N., Lapasov Yu.O., Mamatkulov Z.Yu. Economic efficiency indicators achieved during optimization work using GPS-navigators // Agro ilm. - Tashkent 2018.88-92 p.
5. Inamov A.N., Mirjalolov N.T. Satellite communication and GPS imaging using the GeoGIS program // Scientific journal, Internauka №14 (48) - Moscow 2018. 63-65 p.
6. NAP, 2008. Earth Observation from Space. www.nap.edu.
7. Niyogi D., Mahmood R. and Adegoke, J.O. 2009. Land-Use/Land-Cover Change and Its Impacts on Weather and Climate. Boundary Layer Meterology. 133(3), 297-298.
8. Ormsby, Napoleon, Burke, Groessi, Bowden. Getting to know ArcGIS desktop//ESRI Press,380 NewYork Street, Redlands, California 92373-8100. 2010.
9. Ormsby, Napoleon, Burke, Groessi, Bowden. GIS, spatial analysis and modeling//ESRI Press,380 NewYork Street, Redlands, California 92373-8100. 2010.
10. Rao, S.S. 2008. Social development in Indian rural communities: Adoption of telecentres. International Journal of Information Management, 28(6), 474–482.
11. Reddy, C.S. and Roy, Arijit (2007). Assessment of three decades of vegetation dynamics in mangroves of Godavari delta, India using multitemporal satellite data and GIS. Research Journal of Environmental Science, 2(2), 108–115.
12. Roy P.S. and Murthy M.S.R. 2009. Ecient Land Use Planning And Policies Using Geospatial Inputs: An Indian Experience. In: Land Use Policy. Editors: A.C. Denman, O.M. Penrod, Nova Science Publishers, Inc.
13. Roy P.S., Srivastava, V.K., Roy A., Mehtab A., Sampath K., Suresh J.R., Sharma A. and Dwivedi R.S. 2010. Agent Based Land use and land cover change modeling. Unpublished.

FOOD SECURITY RISKS AND THE COVID-19 PANDEMIC IN THE REPUBLIC OF UZBEKISTAN

M.R. Li - PhD in Economics, Tashkent Institute of Irrigation and Agricultural Mechanization Engineers
A. Etenesh - PhD in Development Studies, Sr. research fellow at the Center for Policy Research and Outreach at the Westminster International University in Tashkent
I. Rudenko - PhD in Economics, Senior lecturer, Faculty of Tourism and economics, Urgench State University
F. Saydullaeva - PhD student of Samarkand Center for Agricultural Reform and Innovation Studies of Samarkand branch of Tashkent State University of Economics

Abstract

The article substantiates the importance of research on food security risks. The impact of the COVID-19 pandemic on this issue is considered, the level of food security of the urban population during the pandemic is analyzed. The existing risks that form food security threats are identified and proposals for their elimination are developed.

Key words: risks, food security, COVID-19, threats, proposals, agro-industrial complex.

Introduction. Food insecurity leads to hunger and thirst. Chronic food insecurity leads to a high degree of risks affecting the health of the population and the ensuing socio-economic consequences. In countries with persistent food shortages and distribution problems, there is a decrease in body size, known in medical terms as stunting. This process begins in utero if the mother is malnourished and continues for about the third year of life. This leads to an increase in infant and child mortality, but at a much lower rate than during famine. Once stunted growth has occurred, improved food intake after about two years of age fails to reverse the damage. All of the above makes research on the issues of risks and threats to food security even more relevant.

We divided the most significant food security risks based on the classification developed by O.I. Ulanova. [1]:

- decrease in the investment attractiveness of the domestic real agri-food sector and the competitiveness of domestic products, as well as the dependence of the food market on imports of certain types of agricultural products;
- lag of the domestic production base from developed countries in the level of technological development, differences in the requirements for food safety and the organization of a system for monitoring their compliance;
- risks caused by the consequences of natural and man-made emergencies;
- risks caused by fluctuations in market conditions, the use of government support measures in foreign countries, the state of Uzbekistan's foreign economic relations with other countries.

U.Z. Safin identifies the following types of risks: "macroeconomic risks, natural and climatic risks, social risks, international trade risks, legal risks and criminal risks" [2].

Materials and methods. The situation caused by the COVID-19 pandemic has exacerbated the food security risks that significantly weaken it. Results of a study conducted by the authors in the framework of a project funded by the World Bank to study the impact of the COVID-19 crisis on food consumption in cities of the Republic of Uzbekistan, using primary data collected from cities of Tashkent, Samarkand and Urgench. The article is part of a bigger case study by the authors, entitled "Food security in cities of Uzbekistan in light of the COVID-19 crisis" (Asfaw et al., forthcoming). The survey was conducted on-line with 652 random city residents in July, 2020.

Results and Analysis. The COVID-19 crisis and lockdowns presented growing challenges to urban food and nutrition security worldwide. In Uzbekistan declining purchasing ability coupled with the food inflation affected the food security of many city citizens. Because considerable number of families throughout the country experienced some type of income shortage on the one hand and price increase for many products on the other hand during pandemic, it impacted the amount of food they could purchase. Likewise, only around 30% of the respondents across the country (exception in Urgench – 24%) reported that the amount of food they were buying during pandemic did not change at all. Around 30% of the respondents indicated they slightly or largely increased the purchased amount of food, and the remaining share of the respondents (40% to 45% depending on location) confessed they had to decrease food purchases during pandemic (Figure 1).

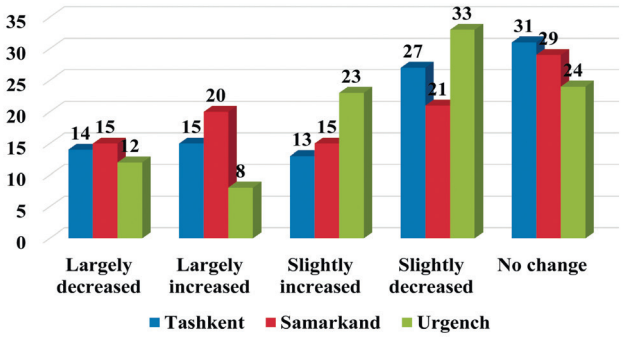

Figure 1. Changes in the amount of food purchased during pandemic, %

The main reason for decreasing the amount of purchased food was higher prices during the lockdown - 40% to 49% of the respondents depending on location selected this answer (Figure 1). During the lockdown there was no shortage of the main food items in the market, the state managed to maintain food security – 11% to 17% of the respondents indicated they experienced some type of food shortage during pandemic. Around one third of the respondents complained they had limited access to their markets/bazaars either because of temporary shutdowns or because respondents voluntarily switched

to 'safer' supermarkets or small shops. Remittance cut was not the main reason for lower food purchases (Figure 2).

Discussions. The presence of the listed risks creates threats to food security, which can lead to non-

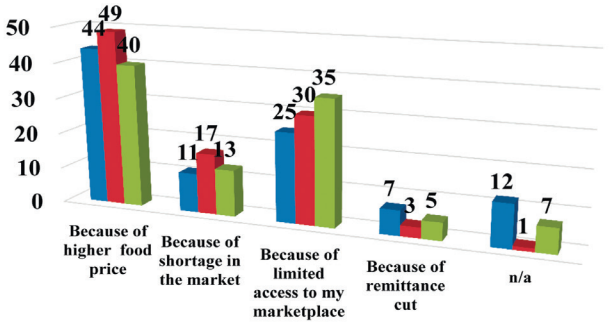

Figure 2. Reasons for buying fewer food items during pandemic, %

compliance with the threshold values of food security criteria. This requires the implementation of government regulation measures to overcome:

• low level of effective demand of the population for food products;

• insufficient level of development of the internal market infrastructure;

• price imbalances in the markets for agricultural and fish products, raw materials and foodstuffs on the one hand, and material and technical resources on the other;

• artificial competitive advantages of foreign products, formed through various measures of state support for food production in foreign countries.

The solution to these problems will be a solid basis for ensuring the country's food security.

Conclusion. Promotion of the development of small business in the country will serve to increase the level of effective demand of the population for food products, in addition, the expansion of the processes of diversification of forms of ownership, the creation of industrial and logistics centers will contribute to solving the problems of developing the infrastructure of the domestic market

The way to eliminate price imbalances in the markets of agricultural and fish products, raw materials and foodstuffs can be the development of new technologies in the food preparation industry.

Besides this, the measures of controlling prices during pandemic on the one hand through government invention such as direct regulation of food prices, realizing state food stocks to avoid food deficit and thus higher prices. On the other hand, the measures of maintaining or increasing real/disposable income of the population to cover the growing food prices through financial aid, allowances or lower income taxes for the population can also be very useful for elimination of food security risks during covid-19 pandemic.

Acknowledgments. The authors express deep gratitude to the organizers of the seminars and competition "Case studies in the field of food security and nutrition in the Eurasian region" of Eurasian Center for Food Security of Moscow State University and the World Bank for financial support of this initiative.

References:

1. Ulanova OI Risks and threats to food security in Russia // Scientific and methodological electronic journal "Concept". - 2017. - T. 31. - S. 131-135. - URL: http://e-koncept.ru/2017/970041.htm.
2. Safin U.Z. Ensuring food security in the system of economic security of Russia (theoretical and methodological approach): author. dis. ... Dr. econ. sciences. M., 2010.S. 16.
3. Asfaw, E, et al 2020 forthcoming.

THE PATTERNS AND EXTENT OF CROP DIVERSIFICATION: EVIDENCE FROM DIFFERENT AGRO-ECOLOGICAL REGIONS OF UZBEKISTAN

A.E. Primov - PhD student, Tashkent State Agrarian University

Abstract

In Uzbekistan, land is more appropriate for cultivating fruits and vegetables. Since independence, the government of Uzbekistan has implemented a number of agricultural policies such as making some crucial structural reforms at the farms, comprising different institutions and enhancing diversification of agricultural production in order to stabilize on agricultural sector of the country. Therefore, crop diversity has an important role in sustainable agriculture. The main objective of the study is to analyze the degree and extent of crop diversification among farmers. We calculated the diversification index based on the Simpson Diversity Index method. The study revealed the mean computed Simpson Index values indicate that diversity index was found 0.59, 0.45, 0.56 and 0.62 for Andijan, Karakalpakstan, Kashkadarya and Tashkent regions, respectively. This implies that Tashkent region farmers shifted towards more diversification cropping patterns than other counterparts of the country. The overall result in the four states combined in this study reveals a mean Simpson Index within the sample of farmers was 0.56. This suggests that the farmers in the study areas were not too diversified in their cropping pattern. While cultivating several crop species also helps the farmers to manage both price and production risks which attains more food options for the household and income through marketing the produce from the surpluses.

Key words: Crop diversification, Simpson Diversification Index, Cropping patterns, Uzbekistan.

Introduction. Agriculture plays a highly important role in Uzbekistan's overall economy. The agricultural sector is one of the leading sectors of the national economy and contributing with over 30% of the annual gross domestic product (GDP) and engages 27% of the country's total workforce and earns 25% of all export revenue [25]. Importantly, about 50% of the country's population resides in rural areas and depend on agriculture as well as other related activities [17]. Since independence in 1991, the government of Uzbekistan has been doing several important reforms in order to find out the best options to increase income of the agricultural sector.

The main important reform was to be replaced state and collective farms by private farms and shirkats. However, the productivity and occupied land area of the shirkats was decreasing throughout the years which led them abolish in agriculture. Instead, the role of private farms and dekhan farms has increased in the agricultural output [12]. Private farms predominantly produce state-order crops which are wheat and cotton, whereas smallholders are occupied in the livestock and partly produce other agricultural crops such as fruits and vegetables [15].

The production of higher value crops, such as fruit and vegetables, was constrained by limited access to land, inputs, modern crop-specific technologies, and finance. Additionally, Uzbekistan's agricultural policies were more highlighted at the strategically significant crops cotton and winter wheat. Additionally, the state planning system has only retained for these crops whilst fruits and vegetables obtained less policy attention in terms of the lack of state procurement system [11, 14]. Following independence, the country has managed to gradually move away from cotton monoculture towards a more diversified pattern of agricultural produce, including cereals, potatoes, vegetables and melons [21, 14, 18].

Recently, agricultural policy in Uzbekistan has launched paying more attention to intensify high-value diversification of agricultural production while focusing on the development of fruits and vegetables. Therefore, the national administration has recently issued crucial several legislative acts in order to enhance the crop diversification through the country [13, 23]. The National Development Strategy for 2017-2021 recognizes the need for diversification for cotton and cereal crops into high value-added and labor-intensive production and processing, including, horticulture, fruits, and vegetables, which are expected to significantly contribute to significant growth of rural jobs, food security and exports revenues [10].

Concept and Measures of Crop Diversification

Crop diversification is defined as a shift in production portfolio away from mono-cropping to adopting a multiple cropping system. There are two common and complementary ways to crop diversification in agriculture, namely horizontal and vertical diversification [4]. Karimov (2013) indicated that enhancing crop productivity on the farm level plays an essential role in developing economic growth, improving food security and easing poverty in the country. Whilst government ought to carrying on crop diversification among farmers, as it supports to obtain extra income, improves food security as well as lessens famine [19]. Dagar (2018) defined that, crop diversification is planned to give a wider choice in the production of a variety of crops in a specified area so as to increase production related activities and minimize risk [9].

Furthermore, crop diversification is a strategy to maximize the use of land, water, and other resources and for the overall agricultural development in the country. It provides farmers with viable choices to grow diverse crops on their land (Saraswati et al., 2011). In line with the existing views, Saraswati (2011) also suggested that the diversification in agriculture is practiced with a view to avoiding risk and uncertainty due to climatic and biological vagaries. It can also help to minimize the adverse effects of the current system of crop specialization and monoculture for better resource use, nutrient recycling, reduction of risks and uncertainty and

better soil conditions. In addition, it also ensures better economic viability with value-added products and the improvement of ecology as well (Saraswati et al., 2011).

Despite these facts, Bobojonov (2013) also indicated that, diversification is explained as the addition of more crops into the existing cropping system and increase farm income and minimizes risk management practice on the farm level and crop diversification is an effective strategy to deal with such problems as water scarcity, drought and salinity. Additionally, easing of cotton and wheat production would increase crop diversification and farm income [7].

The results of the previous studies emphasized that most of the achievements in cotton and wheat production are based on high input use technologies such as water, seed, fertilizers, and pesticides which are not sustainable on a long-term basis. Therefore, high input use technologies will not be appropriate for all privet farms [21]. Furthermore, the area available for high-value alternative crops however, cultivation of these types of crop is very limited in spite of high economic and ecological potential [6].

Hence, it is the right time to look for a suitable and realistic strategy by which cropping intensity could be enhanced and diversification achieved. Moreover, comprehensive studies of crop diversification in Uzbekistan are still sparse and mostly studies based on hypothetical scenarios and multi-sensor remote sensing data results, only limited research on this subject has been conducted in Uzbekistan to date [7, 8]. To the best of our knowledge, there are currently no study to date has attempted to provide additional comprehensive understanding of the status and extent of crop diversification of the farmers' at the farm level in different parts (regions) of the Uzbekistan.

The rest of the paper is organized as follows: Introduction gives the literature on the concepts of crop diversification and crucial reforms in study regions. The second section outlines the research methodology adopted by this study. Third section illustrates the results and discussions, and the study conclusions and policy implications are summarized in the fourth section.

Materials and methods. *Data Sampling.*

One of study aims to determine the extent of crop diversification index at the farm level. The study is based on an extract of 394 farmers interviewed during a baseline survey in Uzbekistan for 2009-2010 growing season. This section briefly describes sampling methods used to measure crop diversification index at the farm level. The study has used the cross sectional data collected by the International Center for Agricultural Research in the Dry Areas (ICARDA) and International Food Policy Research Institute (IFPRI) using well-structured questionnaires through personal interview method. A total of four districts (Karakalpakstan, Kashkadaryo, Tashkent, and Andijan) from Uzbekistan were included in gathering this data. The four districts were purposively selected in terms of agro-ecological, crop production and marketing access. Tashkent and Andijan provinces are great potential in both cases, however, Karakalpakstan and Kashkadarya districts are in low potential zones, respectively.

Study Regions. In this study, the four regions of Uzbekistan, namely, the Republic of Karakalpakstan, Kashkadaryo, Tashkent, and Andijan were chosen for the analysis because these provinces are located in different part of the country, as shown in Figure 1. The Republic of Karakalpakstan in northwest Uzbekistan, located southeast to southwest of the Aral Sea, whilst Kashkadarya province is located in the southern part of Uzbekistan. In both provinces, soil salinization is the main agricultural problem. In Karakalpakstan and Kashkadarya provinces about 500,000 ha and 514,000 ha are arable lands where farmers mainly cultivate wheat and cotton crops and these two crops are controlled by the government in terms of state procurement policy [4, 22, 11]. Andijan province is located in the eastern part of the Fergana Valley where Tashkent region is situated in the northeastern part of Uzbekistan. These areas have greater independence to choose their own cropping and subsequently often focus on fruits and vegetables. In these 'non cotton' areas, it is common to see vegetables being produced as second crop after winter wheat, with farmers cultivating vegetable, beans and potato or melon crops (Tashkent - 15.5%, Andijan - 12.9%, respectively) [20, 21].

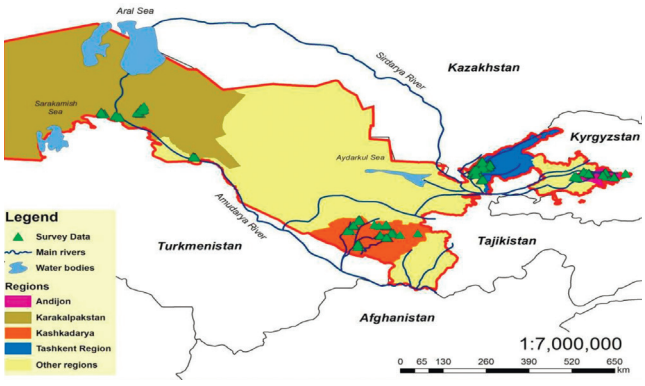

Figure 1. Map of surveyed areas of the study regions. Source: Own source

A total of four districts (Karakalpakstan, Kashkadaryo, Tashkent, and Andijan) from Uzbekistan were included in gathering this data. The four districts were purposively selected in terms of agro-ecological, crop production and marketing access. Tashkent and Andijan provinces are great potential in both cases, however, Karakalpakstan and Kashkadarya districts are in low potential zones, respectively. The Simpson Diversity Index was measured while utilizing Stata version 14 statistical software tools in order to measure the degree of crop diversification index for the particular crops of interest in the study areas.

Crop diversification analysis

The extent of crop diversification can be measured by using several indices Simpson's Index (SI), Herfindahl Index (HI), Margalef Index (MI), Composite Entropy Index (CEI), Entropy Index (EI) and Shannon Index (ShI). These indices have been widely used by many other researchers to estimate the nature and extent of crop diversification practices of farmers [5, 7, 16, 8]. However, in terms of data availability and crop patterns, this study is employed Simpson Diversity Index (SDI) because it is the most commonly used index in numerous studies related to crop diversification [24, 3] including in Uzbekistan [7, 8]. The Simpson Index (SID) is calculated using the following equation:

$$SID = 1 - \sum_{i=1}^{n} P_i^2 \qquad (1)$$

$$P_i = \frac{A_i}{\sum_{i=1}^{n} A_i}$$

where, A_i is the value or area of the ith commodities and P_i is the proportionate value or area of the ith commodities in the total value or area.

The index ranges between 0 and 1 value. If the values close to 1 point at more diversify cropping pattern or complete diversification, value of 0 indicates in contrast a situation of monoculture or complete specialization. In this study, we used several agricultural crops in order to calculate the index common in smallholder farming in four provinces of Uzbekistan. Crops included cereals (barley, rice, wheat), pulses (bean and leguminous), potatoes, spices, vegetables and others. Based on literature review the level of crop diversification was classified as shown in Table 1.

Table 1

Category of crop diversification based on value

Category	SID value
No diversification	≤ 0.01
Low level diversification	0.01 to 0.25
Medium level diversification	0.26 to 0.50
High level diversification	0.51 to 0.75
Very high-level diversification	> 0.75

Results. At the time of survey period, farmers have been cultivated around 23 crops including cereals, pulses, root and tubers and vegetables on a given piece of land through allocating the crop season into four different periods. In terms of diversification, the result indicated that the average crop diversification index within the sample of farmers was 0.56 with a standard deviation of 0.17. The result implies that most of the farmers had a quiet high level of crop diversification intensity in different part of the Uzbekistan (Figure 2) whereas still around 11% of farmers have not practiced any types of crop diversification activities or cultivate only one or two state order crops cotton and wheat. The finding was almost comparable with the findings of Bobojonov et al., (2013) and Conrad et al., (2017) who found 0.65 and 0.68 in Khorezm (in 2008) and Fergana Valley (during 2010-2012), respectively.

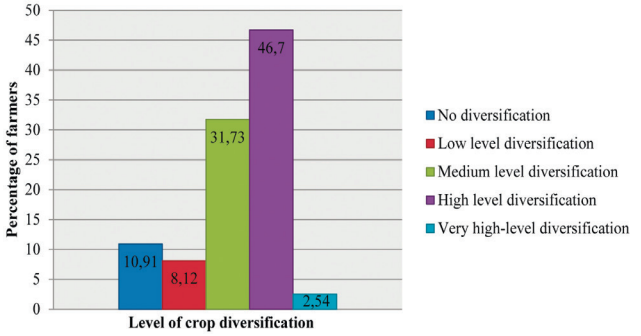

Figure 2. Level of crop diversification of farmers in study areas. Source: Own estimation based on survey data

Figure 3 also portrayed that the crop diversification index was normally distributed and moderately skewed to the right implying that most of the farmers were not too diversifier in their cropping portfolio because of the majority of farmers were more likely to cultivate only cereal crops such as cotton, wheat and rice due to the

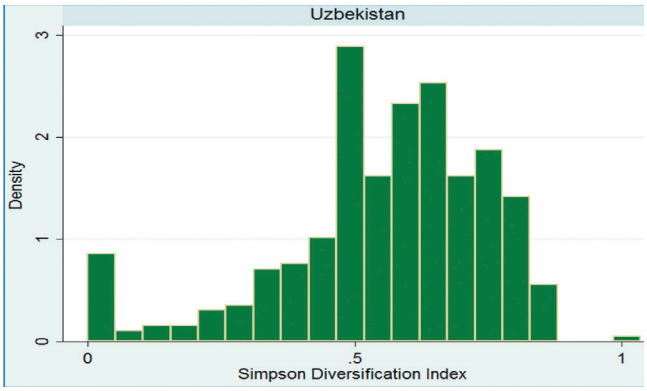

Figure 3. The mean crop diversification index in study areas. Source: Own estimation based on survey data

strong regulation of the national government on the agricultural practices in the country [1].

Discussions. Crop diversification as an effective strategy which can help farmers to mitigate potential risks associated with mono-cropping and reallocate productive resources away from low-value food grains towards high-value cash crops to help increase and sustain farm income. The survey results show that Tashkent regions farmers shifted towards more diversification cropping patterns than other counterparts of the country. In addition, the overall result in the four states combined in this study reveals a mean Simpson Index within the sample of farmers was 0.56. This implies that the farmers in the study areas were not too diversified in their cropping pattern. Regional and district level of crop diversification level are also presented in Table 3. The results in table 3 shows the mean Simpson Index was found 0.59, 0.45, 0.56 and 0.62 for Andijan, Karakalpakstan, Kashkadarya, and Tashkent states, respectively.

Table 2

Descriptive statistics of level of crop diversification in study areas

Regions	Districts	Observation	Mean	SD	Min	Max
Andijan	Ulugnar	13	0.56	0.15	0.20	0.75
	Balikchi	25	0.66	0.11	0.45	0.83
	Andijan	26	0.55	0.17	0.02	0.78
	Djalakuduk	13	0.56	0.10	0.47	0.75
Karakalpakstan	Shumanai	16	0.41	0.15	0.11	0.63
	Chimbai	16	0.49	0.23	0	0.75
	Hoddjaili	16	0.36	0.24	0	0.69
	Turtkul	16	0.54	0.19	0.03	0.76
Kashkadarya	Chirokchi	18	0.56	0.18	0	0.80
	Yakkabog	18	0.60	0.08	0.47	0.74
	Kamashi	18	0.65	0.09	0.52	0.82
	Kasbi	36	0.51	0.17	0	0.82
	Kasan	16	0.50	0.09	0.37	0.77
	Nishan	15	0.54	0.10	0.41	0.67
Tashkent	Kuiichirchik	34	0.61	0.12	0.35	0.83
	Urtachirchik	34	0.59	0.18	0.09	0.84
	Chinaz	17	0.67	0.09	0.49	0.76
	Buka	17	0.53	0.19	0.17	0.83
	Zangiota	17	0.71	0.13	0.37	0.82

Source: Own estimation based on survey data.

Conclusions and policy implications. Crop diversification is considered a key potential strategy for improving inclusive farm income and household food security. The study has examined the degree and extent of crop diversification at farm level across different states of Uzbekistan. The Simpson Index values indicate that the mean computed diversity index was found 0.59, 0.45, 0.56 and 0.62 for Andijan, Karakalpakstan, Kashkadarya and Tashkent regions, respectively. This implies that Tashkent region farmers shifted towards more diversification cropping patterns than other counterparts of the country. The overall result in the four states combined in this study reveals a mean Simpson Index within the sample of farmers was 0.56. This suggests that the farmers in the study areas were not too diversified in their cropping pattern. Crop diversification also helps the farmers to improve on the right selection and cultivation of different crop types on their farms. We therefore conclude that crop diversification enhances availability of foods for the households and income of farmers.

The policy implication of the study is to encourage farmers cultivating several crop species helps them to manage both price and production risks which attains more food options for the household and income through marketing the produce from the surpluses. Therefore, the government needs to intensify the promotion of crop diversification in order to increase farm income and food security in the country. Crop diversification also helps the farmers to improve on the right selection and cultivation of different crop types on their farms. Alongside, crop diversification might contribute to the efficient use of labor in the farming.

References:

1. Abdullaev, I., De Fraiture, C., Giordano, M., Yakubov, M., & Rasulov, A. 2009. Agricultural water use and trade in Uzbekistan: Situation and potential impacts of market liberalization. International Journal of Water Resources Development, 25(1), 47-63. http://doi.org/10.1080/07900620802517533.
2. ADB, 2019. Completion Report, Uzbekistan: Innovations for Agriculture Modernization.
3. Aheibam, Monika, Ram Singh, S. M. Feroze, N. Uttam Singh, R. J. Singh, and A. K. Singh. 2017. "Identifying the Determinants and Extent of Crop Diversification at Household Level: An Evidence from Ukhrul District, Manipur." Economic Affairs 62(1):89.
4. Ahmadzai, H. (2018). "Status, Patterns, and Microeconomic Drivers of the Extent of Diversity in Crop Production: Evidence from Afghanistan". School of Economics, University of Nottingham, CREDIT Research Paper 17/07.
5. Begdullayeva, T., Kienzler, K.M., Kan, E. 2007. Response of Sorghum bicolor varieties to soil salinity for feed and food production in Karakalpakstan, Uzbekistan. Irrig Drainage Syst 21, 237–250 https://doi.org/10.1007/s10795-007-9020-8
6. Benin, S., Smale, M., Pender, J., Gebremedhin, B., & Ehui, S. 2004. The economic determinants of cereal crop diversity on farms in the Ethiopian highlands. Agricultural Economics, 31(2-3), 197–208.
7. Bobojonov, I. 2008. Modeling crop and water allocation under uncertainty in irrigated agriculture: A case Study on the Khorezm Region, Uzbekistan, Ph.D. Thesis. Bonn University, Bonn, Germany.
8. Bobojonov, I., Lamers, J. P. A., Bekchanov, M., Djanibekov, N., Franz-Vasdeki, J., Ruzimov, J., & Martius, C. 2013. Options and constraints for crop diversification: A case study in sustainable agriculture in Uzbekistan. Agroecology and Sustainable Food Systems, 37(7), 788-811. http://doi.org/10.1080/21683565.2013.775539.
9. Conrad, C., Löw, F., Lamers, J.P.A. 2017. Mapping and assessing crop diversity in the irrigated Fergana Valley, Uzbekistan. Appl. Geogr. 86, 102–117.
10. Dagar, V., Jit, P., Bhattacharjee, M., Lochav, M. 2018. An analysis of income from crop diversification in Haryana. Indian Journal of Economics and Development. Vol 6 (11), November 2018.
11. Decree of Republic of Uzbekistan. PD-4947, 2017. "National Development Strategy for 2017-2021". Collection of low documents Republic of Uzbekistan. National database of legislations Republic of Uzbekistan, www.lex.uz
12. Djumaboev K, Hamidov A, Anarbekov O, Gafurov Z and Tussupova K. 2017. Impact of Institutional Change on Irrigation Management: A Case Study from Southern Uzbekistan. Water, 9(6), 419, doi: 10.3390/w9060419 http://www.mdpi.com/2073-4441/9/6/419
13. Hasanov, S., Mirza, N. A. 2011. Agricultural efficiency under resources scarcity in Uzbekistan: A Data Envelopment Analysis. Business and Economic Horizons, 4(1), 81-87.
14. Hasanov, Sh., Ahrorov, F. 2013. Uzbekistan's Agriculture Status Quo, Challenges and Policy Suggestions. International Conference and Young Researchers Forum-Natural Resource Use in Central Asia: Institutional Challenges and the Contribution of Capacity Building (No. 189913). University of Giessen (JLU Giessen), Center for International Development and Environmental Research.
15. Hasanov, Sh. 2016. Agricultural policies to enhance the development of fruit and vegetable subsectors in Uzbekistan. European Scientific Journal, vol. 12 (13), May. http://dx.doi.org/10.19044/esj.2016.v12n13p479
16. Hasanov, Sh., G, Sanayev. 2018. Non-farm employment trends and policy in rural areas of Samarkand region (Uzbekistan). Discussion Paper, #176. IAMO, Germany.
17. Hitayezu, P., Zegeye, E. W., & Ortmann, G. F. 2016. Farm-level crop diversification in the Midlands region of Kwazulu-Natal, South Africa: patterns, microeconomic drivers, and policy implications. Agroecology and Sustainable Food Systems, 40(6), 553–582.

18. FAO, 2017. “Country programming framework for the Republic of Uzbekistan 2014-2017”
19. FAO News, 2019. http://www.fao.org/europe/news/detail-news/en/c/1177059/ Accessed on: 20.10.2020
20. Karimov, A. 2013. Productive Efficiency of Potato and Melon Growing Farms in Uzbekistan: A Two Stage Double Bootstrap Data Envelopment Analysis. Agriculture 3, 503-515; doi:10.3390/agriculture3030503
21. Misirova S. A. 2015. Systematic Types of Fungi of Allocated and Determined Types from Decorative Flowers in Conditions Region Tashkent. Agricultural Sciences, 06, 1387-1392. doi: 10.4236/as.2015.611134
22. Nurbekov, A., Aksoy, U., Muminjanov H., Shukurov, A. 2018. Organic agriculture in Uzbekistan: Status, practices and prospects. FAO, Tashkent.
23. Rudenko I., Nurmetov K., Lamers J.P.A. 2012. State Order and Policy Strategies in the Cotton and Wheat Value Chains. In: Martius C., Rudenko I., Lamers J., Vlek P. (eds) Cotton, Water, Salts and Soums. Springer, Dordrecht. https://doi.org/10.1007/978-94-007-1963-7_22
24. Sanaev, G., Kim K. 2017. Analysis of Technical Efficiency of Tomato Production in Samarkand region, Uzbekistan. JRSD-26, 247-271.
25. Saraswati, P., Bhat, A. (2011): Crop Diversification in Karnataka: An Economic Analysis. Agricultural Economics Research Review Vol. 24 December 2011, 351-357.
26. Singh, N. P., Ranjit Kumar, Made O. A. Manikmas, Bambang Sayaka, Ketut Kariyasa, Lara Marie M. De Villa, Fezoil Luz C. Decena, and Rogelio N. 2002. Concepcion. UNESCAP-CAPSA CAPSA Working Papers.
27. World Bank, 2020. Agriculture modernization in Uzbekistan. Retrieved on 31 October 2020, https://www.worldbank.org/en/news/press-release/2020/03/20/world-bank-to-provide-further-support-to-modernization-of-uzbekistans-agriculture-sector.

MAIN DIRECTIONS FOR DEVELOPING FOOD SECURITY

Sh.M. Murodov - PhD at the department of Economics
Tashkent Institute of Irrigation and Agricultural Mechanization Engineers

Abstract

Socio-economic and political processes and realities taking place in the world that pose a threat to it are the main factors that threaten food security in countries. This is reflected in the emergence of global economic, financial, agrarian crises, a reduction in international food markets and an increase in prices for them, on the one hand, and in the persistence of a trend towards a decrease in acreage of agricultural crops in the context of an increase in the world population and an intensification of the urbanization process, on the other. An increase in the production of dangerous products as a result of the widespread use of various antibiotics, hormones and similar components harmful to human health in the process of food production in order to generate high incomes on the world market in the context of global warming, globalization of the economy, the spread of plant pests and various dangerous viruses still further aggravates the problem.

Key words: agrarian policy, agro-industrial complex, agrarian food sector, food security doctrine, food, food security, forecast, population, supply directions, agricultural products, strategy.

Introduction. On the agenda of the meeting with the participation of UN member states in September 2015, the global Millennium Development Agenda and the 2030 Sustainable Development Goals were adopted. One of the objectives of this program is to "end hunger, ensure food security and improve nutrition, and promote sustainable agriculture ". In particular, since 2020, the issue of growing and delivering the main types of agricultural and food products for consumption by the population is considered the most urgent task on a global scale in the context of epidemiological risks, that is, in connection with the COVID-19 pandemic. Of course, in this situation, as a result of "panic purchases" observed in many states, the disappearance of the main types of food products in trade, the measures of the main exporting countries to stop the export of these goods, in some states, lead to instability in food prices.

In particular, in China for the same period (January-February), when measures were taken against the spread of Coronavirus, food prices rose by 21.2% compared to January-February of the previous year . Therefore, the issue of ensuring food security in the countries of the world is directly related to the elimination of these problems that are observed on a global scale. Since the first years of independence, food security issues have occupied one of the central places in the socio-economic policy of Uzbekistan. Therefore, the Strategy of Action for five priority areas of development of the Republic of Uzbekistan in 2017-2021 set the task: «Modernization and intensive development of agriculture: deepening structural reforms and dynamic development of agricultural production, further strengthening the country's food security, expanding the production of environmentally friendly products, significant increasing the export potential of the agricultural sector ». In addition, the beginning of actions for our country's accession to the World Trade Organization indicates that the problem of ensuring food security is one of the urgent not only at the territorial or national, but also at the international level. In this regard, the assessment of food security, the study of scientific, theoretical and methodological aspects of its provision, as well as research to substantiate priority areas are considered urgent problems in this area [1].

Methods. Scientific research on the problems of economic security, including food security, is becoming more and more relevant in the context of the intensification of global processes in the market economy and the world economic system. The problems of economic security, including the problems of food security, were studied in the scientific works of such scientists as M.G. Alimzhanov, A.N. Anishchenko, K.M. Bekmukhamedova, A.M. Zhondarev, L.P. Goncharenko, A.A. Kaygorodtsev, A. V. Kolosov, E. N. Krylatykh, A. A. Lysochenko, V. Z. Mazlova, N. V. Mezhonova, V. I. Nazarenko, E. A. Oleinikov, V. K. Senchagov, T. V. Uskova, I. N. Furs, in our country leading scientists such as O. A. Abduganiev, H. P. Abulkasymov, S. S. Bekenov, B. B. Berkinov, B. E. Mamarakhimov, T. S. Rasulov, Sh. .R.Kobilov, D.N.Saidova, T.S.Rasulov, I.B.Rustamova and others. However, insufficient attention paid to a comprehensive study of scientific, theoretical and methodological issues of assessing and ensuring food security in the republic requires special attention and an approach to studying and solving food security problems. [4]

First of all, you need to define the term food safety. Food security is a complex concept with at least two meanings. The first is related to the purely economic process of food supply. The second is caused by the importance of food security for maintaining national security in its internal and external manifestations. The reliability of food security of the state is determined by a number of indicators, the most important of which are the following: the level of agricultural production in the country; the degree of food self-sufficiency; carryover stocks; the level of consumption of critical foods and the availability of food for the poorest and the size of this group.

By all these indicators, the situation in Uzbekistan is quite serious. Food security is a state of the economy of Uzbekistan, including its agro-industrial complex, in which the population is provided with appropriate resources, potential and guarantees and without reducing the state food reserve, regardless of external and internal conditions, its needs for food are satisfied in accordance with the physiological norms of the country. Food security is a well-functioning system that provides all segments

of the population with food according to accepted physiological standards (definition by FAO, Food and Agriculture Organization of the United Nations). We are talking about meeting the needs of the population through our own production and rationalizing the necessary imports for those products for the production of which there are no internal conditions. Ensuring food security contributes to a sustainable social climate in society. In the absence of the necessary supplies and reserves in the regions, discontent of the population may arise, which makes it possible to consider the food problem as the most important structural element that ensures the national security of the country. Ensuring food security is based on the organization of the entire agro-industrial complex - from growing plants and animals to providing it with means of production and selling end products. These are the problems of labor resources, raw materials, materials, etc., covering large inter-sectoral, and in fact, national problems.

The food security of Uzbekistan, given its endowment with natural resources, is based on the maximum self-provision of basic foodstuffs as a pivotal element in maintaining national sovereignty. The mechanism for ensuring food security includes a system of socio-economic and institutional-legal norms to prevent threats leading to the loss of the population's provision of basic food products. The system provides for constant monitoring of food production and imports, as well as per capita consumption, taking into account their availability. At the same time, maximum permissible values of food consumption per capita are developed, a decrease in which can lead to the destabilization of society. Comprehensive monitoring allows us to identify external and internal threats to food security and food independence and outline the main ways to prevent them. FAO experts determine the state of global food security by the volume of world grain reserves and its production per capita. A transitional margin equal to 17% of the total consumption over a two-month period is considered safe. A level below 17% leads to an increase in world grain prices.

The provision of the population with food is carried out by:

1) the development of domestic production using such factors of intensification as land reclamation, chemical application, mechanization, biotechnology, integration and cooperation, complex processing of raw materials to reduce its losses, etc;

2) quotas for the import of finished products, which allows supporting domestic producers;

3) combined.

The increased attention to the food problem of Uzbekistan is associated not only with the vital need, but also with those global climatic and social changes that are taking shape in the world. In connection with climatic changes in Uzbekistan, a land reclamation program with targeted budget financing is urgently needed. If in the world 17% of irrigated land provides 40% of food production, then in Uzbekistan during the transition to the market, land reclamation was actually destroyed. Meanwhile, the climatic factor - droughts and lack of precipitation - has a significant impact on the value of gross harvests of agricultural crops in Uzbekistan. Uzbekistan should have such a number of irrigated areas that, under all extreme conditions, would meet the needs of the population for food, reserves and export potential.

The strategic goal of food security is to provide the country's population with safe agricultural products, fish and other products from aquatic biological resources (hereinafter - fish products) and food. The guarantee of its achievement is the stability of domestic production, as well as the availability of the necessary reserves and stocks [5].

The main tasks of ensuring food security regardless of changes in external and internal conditions are:

- timely forecasting, identification and prevention of internal and external threats to food security, minimization of their negative consequences due to the constant readiness of the system for providing citizens with food, the formation of strategic food stocks;
- sustainable development of domestic production of food and raw materials, sufficient to ensure the country's food independence;
- achievement and maintenance of physical and economic accessibility for every citizen of the country of safe food products in volumes and assortments that correspond to the established rational norms of food consumption necessary for an active and healthy lifestyle;
- food safety [2].

The strategy, to a certain extent, represents the consensus of domestic agricultural economists regarding the main directions of development of the country's agro-industrial complex.

The Strategy proposes a whole range of interrelated measures to improve the elements of the economic mechanism: in the areas of pricing, lending, direct government subsidies, insurance, taxation, customs and tariff regulation, proposals are made to improve economic institutions.

About world food security implies the interconnection and interaction of the following components (Figure 1).

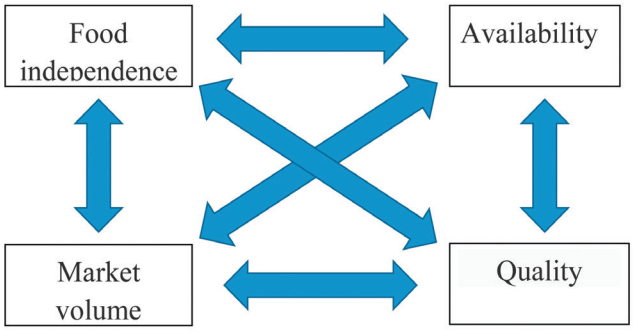

Figure 1. Interconnection and interaction of the following components

In our opinion, as important elements of the concept of food security, which is set out in the Rome Declaration on World Food Security, it is important to add to it social aspects based on the achievement of food security in physical (quantitative) and economic terms, food independence, reliability and stability and other components. (Figure 2) [3].

It should be noted that food safety is ensured at different levels. Therefore, food security manifests itself in different ways. Based on the results of the study, in our

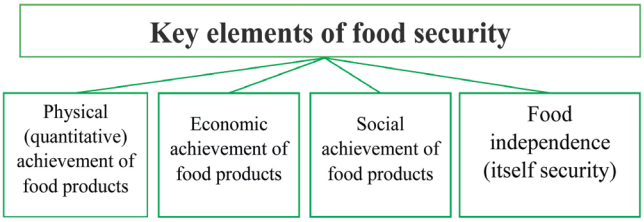

Figure 2. Key elements of food security

opinion, it is advisable to highlight the following levels of food safety:

– a high level of food security - the production of agricultural and food products is at a level above the required minimum level of consumption of the population, which is provided and exported only by the country's producers;

– ensured food security - the production of agricultural and food products mainly meets the internal needs of the state, and consumption is at a level above the required minimum level of the population, which is provided by the country's producers;

– additionally ensured food security - the production of agricultural and food products does not fully satisfy the internal needs of the state, food products from abroad are partially imported so that the consumption of the population is above the required minimum level;

– food dependence - the production of agricultural and food products does not meet the domestic needs of the state, the required minimum level of consumption is ensured by importing food from foreign (third) countries.

It should also be noted that it is important for the country to take into account both external and internal threats in ensuring food security.

External threats to the country's food security are manifested in socio-economic and political processes, factors and realities that arise outside the country, including on a global and global scale, as well as in neighboring countries and partners that pose a threat to it. Internal threats include factors, processes and realities that negatively affect the country's food security, create risks, complicate it, and cause problem situations. [4]

Results and discussion. Ensuring food security is an important priority direction of the economic strategy and policy of any country, and political, social, and national stability in society depends on the effectiveness of its implementation. To do this, it will be necessary to formulate a system for ensuring the country's food security and a mechanism for its implementation.

The dissertation notes that the mechanism for ensuring food security is a set of interrelated organizational forms and economic methods at the international, national and regional levels, combined into a regulatory mechanism based on uniform legal norms that allow the state to stabilize the level of food security.

In our opinion, the mechanism for ensuring national food security includes security actors at the international, national and regional levels, tools and principles for ensuring food security and its assessment, the development and implementation of a program to improve the level of food security, their monitoring and adjustment to programs taking into account the results of monitoring.

It is also important to clearly define the criteria and indicators of food security in the implementation of state policy aimed at ensuring the food security of the country. Today, there are several methodologies based on a system of indicators for assessing food security. The methodologies of the Food and Agriculture Organization of the United Nations (FAO) and the Global Food Security Index (GFSI) deserve special attention not only in theoretical understanding of this problem, but also in its assessment.

The FAO International Food Security Identification and Assessment System has been introduced since 1996, and the FAOSTAT website has been published as an open database since 2011. Since 2016, the system of these indicators has been improved in accordance with the objectives of the United Nations Global Program on the Millennium Development Goals and the Sustainable Development Goals for the period up to 2030. And the GFSI has been operating since 2012, mainly of three scorecards, that is, the capacity and consumption of economically affordable food products; availability and sufficiency of food products; the quality and level of food safety, in order to assess the impact on food security, such risks as global climate change and a decrease in the amount of available natural resources, since 2017, the indicators "natural resources and stability".

For example, according to the food security index ranking analysis, according to the levels achieved in the countries of the world in terms of ensuring food security, high-income countries occupy the highest places in the ranking. However, in 2019, in the ranking of these countries, compared to 2012, there are either positive or negative situations. There is a positive situation in our republic, if in 2012 it ranked 72nd in the world, then in 2018 - 80th place. And in 2019 it was 9 points higher than in 2018 (Figure 3).

The analysis also showed that as a result of large-scale economic reforms carried out in our country, there were positive situations in the assessment of this rating, and if, according to 2012 estimates, the growth in the level of economic acceptability of food products amounted to 35.1 percent, the level of accessibility and sufficiency - 44 , 9 percent, quality and safety level - 44.9 percent, then in 2019 the growth was 65.6%, respectively; 55.1%; 53.4% vs. 54% [8].

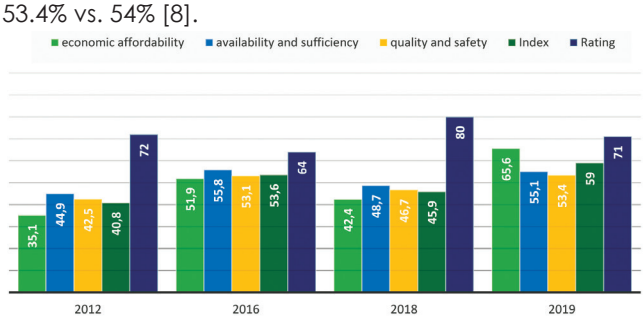

Figure 3. Rating of the Republic of Uzbekistan among the countries of the world in terms of food security

Based on the main goals and objectives of the activities of the main state and non-state structures that form the institutional basis for ensuring food security, the mechanism for ensuring food security in the Republic of Uzbekistan, in our opinion, includes three important areas, namely: regulation and stimulation of food production in agro-industrial complex, achieving and meeting the needs of the population in food products,

as well as levers and measures to increase opportunities in this area, improve the system of organizing food security management in the Republic of Uzbekistan. [5]

Analysis of management and legal support, ensuring food security of our country, shows that the necessary forms and methods of state intervention in agri-food relations in accordance with the current situation, the relationship of market participants with the goals of agri-food policy require legislative consolidation. The analysis showed that at present the issues of the possibility of economic and physical possession of food products by the population of the country, as a necessary condition for the realization of constitutional rights to life, do not have a specific feature. Because the mechanism for ensuring the human rights to food is not well developed and the concept of food security is not sufficiently harmonized with generally accepted international law. This also requires further refinement of the legislation.

Thefactthatfoodsecurityincludestheimplementation of complex measures, as well as the implementation of these tasks, in turn, is assigned to various state-non-state bodies and departments, that is, the absence of a coordinating body for the implementation of the tasks of organizations and departments belonging to different departmental affiliations , does not allow you to effectively organize the implementation of these tasks. Therefore, in our opinion, it is advisable to adopt a law "On food security of the Republic of Uzbekistan", which establishes strategic goals and priority directions in the food sector and related sectors of the economy. This law also occupies a special place in the legislative system for the development of international law, which is considered as a necessary condition for ensuring fundamental human rights and freedoms, including the right to life. In addition, in order to further improve the mechanism for ensuring food security, it is advisable to formulate, under the Cabinet of Ministers of the Republic of Uzbekistan, a system for coordinating the performance of the functions of food supply by state authorities and authorized bodies, economic management and other interested organizations responsible for the stable provision of insects with safe and high-quality food products, bringing the level of consumption of the population to rational norms, assessment and control based on monitoring the state of the agro-industrial complex and food security. This system should make it possible to form a single electronic portal for identification, analysis and forecasting of food security in the regions. Since the criteria and indicators for assessing food supply require an approach that takes into account the case of territorial differentiation, due to the climatic conditions of the regions of the republic, the demographic situation, national traditions, etc.

In order to study the problems of ensuring food security in Uzbekistan, the dissertation analyzes the ratio of production volumes of the main types of agricultural products per capita to rational consumption standards. As analyzes show, the growth in the production of basic types of food products per capita in 1991-2019 came a little closer to the rational consumption rates established by the World Health Organization and the Ministry of Health of the Republic of Uzbekistan, for the production of grain crops, vegetables and melons and gourds, these norms (table 1) [7].

The analysis shows that the above positive aspects can be assessed as the final result of economic reforms carried out in the agricultural sector during the years of independence. In particular, the production of potatoes, milk and dairy products, eggs, fruits and berries, meat (in live weight) per capita somewhat approached the level of rational norms of their consumption. Cereals are provided on average by 150% in relation to the rational norms of average per capita consumption. However, this situation does not mean that food security has been achieved in terms of growing grain crops in the country. The reason is that one of the indicators characterizing food security is the degree of dependence on imports of these products. The analysis shows that every year our country retains a significant volume of grain and flour imports. In turn, this is due to the lack of direct access to the consumption of bread and bakery products from grain varieties grown in the Republic.

On the other hand, grain is grown mainly in irrigated crop areas. This in turn. is one of the main internal threats

Table 1

The ratio of the volume of production of basic types of agricultural products per capita in Uzbekistan to rational consumption rates (%)

	In relation to WHO standards *,%			In relation to the norms of the Ministry of Health of the Republic of Uzbekistan,%		
	1991	2016	2019	1991	2016	2019
Grain	76,7	206,3	159,1	71,7	192,7	148,6
Potatoe	17,9	95,4	85,5	17,8	95,1	85,2
Vegetables and melons and food crops	146,9	249,6	247,3	153,7	261	258,7
Fruits and berries	31,1	119,5	96,9	30,2	115,9	93,9
Meat (live weight)	54,6	99,6	103,7	52,4	95,6	99,6
Milk	36,4	76,4	78,0	35,6	74,8	76,3
Eggs (pieces)	24,6	83,2	91,0	21,8	73,8	80,7

that impede the implementation of the task of ensuring sustainable food security in conditions of limited water resources and the continuation of this trend in the future.

Also, one of the main problems hindering the sustainable maintenance of agricultural production is the high level of dependence on imports of seeds and pet food for growing food products (Figure 4) [8].

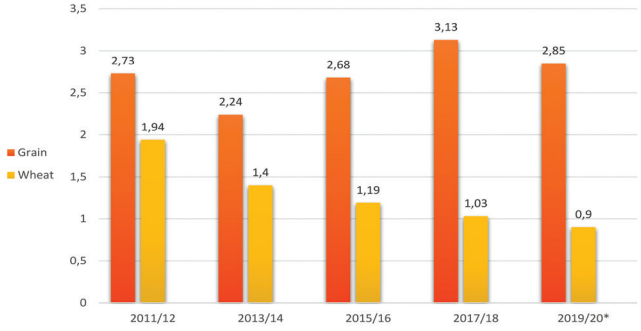

Figure 4. Dynamics of imports of wheat and flour in the Republic of Uzbekistan, million tons

Per capita consumption of bread and bakery products has always been above the level of rational norms in accordance with these recommendations. In 2019, the actual level of per capita consumption of vegetable oil in relation to the norms recommended by WHO and the Ministry of Health of the Republic of Uzbekistan was higher by 183.6 and 263.7 percent, respectively. In addition, in 2019, compared to 1990, the actual level of consumption of meat and meat products increased in relation to rational norms from 44.2 percent to 61.6 percent and from 42.5 percent to 59.2 percent, respectively [7].

Such positive shifts can be recognized as a positive result of cooperation between the agrarian sector of the republic and the agrarian sector of the world economy. Therefore, in 2015, our country was recognized as one of 14 countries that received an award from the Food and Agriculture Organization of the United Nations (FAO) for achieving the Millennium Development Goals in the field of food security.

At present, in order to achieve the consumption of

Table 2

Dynamics of changes in the actual level of consumption of basic food products per capita in relation to rational consumption rates (в %)

Types of products	Rational consumption rate according to WHO (kg/person per year)	Rational consumption rate in RUz (kg/person per year)	In relation to WHO standards *,%		In relation to the norms of the Ministry of Health of the Republic of Uzbekistan,%	
			1990 г.	2019 г.	1990 г.	2019 г.
Bread and bakery products	120,5	129	141,1	147,4	131,8	137,8
Meat and meat products	70,1	73	44,2	61,6	42,5	59,2
Milk products	404	413	45,3	66,8	44,3	65,4
Vegetables and melons	140,3	134,1	76,3	197,6	79,8	206,7
Vegetable oil	13,1	9,1	91,6	183,6	131,8	263,7
Sugar, along with confectionery	36,5	40,5	32,8	85,5	29,6	77,03

As you know, one of the directions for achieving food security is directly related to the level of modernization, technical and technological modernization of the warehouse, processing and transport infrastructure, not only in agriculture, but also in other branches of the agro-industrial complex - food industry, agriculture and food. During the years of independence of the Republic of Uzbekistan, as a result of the implementation of programs for reforming industries, structural transformations and diversification, as in all sectors of the economy, there is a tendency for the share of the food industry to grow in the gross volume of industrial production. As a result, when comparing the rational norms recommended by the World Health Organization and the Ministry of Health of the Republic of Uzbekistan on average per capita consumption of basic types of food products, the actual consumption levels in the years of independence also tend to grow. After all, comparing these indicators with medical standards makes it possible to assess the state of healthy consumption of the population.

basic types of food at the level of rational norms, it is necessary to intensively develop agriculture, food and processing industries, and further improve the culture of consumption of the population.

Conclusions. The analysis shows that the level of processing of agricultural food products in our country is much lower, as evidenced by the presence of problems in this direction. These problems are associated with an insufficient number of enterprises of processing networks, as well as with the fact that their main production assets are outdated enough, processing enterprises are located unevenly throughout the republic. Also, one of the most important problems in the food industry is associated with the fact that the level of processing of agricultural products is still low.

Based on the context, from our point of view, the main directions should be reflected in the following decisions:

1. Proceeding from the fact that food security includes the implementation of complex measures,

imposing on various state and / or non-state bodies and departments, in addition, due to the lack of a coordinating body for the implementation of the tasks of organizations and departments belonging to different departmental affiliation, it does not allow effective organize these tasks. We believe that the adoption of the law "On Food Security of the Republic of Uzbekistan", which establishes strategic goals and priorities in the food sector and in interconnected sectors of the economy, is considered appropriate, which will take a special place in the legislative system for the development of international law.

2. An important area of ensuring food security is the protection of the rights and interests of consumers. To do this, it is necessary to increase the effectiveness of public control over the activities of non-profit organizations, eliminate the illiteracy of consumers' legal knowledge with the help of the media, etc.

3. Based on the characteristics of agricultural land, it is necessary to develop and implement a scientifically grounded program for the placement of agricultural crops in the regions, in order to prevent a sharp reduction in the area of agricultural crops.

4. To form a system of regulation and control over the application of regulations for chemical agents applied to agricultural products by means of laboratory analysis of the residual amounts of nitrates, pesticides and heavy metal salts contained in the product for consumption.

References:

1. Vilkov I.A. The complex of organizational and economic conditions for ensuring food security. DOI: 10.18454/IRJ.2016.51.071.
2. M.G. Porvadov, E.A. Kuznetsov. Food security as a component of the national security of the state. ISSN 2221-7711 Russia's national priorities. 2016. №1 (19).
3. Guliyev E.A-ogli. Current realities and trends in global food security. Russian Journal of Entrepreneurship. №7/ 2018. ISSN 1994-6937/
4. Sergeev I.A., Sergeev A.U. Threats to food security in Russia. Food security and policy. — 2014. — T. 1. — № 1. —C.13-24. http://journals.creativeconomy.ru/index.php/ppib/article/view/253.
5. H.P.Abulkasimov, N.Saydaxmedova. Supplying food safety issues in Uzbekistan. European Journal of Economics and Management Sciences. Austria, Vienna. №1, 2017. Pg 17-21.
6. H.P.Abulkasimov. The basic results and the perspective directions of the independent development of the economy of Uzbekistan. Innovation sustainability harmonizing science, technology and economic development with human and natural environment. Proceedings of the uzbek-japan sumposium on ecotechnologies. Tashkent, 2016 14 may. Pg 240-248.
7. Data from the Ministry of Economy of the Republic of Uzbekistan and the State Committee of the Republic of Uzbekistan on Statistics.
8. Report of FAO (Food and Agriculture Organization of the United Nations) and Global Food Security Index for 2012-2018. https://gtmarket.ru/ratings/global-food-security-index/info.

OPPORTUNITIES FOR PUBLIC-PRIVATE PARTNERSHIPS IN THE FIELD OF AQUACULTURE

G.D. Dusmuratov - c.e.s., associate professor, I.O. Yunusov - PhD, associate professor
Tashkent Institute of Irrigation and Agricultural Mechanization Engineers

Abstract

The problems and solutions of the introduction of public-private partnership (PPP) mechanisms in the aquaculture sector are considered. Based on the analyzed experience of foreign countries and Russia, it was concluded that it is necessary to create a fishery cluster for the implementation of PPP projects by joint efforts. In addition, recommendations for the most effective implementation of PPP mechanisms were given.

Key words: public-private partnership, aquaculture, small business, fishery complex, large enterprises, regional cluster.

Introduction. The intensive development of aquaculture in the world began in the 50 years of XX century. A stable growth in the volume of fish production is observed annually. In recent years, Uzbekistan has paid great attention to the development of the fishing industry, the expansion of fish production, further improvement and research in the field of fish farming, improvement of training and retraining of personnel and increasing the export potential of the industry. For this, the necessary legal framework and conditions for enterprises are being created; measures are being taken to increase the attractiveness of the sphere for investors, including foreign ones. By the decree of President of the country dated April 6, 2018, the establishment of a free economic zone for fish farming "Fish Producer" in the Kuyichirchik district of the Tashkent region was approved. Its activities have been established in accordance with a government decree of August 20 this year.

According to the recommendations of the Ministry of Health of the Republic of Uzbekistan, the minimum amount of fish consumption in Uzbekistan, necessary for the healthy development of the body, is 12 kg per person in a year. For comparison, the following facts can be cited. Average per capita fish consumption per year in Japan is 65 kg, in North America - 24 kg, in EU countries - 21 kg.

The dynamic growth of the population of the republic leads to an increase in demand for fish products. According to various estimates, to meet the needs of the population of Uzbekistan on the basis of medical standards, it is necessary to produce about 400 thousand tons of fish products annually.

Aquaculture (from the Latin aqua - water and culture - cultivation, breeding, cultivation) - breeding and cultivation of aquatic organisms (fish, crustaceans, molluscs, algae) in natural and artificial reservoirs, as well as on specially created marine plantations.

Mariculture is the part of aquaculture that deals with fish farming and the rearing of other organisms in marine waters (marine farming). Fish farming is a form of aquaculture. It provides for fish farming in fish hatcheries in tanks or pens. Equipment that allows young fish to be released into the wild for recreational fishing or to replenish natural species is usually referred to as fish hatchery stations.

Aquaculture is one of the fastest growing food industries in the world, most of which is currently produced in developing countries, where aquaculture is expected to continue to provide food for the population. The vast majority of aquaculture practices around the world provide significant social and food benefits, typically with little or no environmental cost. This industry is actively developing in the Republic of Uzbekistan, where intensive technologies are being introduced to improve production efficiency.

Aquaculture is important for obtaining fresh fish products and expanding their range. The annual increase in the demand for fish products in Uzbekistan requires an increase in production volumes, which leads to raise in the costs of maintaining the inventory base and modernizing production.

The productivity that the state requires from the agricultural complex, and in particular from the aquaculture sector, cannot be fully ensured without the use of PPP, since the level of budgetary provision differs from region to region, and therefore some regions are simply not able to build or contain even basic production facilities and infrastructure, not to mention modernization and reconstruction. Therefore, it has become extremely important for the state to find solutions that will make it possible to use the capital of the private sector to solve the problems of state policy.

The use of PPP in the fishing industry has also largely become an urgent measure for Uzbekistan, necessary in order to keep pace with the growth rates of fishery complexes in other countries, where since the middle of the last century the state took the industry into its own hands to ensure its stable growth and functioning. At the same time, it is still important to maintain a balance between government support and stimulation of self-development of companies in the industry.

In this regard, an acute question arises: how to integrate the PPP mechanism into the field of aquaculture at the republican and local levels, so that this synthesis would lead to the strengthening of the fishery complex. This question should be answered by an analysis of the existing risks and opportunities of the fisheries industry in Uzbekistan, as well as world experience in the use of PPPs in aquaculture.

Materials. On May 10, 2019, President of Uzbekistan signed the Law on Public-Private Partnership (PPP). The document was officially published in the National Legislation Database on May 11.

According to the law, a public-private partnership is a cooperation between public and private partners, legally formalized for a certain period, based on the pooling of their resources for the implementation of a PPP project.

The basic principles of PPP are equality before the law of public and private partners, transparency of procedures, competitiveness and objectivity in the selection of a private partner, inadmissibility of discrimination and corruption.

The Agency for the Development of Public-Private Partnerships under the Ministry of Finance has been designated as the regulator in this area.

The public partner enters into a PPP agreement with a private partner, determined through a tender or direct negotiations. Bidding criteria should be clear and free from discriminatory provisions.

To participate in a tender, a private partner must have legal capacity, have the financial, technical and labor resources necessary to fulfill obligations and have no bases, the presence of which could lead to a conflict of interest.

The term of the public-private partnership agreement is up to 49 years.

The selection of a private partner will be based on a tender or direct negotiations. At the same time, the procedure for holding a one-stage and two-stage tender is established: for PPP projects with a total cost equivalent to $ 1 million (inclusive), a one-stage tender is held, more than $ 1 million - a two-stage tender (prequalification and selection of the winner).

A PPP agreement without a tender based on direct negotiations may be concluded in the following cases:

• ensuring the defense capability and security of the state;

• belonging to a certain person of exclusive rights to the results of intellectual activity, other exclusive rights, land plot, other real estate and other property, which is an indispensable condition for the implementation of a public-private partnership project;

• defined by decrees and resolutions of the President of Uzbekistan.

The document provides for mechanisms to protect the interests of a private partner and establishes a procedure for monitoring and reporting on the implementation of PPP projects. The mechanisms of financial support for PPP have been identified, the main types of which are grants and subsidies, tax benefits, contributions in the form of assets, loans, government guarantees and others.

In total, as follows from the Program of Measures for the Accelerated Development of the Fishing Industry in the Republic for 2018-2023, approved by the President of the country, 35 million pieces of fish seed will be grown in five new joint and foreign joint ventures in two years. The cost of ongoing projects is estimated at 5 billion soums.

The program includes:

- improvement of selection and breeding work for intensive cultivation of valuable fish species, fish seed (fry) on the basis of public-private partnership;

- expansion of the production of fish products (canned food, caviar, flour, delicacies and others);

- implementation of measures for the development of aquaculture, effective and rational use of land and water resources;

- further development of research work in the field of fish farming;

- improvement of training, retraining and advanced training of personnel;

- increasing the export potential of the fishing industry;

- increasing the fodder base for the development of fish farming, improving the culture of fish consumption, as well as further increasing the role of the "Uzbekbaliksanoat" Association in the management and coordination of the fishing industry;

- creation of conditions for strengthening the material and technical support of fish farms.

Nevertheless, even in spite of the legal regulation of the industry, there are various kinds of risks that hinder the inflow of investments into the fishery sector, namely:

1) Legal risks:

• inadequacy of the administrative control system to the peculiarities of fish products, which have a limited shelf life;

2) Economic risks:

• low purchasing power for quality fish products in Uzbekistan;

• impossibility to conduct any financial transactions with quotas (as collateral, object of transactions in the secondary market, etc.).

Discussions. All the above problems and risks are becoming weighty arguments in favor of reorganizing the aquaculture sector in Uzbekistan. The most popular way to increase the profitability and financial attractiveness of the industry is the introduction of public-private partnership mechanisms. There are several potential benefits of PPPs. They are:

• improving the quality of service. The private sector has an incentive to be efficient, while the Government has experience in governance; when properly regulated, a PPP contract can also stimulate innovation through performance indicators and penalties for non-compliance;

• increasing profitability. PPP enables the public sector to take advantage of the innovation, expertise and flexibility of the private sector;

• increasing investment without burdening public resources. By bridging the gap between infrastructure needs and public financial capacity, PPPs can provide public goods and services without recourse to taxpayers;

• best risk sharing: risk can be delegated to the party that can handle it at the lowest cost;

• fast implementation. If pay is tied to the performance of certain jobs, the private sector will be motivated to complete the job promptly;

• increased investment in technical innovation. PPPs can create incentives for the development of new technologies and abstract them from inclusion in government budgeting cycles.

Having analyzed all the opportunities and limitations

of the aquaculture sector in the PPP format, then one should move on to specific examples of PPP integration into the fishery sector to identify positive and negative trends in practice.

When considering foreign experience in the implementation of PPPs in the aquaculture sector, one can observe a certain tendency that most research and news on this topic comes from developing countries, while the countries of Europe and North America find themselves outside information sources in the context of interaction between the state and the private sector in aquaculture. ... Most likely, this is due to the fact that such interaction, as noted above, has existed in these countries for more than a dozen years, and it makes no sense to introduce fundamental innovations into an established industry.

In this regard, we will consider the cases of developing countries, the experience of which can be used in Uzbekistan. For example, consider the aquaculture industry in Indonesia and India.

Indonesian experience. On the northeast coast of Aceh, Indonesia, thousands of small-scale aquaculture farmers struggled to manage production due to shrimp diseases, poor quality of shrimp larvae, lack of consultation and poor management. Production was already low and inconsistent, and the 2004 tsunami brought additional losses. From humanitarian investments to rehabilitate aquaculture infrastructure and livelihoods, partnerships have emerged between newly formed farmer organizations, donors, local governments and research institutions. Aquaculture Livelihood Service Centers (ALSCs) have spawned 24 production cooperatives.

These are community organizations using traditional community leaders. ALSC offers services to more than 2,600 farmers with over 2,000 hectares of brackish waters suitable for shrimp farming. These services help farmers apply better management practices, reducing disease risk and improving productivity. ALSC's business units provide services such as collective buying of hoppers, feed and fertilizers, demonstration ponds, microfinance, inventory management and marketing. ALSC plans in the future to expand the number of farmers served and complete the value chain by improving harvesting technologies and gaining access to international markets.

From interviews and an online survey of the research organization, information was obtained on the views and experiences of PPP partners and was able to highlight the main principles that were most important for the development and implementation of successful partnerships in the field of aquaculture and fisheries:

• a government-backed public-private partnership strategy with a regulatory framework that supports property rights, accelerates entry into macroeconomics and eradicates corruption;

• the intentions and motives, interests and obligations of all partners (public, civil and private) must be consistent with each other in order to allow any partnership to be workable;

• strong leadership from the private partner in the management of the PPP is essential;

• solid financial funds and economic planning with acceptable and sustainable goals are key factors in the development of entrepreneurship and business;

• formal, approved, transparent, fair and balanced governance structures and information flow within PPPs are necessary to maintain trust and commitment from all partners;

• synergy created by applying skills, knowledge and knowledge from different sources is a key motivating factor for joining the partnership; continuous capacity building and knowledge transfer are required by all partners.

India experience. India was the forerunner of PPP relationships in aquaculture. In 1971, the All India Coordinated Research Projects were launched in active partnerships with various state governments for wider adoption of new technologies. In addition, a marketing and demonstration program in private waters was implemented; the Labto Land program and many other programs have strengthened PPP in aquaculture. The Government of India has initiated another PPP model through the farm development agencies, which operate in more than 400 units. They have produced good results in the current environment, and therefore partnerships are initiated by NGOs, cooperatives and individual entrepreneurs.

India has a more unplanned-administrative economy. Globalization and an open market economy have led to a growing interest from corporate and green investors in Indian aquaculture, which offers great opportunities for the sector to demonstrate accelerated growth maintain and expand the export market.

The aquaculture sector is known to be diverse, encompassing traditional, artisanal and family businesses, medium-sized fisheries and multinational aquaculture and mariculture enterprises. The technology is also diverse.

Despite the fact that the trend in the development of aquaculture is shifting towards the development of modern intensive production technologies such as high-tech, traditional breeding systems for carp, tilapia, catfish, etc. will continue to operate in fish ponds and open farms, shrimp in brackish waters, fish in marine cages and inland waters, catfish in ponds or paths, bivalve mollusks in lines and stakes, algae in lines and ponds.

These methods will remain important aquaculture systems for the participation of small-scale poor farmers in international trade. All systems provide opportunities for PPP development from product development to service-oriented partnerships. Several states have formed PPP appraisal committees and have involved authorities in promoting the partnership.

Based on foreign experience, we can conclude that the successful implementation of PPP in the field of aquaculture largely depends on the cooperation of private partners. As we can see, Indonesia and India have taken a big leap forward in aquaculture through the creation of cluster-type interactions, where private sector companies come together to form associations to jointly implement PPP projects. In such conditions, small-scale farming will have the opportunity to use traditional

fish farming methods along with the latest technological advances, and therefore to be competitive in the domestic and international markets. Experience shows that a cluster can include: large enterprises, small and medium. Today, one of the most common directions in the development of aquaculture is the cluster system, the role of clusters is very important in ensuring innovative development of the industry and ensuring the competitiveness of goods and services (Figure 1).

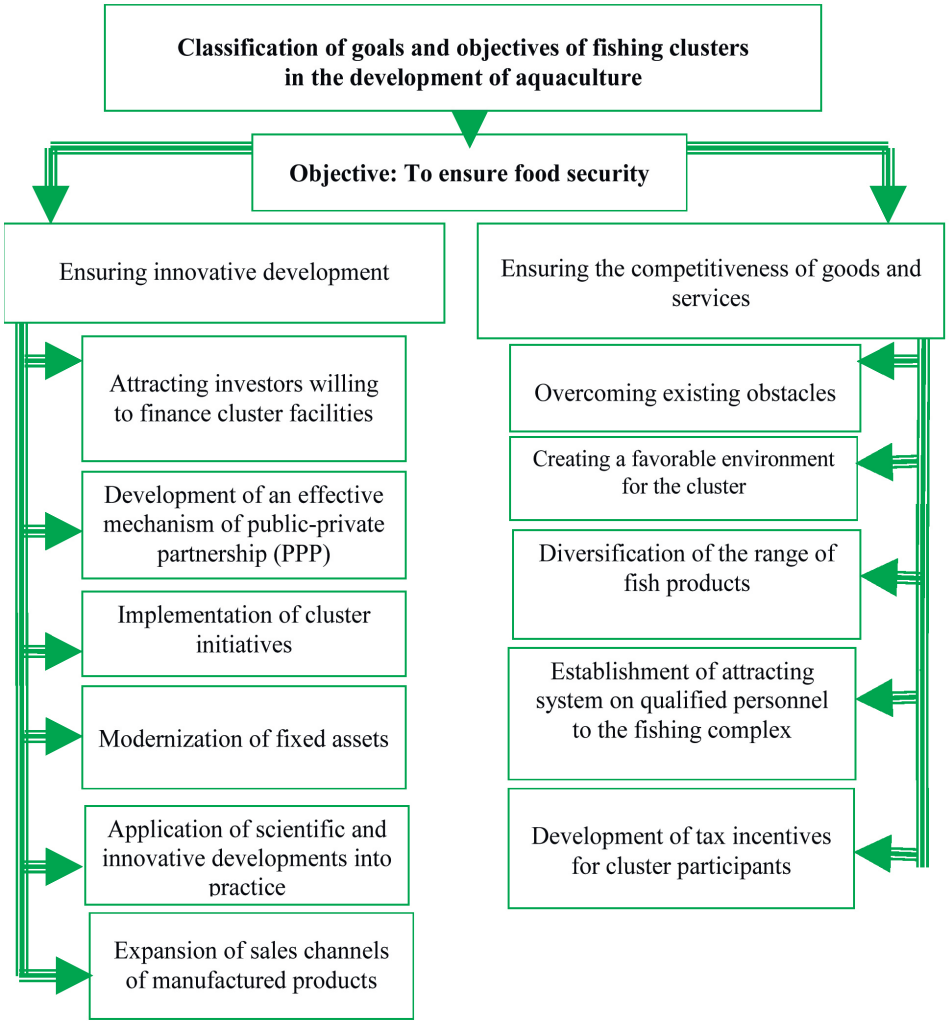

Figure 1. Classification of goals and objectives of clusters in the development of aquaculture

Conclusions. It should be noted that the analysis of factors, planning and control over the activities of all subjects of the cluster have their own specifics, in connection with which it is necessary to centralize all the above functions. This will allow coordinating the activities of the cluster, creating a coherent strategy and acting within the framework of a large organization united by a common goal. All of the above will increase the growth of fish production, increase the degree of implementation of innovations and their level, increase the level of automation of production and administration processes, create new aquaculture facilities, expand production capacity and expand the range of products due to the wide representation of cluster organizations.

On a broader scale, it should be said that a smallholder model for the product value chain is required to enable farmers to develop and remain competitive. Success is more likely if the public sector can:

- promote the use of PPPs in fisheries and aquaculture development as a major investment route in production and in sector-related services such as incubators, feed production, advisory services and marketing;
- to develop PPP-related skills in local government institutions through centers of competence specialized in the development of fisheries, aquaculture and agriculture;
- to implement strategies for private sector development with a more active role of the private sector. Make active use of PPP structures, where incentives and obligations are designed to meet specific social needs for services, infrastructure, improved livelihoods and social development;
- to recognize smallholder farmers and fishers as commercial partners of the private sector that are of great importance to society and the economy. Small-scale operators should interact with each other to achieve commercial order through the development of appropriate management intermediaries;
- to create financial support structures for the private sector, especially for small farmers, for example, through support packages based on microfinance, tax incentives and insurance to mitigate risks;
- to build platforms or associations with a high degree of importance, bringing together partners of different sizes who agree on strategic goals for the development of the sector and social needs and assign responsibilities appropriately;
- to provide capacity building and general education for smallholders and their organizations to enhance their technological, management and commercial skills to meet the demands of complex value chains.

An important role in the use of PPPs in the development of aquaculture in Uzbekistan will be played by recent changes in the PPP regulation. On May 10, 2019, the law "On public-private partnership" (PPP) will be adopted. Aquaculture businesses naturally fall under this law. The application of the law will help to strengthen regional economies and modernize the agricultural sector. That is, the use of modern organizational and financial mechanisms in the development of aquaculture, namely the implementation of a cluster approach using PPP, will make it possible to make a breakthrough in its development and achieve the goals set in the Agriculture Development Strategy of the Republic of Uzbekistan.

References:

1. Report of President of Uzbekistan at the meeting of the Cabinet of Ministers dedicated to the results of the country's socio-economic development in 2015 and the most important priority areas of the economic program for 2016.
2. U.Sangirova, J.Namozov, U.Ahmedov, G.Dusmuratov, R.Xakimov Features of GIS application in agriculture. // Journal of Xi'an University of Architecture & Technology Volume XII, Issue IV, 2020 Issn No: 1006-7930 P.305-308 (Scopus base).
3. U.Sangirova, J.Namozov, U.Ahmedov, G.Dusmuratov, R.Xakimov. Features of GIS application in agriculture and logistics. // VIII International Scientific Conference Transport of Siberia – 2020. IOP Conf.Series: Materials Science and Engineering. 918 (2020) 012140 doi: 10.1088/1757-899X/918/1/012140, P.1-6. Scopus.
4. Yunusov I.O. The main aspects of improving the production efficiency of fish products. "Economics and innovation technologies" journal. № 1, 2017. - P 1-6.
5. Ponomareva O.N. Ways to increase the economic efficiency of reproduction of fish stocks / / Bulletin of the State Agrarian University of Krasnoyarsk. 2006.- P.35-37.
6. Yunusov I.O. Essence and Indicators, characterizing the economic efficiency of Reproduction of Fish reserves. // Scientific Journal: Economics and Finance. Issue1. Ukraine – 2019, (ISSN 2311-3413, (12) Index Copernicus, (18) Ulrich's Periodicals Directory). – P.11-17.
7. Yunusov I.O. Determining the interdependence of factors, affecting the development of fish farming. // International Journal of Research Culture Society. Monthly Peer-Refereed, Indexed Journal. Volume-3, Issue-8, Aug – 2019. (ISSN: 2456-6683, (23) Scientific Journal Impact Factor, id=19648, (14) Research Bib, (1) Web of Science (Web of knowledge), Impact Factor: 4,526 http://ijrcs.org). – P.42-47.
8. Юнусов И.О. Необходимость производства рыбных продуктов в стране. // XXX Плехановские чтения/тезисы докладов. Российский экономический университет имени Г.В.Плеханова. – Москва. 2017. – С.81-82.
9. Сангирова У.Р., Юнусов И.О. Баликчилик тармокини баркарор ривожлантириш масалалари. // "Агроиктисодиёт" журнали – 2018, №1(4). – Б.33-35. (08.00.00. №25).
10. FAO Sofia Report 2016 and Globefish Highligh October 2017; FAO Food Outlook June 2016, EUMOFA Monthly Highlights 4/2016.
11. Шохимардонов Д. Дунё баликчилиги. // O'zbekiston qishloq xo'jaligi. – 2008, №5. – 17 б.
12. Комилов Б.Г., Халилов И.И. "Дарё форелини етиштириш – Ўзбекистондаги фермерлар учун юкори даромадли агротижорий имконият". http://sgp.uz/uz/news/1029.

EXPERIENCES ON WATERMELON AND MELON CULTIVATION AND THEIR EXPORT: IN CASE OF SPAIN

U.Z.Alimov - PhD student
Tashkent Institute of Irrigation and Agricultural Mechanization Engineers

Abstract

The article analyzes the growth and export of olericultural products in Spain. It is possible to get acquainted with the problems faced by growers in the cultivation of olericultural products and get information about the general state of the industry. Some of the best practices in the Spanish olericultural industry have been recommended for use in Uzbekistan.

Key words: olericulture, irrigated agriculture, organic products, climate change, drought, exports, digital marketing.

Introduction. Today, a small portion of Europe's gross domestic product (GDP) falls on agriculture, and it is clear that the impact of agriculture on the European economy is considered low. However, the area used for agriculture (agricultural and forestry lands) occupies 40 per cent of the EU land area. It also plays an important role in the lives of the rural population and their incomes. The importance of agriculture is also reflected on a global scale. Irrigated land for agriculture accounts for one-fifth of the world's arable land, but produces 40-45 percent of the world's food. The production of agricultural products on irrigated lands is much higher in Spain. In Spain, irrigated agriculture accounts for more than 60 percent of agricultural output. However, irrigated land accounts for 14 percent of the land used in agriculture. In Europe, Spain has a significant position in terms of agricultural production. Spain ranks second in the European Union after France with 24 million hectares of agricultural land (for crops and pastures), and Spain ranks fourth (11%) after France, Germany and Italy in terms of production. In Spain, the cultivation of olericultural products is based on specialization by region, the cultivation of melons in Castilla-La Mancha, Murcia, Catalonia, the cultivation of watermelons in Andalusia, Valencia, Murcia has For example, irrigated land in the Castile-La Mancha region accounts for 11 percent of the irrigated land used in Spanish agriculture, but the region produces more than 40 percent of its agricultural output. Spain led the world in watermelon exports in 2019, accounting for more than 30 percent of world watermelon exports. (Figure 1).

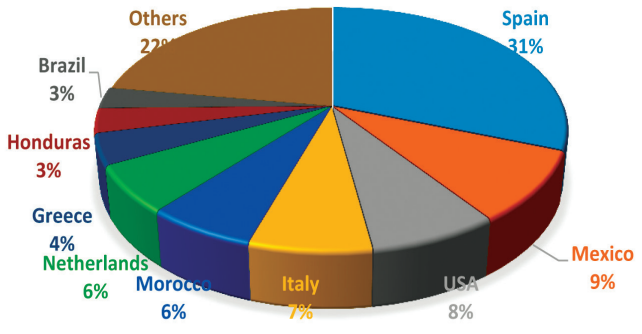

Figure 1. In 2019, the countries that exported the most watermelons in the world. Source: Central Intelligence Agency, created by the author based on data from the World Economic Outlook Database

Despite being a world leader in olericultural products exports, in 2019, watermelon and melon exports in Spain fell by 4.8 percent. In addition, the role of olericultural products in the structure of Spanish exports is very low (Table 1). Table 1 provides information on the top 10 most exported goods and services in Spain, as well as the share of olericultural products in exports and growth in 2019. The impact of watermelon and melon exports on the Spanish economy is very low, as can be seen in Table 1.

In 2019, watermelons and melons accounted for 0.25% of the total volume of goods and services exported in Spain.

The Common Agricultural Policy (CAP) has been in place since 1962 to summarize the EU's agricultural reforms. The Common Agricultural Policy is to support farmers and increase agricultural productivity, provide affordable food, increase employment in the agro-industrial and other agricultural-related sectors, fight for sustainable agricultural development, climate change and the rational use of natural resources, designed to ensure a decent standard of living, and this policy is common to all EU member states. The new "General Agricultural Policy" adopted in 2013 is planned to be implemented in 2014-2020, which sets the following goals:

- strengthening the competitiveness of the agricultural sector;
- development of sustainable agriculture and innovation;
- support for job creation and economic growth in rural areas;
- providing financial assistance to support the efficient use of land.

Method and materials. We can draw conclusions about the current state and development strategies of Spanish olericulture by analyzing the problems and obstacles in the olericultural network. It provides an analysis of the volume of olericultural production and export performance. We can assess the overall state of the network by systematizing existing problems and providing information on their solutions.

In Spain, the growth rates of olericultural products, including watermelons and melons, have varied in recent years. (Figure 2).

Although watermelon cultivation in Spain was on an upward trend in 2014-2017, by 2018, 35.8 thousand

Table 1

Information on products exported by Spain in 2019

№	Name of goods and services	Export volume (USD)	Share in total exports	Growth rate in 2019 compared to 2018 (in%)
1	Automobiles	34,406,167,000	10.3	-4.1
2	Refined petroleum products	15,550,608,000	4.7	-5.3
3	spare parts of automobile	10,653,366,000	3.2	-9.3
4	medicines	9,373,388,000	2.8	+11.5
5	Trucks	5,815,287,000	1.7	-10.2
6	Pork	5,123,537,000	1.5	+27
7	Women's clothing	3,723,689,000	1.1	+8.9
8	Planes, spaceships	3,712,952,000	1.1	+7.7
9	Citrus fruits (wet and dried)	3,586,097,000	1.1	-1.8
10	Olive oil	3,286,791,000	1.0	-8.1
11	Watermelon, melon	831,611,000	0.25	-4.8
12	Others	237,488,107,000	71.2	+1.6

Source: Compiled by the author based on Eurostat and worldstopexport data.

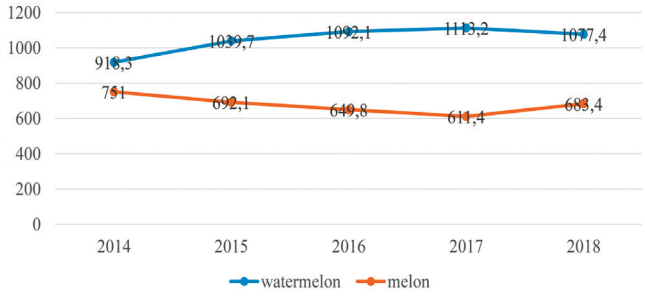

Figure 2. The volume of watermelon and melon cultivation in Spain in 2014-2018 (thousand tons) Source: https://www.statista.com/

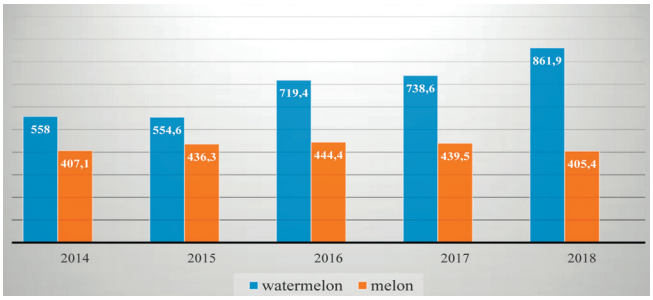

Figure 3. Exports of watermelons and melons grown in Spain in 2014-2018 (thousand tons). Source: https://www.statista.com/

tons less watermelons were grown than in 2017. Melon production has maintained a declining trend in 2014-2017, and only in 2018 did it achieve growth compared to the previous year. In 2018, 27.0 thousand tons more melons were grown than in 2017. In 2018, Spain led the production of 683.4 thousand tons of melons with 244 thousand tons of Castile-La Mancha, 219 thousand tons of Murcia and 133.2 thousand tons of Catalonia. Watermelons and melons grown in Spain have a significant share in world exports (Figure 1). In Figure 3, the volume of watermelon exports grown in Spain in 2014-2018 maintained a steady growth, but the export volume of melons grown did not maintain the same growth trend. In 2016, 444.4 thousand tons of melons were exported, which is the highest figure in the analyzed years.

Despite the positive results achieved in the cultivation and export of olericultural products, producers in Spain are facing problems. The most important of these problems are climate change and the relatively low standard of living in rural areas. Today, rising temperatures, droughts and floods are worrying growers. The location of the leading melon-growing regions in the southeast can lead to significant adverse effects on drought and rising air temperatures (Figure 4). 34% of the total agricultural land is irrigated, and agricultural products grown on irrigated land account for 50% of the total production. Demand for water is growing in the southeastern part of Spain, which grows its main olericultural products. According to accurate estimates, the demand for agricultural irrigation in 2020 is projected to fall from 771 mm to 701 mm, while the demand for irrigation is projected to increase by 6% in 2020 compared to 1961-1990 and by 9% in 2070.

Another important problem faced by large and medium-sized farms producing olericulture is the lack of manpower. Eighty-four percent of Spain's territory is rural, with only 16 percent of the population. The average age of the rural population is higher than that of the urban population, which is a particular concern for these farmers, as it is observed that mostly young people and women are leaving the villages. In Spain, 3.7 percent of the rural population is under the age of 35, and 33 percent is over the age of 64.

Results and discussion. Spain is a country with great potential for growing olericultural products. As can be seen from Figure 1 above, Spain accounted for 31% of world watermelon exports in 2019, amounting to $ 473.9 million, and was the world leader. In 2018, Spain achieved the highest yield in melon exports. According to Figure 3, although melon exports to Spain decreased in 2016-2018 (444.4 thousand tons in 2016, 439.5 thousand

Figure 4. Map of the territorial division of Spain Source: Urban History Journal No. 43, Part 2, May 2016, p.293

tons in 2017, 405.4 thousand tons in 2018), Spanish melon exports accounted for 305.8 million euros in revenue. achieved. This is estimated at an average melon price in 2018 of 0.754 euros per kilogram when exported. In recent years, the number of companies engaged in the export of olericultural products is declining. According to the Estacom statistical service, in 2018, 538 companies were engaged in the export of 1267.3 thousand tons of watermelons and melons, in 2014, 622 companies were engaged in the export of watermelons and melons. In 2018, the main buyers of Spanish melons will be European countries (France, Germany, Great Britain, the Netherlands, Portugal). One of favorite products in the summer in Spain is melon and watermelon. St. Gregory is the most famous melon variety, grown in La Mancha. Also the most popular varieties are French cantaloupe, reddish blue-gray melon and light yellow, smooth post honeydew, galia. Melons grown in the eastern part of Spain are in demand as the highest quality product. In October, a melon museum and festival will be held in Villakonois, Madrid. Although year-round, greenhouse-grown melons are highly competitive, Spanish melons remain in place.

Conclusions and recommendations. Spain has favorable geographical, natural and organizational-economic conditions for growing olericultural products. Spain's leadership in watermelon exports, the high revenue from melon exports can be the basis for the development of the industry and the fight against existing problems.

In Spain, climate change is cited by scientists as the main problem on the negative impact on the olericultural network, but the negative impact of the social problem on the development of the network is high. Today, issues such as the use of new hybrid seeds, the use of high technologies in fertilization and processing, the high demand for labor in the cultivation of melons lead to an increase in the impact of the social problem. In recent years, the migration of people living in rural areas, especially young people and women, to cities has increased. It can be said that the decrease in the volume of melon production and the decrease in the number of companies exporting melons are also due to the social problem.

We can recommend the following Spanish experience in the cultivation and export of olericultural products in Uzbekistan:

1. Development of selection work in the field of olericulture. It is important to create varieties that are competitive in the world market. The experience of long-term storage of new varieties, disease resistance, minimization of the use of chemicals in the cultivation of organic products or disease protection, the creation of unique products with a complete and shape, taking into account the wishes of consumers in some regions and countries. Increasing the share of local companies in seed production, development of scientific research, directing financial resources for scientific research in the creation of seedless hybrid varieties.

2. Development of the system of sales of olericultural products will increase the economic interest of the industry. Organize melon museums and festivals in the regions to promote sales at the peak of production, expand marketing opportunities by promoting marketing using digital tools to promote the usefulness and specificity of taste, strengthen communication and sales channels.

3. Creating a system of growing organic products, developing the medicinal properties of products and ensuring the preservation of useful minerals in them.

4. Three aspects should be taken into account when calculating efficiency: economic, environmental and social. The importance of family business in agriculture is associated with the development of cooperatives. Vertical integration is important as it increases the chances of revenue retention in this network. Family farming is a characteristic feature of Spanish agriculture. The widespread use of intensive methods in the cultivation of melons, the introduction of crop production at all times of the year, the provision of subsidies to the industry by the state are also important aspects of development.

References:

1. European Environment Agency, environmental statement 2006.
2. Food in a green light A systems approach to sustainable food, EEA report №16 2017 European Environment Agency, Copenhagen
3. Petra Doll and Stefan Siebert "Global modeling of irrigation water requirements" WATER RESOURCES RESEARCH, VOL. 38, NO.
4. Water resources across Europe - confronting water scarcity and drought, EEA Report №2/2009, European Environment Agency, Copenhagen
5. Common Agricultural Policy info, Food Farming Fisheries 2013
6. Eurostat: Agriculture, forestry and fishery statistcs 2018
7. T.Azcarate "Food policy in Spain" Reference Module in Food Science, 2019
8. Hortinfo report 2018
9. Silvia Andres Gonzalez-Moralejo, Francisco Estruch Sanchis "The Common Agricultural Policy and the Increased Competitiveness of Spanish Regional Agriculture" Journal of Agricultural Science; Vol. 9, No. 6; 2017
10. Ю.А. Быковский, Т.Г. Колебошина «Пути развития бахчеводства в Волгоградском Заволжье» журнал Кортофель и овощи №7 2015
11. I.Yunusov Foreign experiences on the development of fish-farming: in case of Croatia, Journal of "Sustainable Agriculture" №1(5).2020
12. Испания харитаси, Urban History журнали 43-сон, 2-кисм, май 2016, 293-бет
13. statista.com
14. fao.org
15. climatechangepost.com

POSSIBILITIES OF ATTRACTING FOREIGN INVESTMENT IN THE ECONOMY OF THE REPUBLIC OF UZBEKISTAN

U.K. Akhmedov - PhD, associate professor
Tashkent Institute of Irrigation and Agricultural Mechanization Engineers.
S.Kh. Kholmatov - associate professor of "Agribusiness and Marketing" department
Andijan Institute of Agriculture and Agrotechnology

Abstract

The article points out the need to attract foreign investment to the economy of Uzbekistan. Favorable conditions created for foreign investors are highlighted. Opinions are given on the solution of some of the problems that hinder the increase in investment.

Key words. Investments, foreign investors, investment climate, investment attractiveness, investment projects, centralized investments.

Introduction. Today, the issue of the formation and development of investment activities in the Republic of Uzbekistan is very relevant. This is evidenced by the frequent study of the issues raised in numerous monographs. One of the indicators of the future development of the state is high investment activity. As the foreign experience shows, the country that pursued an active investment policy achieved sustainable growth of its economy. Therefore, investment is the driver of the economy, in other words, it is the heart of the economy [5].

Modern Uzbekistan is a leading state in the Central Asian region, ensuring stability and economic development of the region as a whole. Among the advantages that the modern economy of Uzbekistan offers for foreign companies are political and macroeconomic stability, favorable natural and climatic conditions, hospitable and hardworking people and many others.

In the Republic of Uzbekistan there are no restrictions on the form of investment. Foreign investors can create enterprises on the territory of the republic in any organizational and legal form permitted by law.

The principles of the formation of a sound regional investment policy are: efficiency, structural balance, purposefulness, national significance.

So, we can conclude that the implementation of the correct investment policy is a difficult task, and the solution of many tasks will largely depend on the measures taken to: reduce inflation; tax policy; restructuring of the banking system; legal framework for investment activities; budgetary policy; distribution of leasing investments.

In this regard, when developing an investment policy, the most important tasks should be: creating conditions for enhancing investment activity; deepening institutional and structural transformations, the main task of which should be financial stabilization and the inclusion of all possible sources in the investment sphere, and this requires a legislative framework that provides investors with certain rights and guarantees.

Materials. In general, the investment attractiveness of industries is determined by the relatively low costs of production factors (electricity, natural gas, labor), a significant domestic sales market - about 34.38 million resident population as of October 01, 2020 [8], duty-free access to the markets of the CIS countries (according to various estimates, over 285 million people).

In Uzbekistan, the achieved macroeconomic stability, deepening economic and institutional reforms, improving the investment climate in the country contributed to a significant intensification of investment activity and an increase in the volume of capital investments in the economy. So, in 2018, investments in the amount of 107.3 trillion soums (about 12.9 billion US dollars) were spent in the republic, which is 18.1% more than in 2017; in 2019, the development of investments in fixed assets amounted to 195.9 trillion soums, which is 38.3% of GDP (for comparison, this figure in 2015 was 44.8 trillion soums, or 21.3% of GDP) [7].

The most significant qualitative changes are taking place in the structure of investments by sources of financing. Due to higher growth rates, the share of investments from non-centralized sources is increasing, primarily the share of private and foreign direct investment. In 2018, as part of financing sources for all investments in the economy of the republic, 42.2 trillion soums or 39.3% of all investments are the own resources of enterprises and the population, and 65.1 trillion soums or 60.7% of investments were provided at the expense of attracted funds. If in 1990 there was practically no investment from abroad in the country's investment portfolio, then in 2000 the share of foreign investment and loans was 23.2%, of which 19.8% were foreign investments and loans attracted under the guarantee of the Government, and 3 , 4% - foreign direct investment.

A favorable business environment, a wide system of legal guarantees and benefits for foreign investors, a comprehensive system of measures to stimulate the activities of enterprises with foreign investment contributed to a significant increase in the inflow of foreign direct investment into the country's economy. As a result, in 2012 the share of foreign investments in the total structure of capital investments amounted to 11.7 billion. dollars, of which direct foreign investment - 21.7%. In the following regions of the republic, the share of foreign investments in the total amount of investments in 2018 is the most significant: in the Kashkadarya region - 54.4%, in the Bukhara region - 53.4%, in the Namangan region - 39.6%, in the Navoi region - 36, 4%. This situation is explained by the fact that these regions are rich in natural resources, especially natural gas and mineral resources. Since the main part of foreign investment is attracted to the extraction and processing of natural

gas and the mining industry.

If in 1990 more than 46% of investments in the economy were financed from the state budget, extra-budgetary funds and other centralized sources, then in 2018 in the overall structure of capital investments, funds from the state budget and other centralized sources amounted to 34.5 trillion soums or 32.1 % of all investments.

In the investment strategy of Uzbekistan, priority is given to investment projects aimed at creating new high-tech industries equipped with advanced technology and ensuring deep processing of our raw materials, increasing the country's export potential, and creating new jobs.

In the period 1990 - 2012, in the structure of investments, the share of investments directed to the development of the fuel and energy complex (from 5.2 to 17.1%), transport and communications (from 5.4 to 18.3%), metallurgy (from 0.1 to 2.9%). To create new and modernize existing industries, large capital investments are directed to mechanical engineering, metallurgy, chemical and petrochemical, light, food industries, which determined their significant share in the structure of capital investments in the economy. In 2018, a significant part of the investments attracted to the economy of the republic was directed to the processing industry (22%) and the housing construction industry (16.5%) [7].

Results. In our country, the following priority areas of attracting foreign investment in the republic's enterprises have been identified: the organization of environmentally friendly industries for the extraction and processing of medical raw materials, including oil and natural gas; organization and development of production of science-intensive and competitive products on world markets, including modern information and telecommunication systems; development of transport and telecommunications infrastructure; development of agricultural processing areas based on compact, cheap equipment and technologies; production of resource and energy saving installations and equipment; production of medicines, machinery and equipment; development of the tourism industry.

Thanks to the favorable investment climate, the activities of foreign investors are developing, the number of enterprises with the participation of foreign investors is growing. But at the same time, there are several problems that hinder the widespread attraction of foreign investment. In particular, there are regional disparities in the placement of investments. Thus, 73.5% of all operating joint ventures are located in the capital of the republic. This is explained by the insufficient development of infrastructure in the regions. This means that the development of production and market infrastructure in the regions of the republic is required in a short time.

Conclusion. In addition, to intensify the attraction of foreign investment in the economy of the republic, careful monitoring of enterprises with the participation of foreign capital is required to eliminate problems in their activities. The Government of the Republic has already taken significant steps in this direction. So, starting from 2021, within the framework of programs for the development of social and industrial infrastructure of the Republic of Uzbekistan, funds are provided for financing the following activities as a separate line: a) provision of engineering and communication infrastructure for free economic zones, small industrial zones and large industrial projects with the participation of foreign direct investment ... [2].

To sum up, we can note that the implementation of the above measures will give effective results in attracting foreign capital. In addition, a good effect will be provided by the provision of consulting, legal services to domestic entrepreneurs interested in cooperation with foreign investors, the creation of a permanent, relevant and wide database of foreign businessmen.

References:

1. Об инвестиционной деятельности: Закон Республики Узбекистан №719-I // Собрание законодательства Республики Узбекистан, от 24.12.1998 г.
2. Постановление Президента Республики Узбекистан "Об организационных мерах по формированию программ развития социальной и производственной инфраструктуры Республики Узбекистан", № ПП-4864 от 16 октября 2020 г.
3. О гарантиях и мерах защиты прав иностранных инвесторов: Закон Республики Узбекистан № 609-I // Собрание законодательства Республики Узбекистан, от 30.04.1998 г.
4. Постановление Президента Республики Узбекистан от 26.12.2018 г. за №ПП-4086 «О прогнозе основных макроэкономических показателей и параметрах государственного бюджета Республики Узбекистан на 2019 год и бюджетных ориентиров на 2020-2021 годы».
5. «Обращение Президента Республики Узбекистан Ш.Мирзиёева Олий Мажлису», 22 декабря 2018 года. Источник: www.uza.uz
6. "Процессы модернизации экономики Узбекистана и коммерческие банки в условиях кризиса мировой финансовой системы", официальное издание Банка России - научно-практический журнал "Деньги и кредит". 2010 г. №10, г. Москва
7. www.stat.uz. Сайт государственного комитета Республики Узбекистан по статистике.
8. «Население с начала года выросло на 477,5 тысячи». Источник: https://www.gazeta.uz/ru/2020/10/27/population/.

ISSUES OF ENHANCING THE TRANSFER OF INNOVATIONS TO SMALL BUSINESS

U.K.Akhmedov - PhD, Tashkent Institute of Irrigation and Agricultural Mechanization Engineers
A.G. Tuychiev - PhD, K.K. Mamadaliev– senior lecturer
Andijan Institute of Agriculture and Agro technologies, department of "Agribusiness and marketing"

Abstract

The article discusses theoretical views, as well as the results of a comparative analysis of the study, improvement of the mechanism for financing the transfer of innovations to small business, innovative technologies, their commercialization and the impact of costs on innovation on long-term economic growth, as well as the results of a comparative analysis.

Key words: innovative technologies, commercialization, innovation transfer, sustainable economic growth, econometric analysis, research (R), global innovation index, innovation activity.

Introduction. In today's globalization, the intensification of commercialization of innovative technologies in business calls for the need to increase the efficiency of the use of research results, as well as to improve the use of available resources. The introduction and implication of innovative technologies in business determines, first of all, the use of economical methods of using financial resources in production, as well as the efficient use of productive forces, scientific and technological progress and the development of the economy as a whole.

As the President of our country, esteemed President Sh. Mirziyoyev has repeatedly stated, it is impossible to ensure the country's active participation in international economic relations without creating competitive goods and products in the national economy that meet the standards of the world market.

In particular, the consistent organization of innovation processes in all sectors of the macroeconomy, in all its branches (households, firms, companies, corporations, joint stock companies, private enterprises and other types of production entities), the construction of an effective basis for innovation is central to the production of products that can replace imports, accelerate export and increase foreign exchange earnings [1].

Materials and Methods. Based on international trends in innovation development and the status and characteristics of the mechanism for financing the transfer of innovations to small business in Uzbekistan, the forecast trends in Table 1 are relevant to see the impact of research expenditures on economic growth based on their forecast indicators until 2030 [2].

A cross-country econometric analysis of the impact of foreign innovation financing on sustainable economic growth suggests that a 1 percent increase in government spending on research could increase long-term growth by 0.1 percent. (R= 1 %, Economic growth=0,4 %).

Based on this proportion, forecast indicators have been prepared on the impact of research expenditures on long-term economic growth. At the same time, it was found that a minimum of 0.25% of public spending on research has an impact on economic growth of 0.1%. This means that by 2030, Uzbekistan will be among the top 50 countries in the global innovation index if research spending on forecast indicators is increased.

The results of Table 1 above and the theoretical basis of research and the results of comparative analysis in research can be useful in the development of the concept (or strategy) of innovative development of the Republic of Uzbekistan for 2020-2030. At the same time, Uzbekistan has a sufficient scientific base and potential, as well as favorable macroeconomic conditions and the necessary resources.

Along with this conclusion, the following conclusions are also important for Uzbekistan.

At the end of 2018, Switzerland leads the ranking of countries in the world in terms of innovation opportunities, followed by Sweden and Singapore. The Chinese state is second only to Switzerland, Sweden, Singapore and Finland in terms of science and technology development, but has advantages in the innovation field from countries such as India. In this regard, it is important to consider the experience of leading countries in technology transfer, such as Singapore, Switzerland, Sweden, China and India, as a model for Uzbekistan in terms of innovative capabilities and results.

Table 1

Forecast indicators on the impact of research expenditures on long-term economic growth

Indicators	Reporting year -2018	Forecast											
		2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
The share of research expenditures in GDP, %	0,18	0.43	0,68	0,93	1,18	1,43	1,68	1,93	2,1	2,4	2,6	2,9	3,1
Economic growth, %	5,1	5,2	5,3	5,4	5,5	5,6	5,7	5,8	5,9	6,0	6,1	6,2	6,3

Although Uzbekistan has not yet been included in the Global Innovation Index, Uzbekistan has set a goal to be among the top 50 countries in the Global Innovation Index by 2030.

In recent years, special attention has been paid to the activities of each enterprise in the country, they are provided with many benefits, and the state encourages innovation, which is an achievement of economic reforms and support for innovation, at the same time, the future of a great country is strengthened.

The adoption of the laws on "Standardization and Certification", "Metrology", "Industrial Designs" and "Inventions" and the announcement of 2019 as the Year of "Active Investment and Social Development" are notable examples of state support for innovation.

At the end of the last century, the transition of the main directions of industrial and technological growth to an innovative way of economic development forced the search for new ways to increase the efficiency of the scientific and technological sector. At present, in order to achieve advanced rates of economic growth, it is not enough to support a large amount of research costs, which requires the creation and implementation of management mechanisms that stimulate the transfer of innovative technologies to industrial enterprises. By nature, these are the results of research created at the expense of the state budget.

Commercialization of technology means the process of conducting research services that provide services in order to obtain new products and commercial benefits in the manufacturing sector.

The transfer and commercialization of research results are objective processes that evoke the demands of a market economy.

Technology transfer financing issues should not be viewed as a universal solution or even as a significant source of revenue. Economic profit arise in the process of commercialization of economic activity for both the state and society. The technology transfer will allow the educational institution, research and society to develop and commercialize research results, create a flow of research orders, attract new investment, create new technologies and new jobs, and increase tax revenues associated with the country's power growth.

Since the manufacturers of technologies are scientific institutions and educational institutions, it is expedient to bring them closer to the system of business support and promotion. Educational institutions already have experience in creating innovative infrastructure. Many of them have technoparks and innovation centers, including the creation and promotion of competitive scientific and technical products, as well as innovative consulting on the preparation and implementation of innovative projects. Technology transfer centers operating in educational institutions and research centers have a sufficient reputation as the author of developments and for investors. It is expedient to conduct a systematic state line to support innovative activities through these centers.

One of the innovative systems aimed at overcoming the temporary gap between widespread scientific research in Russia and abroad and the application of their results in production is the technology transfer center. In practice, almost all of them are supported by a ton of state and local governments and administrations, most of the enterprises and business projects that support them are focused on the scientific-scale technological field.

The first system of technology transfer appeared in the 20th century.

The most well-known of these are the Technology Transfer Office (CTO) at the University of California (TTO), the German Fraungof Society (Germany), and the British Technology Group, founded in 1948 by the British government as a national corporation to commercialize scientific and technical results.

Discussions. The dynamics of the creation of technology transfer centers in different countries shows that the legislation reflecting the state policy on the use and regulation of the results of scientific and technical activities obtained with the use of state budget funds has a practical impact on this process.

With such legislation, the Bay Doula laws were enacted in 1980 These laws are aimed at intensifying the process of commercialization of research and development obtained either through financial assistance (Bay-Doula) or in the form of investment in national laboratories, their staff and infrastructure (Stevenson-Wedler) with federal government support.

Many American educational institutions have opened licensing and technology transfer offices.

The activities of innovative offices of educational institutions are constantly monitored by the US government. Managers of the University Technology Association publish publications about their activities every year, provides information on national standards for key indicators of innovative office activities, taking into account the size and type of educational institution.

With the adoption of a technology transfer law by the Japanese government in 1998, the process of establishing a technology transfer center in Japan was intensified.

In France, technology transfer centers became an integral part of the educational institution after the Law on Innovation on July 12, 1999 and 2002. The French Ministry of Scientific Research has issued Recommendations on intellectual property policy.

In 1986, it was decided that educational institutions in the UK had the right to state-funded developments.

In 2001, Italy passed the National Law on the transfer of the right to own, use and regulate intellectual property to inventors, not to organizations.

In Germany, technology transfer centers have focused their activities on creating clusters to develop their programs in accordance with the needs of the industry, the requirements of industrial sectors. They create their own Venture Funds and attract investment to them.

At all levels of cooperation of participants in innovation activities in higher education: regional and individual HEIs, the system of results commercialization should provide the accumulation, analysis and evaluation of innovative potential for the development of programs compatible with the mobilization of resources to implement and promote the results of innovative activities.

Conclusion. As mentioned, the creation of technology transfer centers calls for the need to increase the efficiency of the use of research results, as well as to improve the use of available resources: human, financial and logistical. The main result of the use of scientific and

technical results is the organization of production of products that are in demand in the market. Therefore, the main direction of the technology transfer center is the creation of new businesses based on technological developments in the conduct of research activities of educational institutions.

The transfer of innovation to small business determines, firstly, the use of cost-effective methods of capital investment in business, secondly, the correct placement and efficient use of productive forces, and thirdly, scientific and technological progress and the development of the economy as a whole.

References:

1. Decrees of the President of the Republic of Uzbekistan "On the state program for the implementation of the strategy of action in five priority areas of development of the Republic of Uzbekistan in 2017 - 2021 in the" year of active investments and social development "," On the approval of the strategy of innovative development of the Republic of Uzbekistan for 2019 - 2021 ", "On additional measures to improve mechanisms for financing projects in the field of entrepreneurship and innovation", Resolution of the President of the Republic of Uzbekistan "On additional measures to improve the mechanisms for introducing innovations in the industry and the economy"
2. Abduraupov R.R., Toychiev A.G. Financing the transfer of innovation to small business. Monograph.-Fan .: 2020.-224 p.
3. Gulyamov S.S., Otazhonov Sh.I. Risks in the innovative activity of regions. // Materials of the Forum of Economists of Uzbekistan "Macroeconomic and regional aspects of modeling sustainable economic growth", 14.12.2010, Tashkent / Ed. A.M.Sadykova, Institute for Forecasting and Macroeconomic Research, UNDP.-T .: InfoCOM.uz, 2011.-196 p. (c. 152-159).
4. Salikhov Sh.I. Topical issues of development of innovative entrepreneurship: experience of developed countries (www.inno.uz).
5. Chepel S.V and the group of authors. Economic Growth and Innovation: Theory, Practice and Modeling // IAMI Research Project, supported by UNDP. Tashkent, 2010.
6. Puzankov D.V., Vakhabov A.V., Kutuzov V.M., Muravyev A.V., Shestopalov M.Yu., Ryzhov N.G., Terentyeva I.S., Shokhazamiy Sh.Sh. Models of management of scientific and innovative activities of universities. / Monograph. - T .: Iqtisod-moliya, 2006.-242 p.
7. Toychiev A.G. Financing the transfer of innovation to small business. Abstract of the dissertation.-T .: 2020.-53 p.
8. Electronic source. http://uza.uz/uz/society/o-zbekiston-2030-yilgacha-global-innovatsion-indeks-reytingi-23-09-2018

DEVELOPMENT CHALLENGES OF FRUIT AND VEGETABLE SECTOR OF UZBEKISTAN

S.T. Iskandarov - PhD, Andijan Institute of Agriculture and agrotechnologies, Uzbekistan

Abstract

This article presents development challenges of vegetable and fruit production sector in Uzbekistan. The governmental sector reforms, labour resources, price formation, import and export activities have been the object of the study in this article. The paper reviews several problems with developed support system and further development of fruit and vegetable production in Uzbekistan. The paper is aimed to describe the main problems and challenges and suggest their possible solutions.

Key words: Vegetable and fruit production, labor resources, price formation, import and export activities.

Introduction. Over the years of independence, many efforts to fundamentally restructure the agricultural sector of the country were conducted. According to the principles for reforms, formulated by the President of the Republic of Uzbekistan, the economic transformations in the agriculture are carried out in phases. The following laws have been passed - "On farming", "On dekhkan farming", "On agricultural cooperatives (shirkats)", the Land Code and others. Apart from that, a number of decrees and orders of the President and the Government of the Republic of Uzbekistan were adopted for the development of the agricultural sector as a whole and its individual sectors. In the Presidential Decree "On major directions for deepening of the reforms in agriculture" from March 24, 2018, farming has been identified as a foreground form of economic entity. (www.lex.uz, 2018)

The agrarian reform has led to significant positive changes in the agricultural sector and the production growth. A diversification of the agricultural crops was carried out. Gradual reduction in areas of cotton plant under crops and accommodation in these areas of cereals, vegetables, melons and gourds, potatoes and fodder crops provided an opportunity to prevent shortages and higher prices for food products during the global financial crisis.

In the course of reforming of economic activity, forms in agricultural production there have been developed two types of farming: farms and dekhkan farms. These two types of farming are managed in different modes. Farmers are concentrated on the implementation of government quotas on cultivation of cotton and wheat production and are provided with supply chains, they occupy 84.3% of land resources and their proportion in the production of agricultural products amounts to 35.0%. The republic operates more than 66.1 thousand agricultural holdings. They have been granted to rent 5.8 million hectares of agricultural land in total, of which the planting area amounts to 3.1 million hectares. The average size of a farm accounts for 80 hectares.

Materials. The level of labor resources requirements for the high-yielding cultures is considerably higher compared to that of cotton and wheat. According to the standards, employment of people per 10 hectares of wheat is calculated in 1 person, per 10 hectares of cotton – 5.3 persons, whereas for the production of 10 hectares of vegetables, it takes an average of 21, 7 persons, including those for tomatoes – 25.0 persons, cabbage – 14.0 persons, onions – 28.0 persons, cucumbers – 18.0 persons, melons and gourds - 15.5 persons, potatoes - 16.1 persons, fruits – 7.7 persons, and grapes – 12.2 persons

The analysis of labor productivity in the context of specialization agricultural crops allowed us to establish the following: In vegetable production, for the whole country under the normative employment of 2.17 persons per hectare, the annual requirement for labor resources amounts to 371.1 thousand persons per year with labor productivity of 17.1 tons per person. For comparison: in Andijan region the productivity of labor is 29.5 tons per person, while in the Republic of Karakalpakstan it is 12.0 tons per person (www.stat.uz, 2018).

In this case, there is no intention to contrast the production of high yielding crops with strategic cultures (cotton and wheat); therefore, the increase in the areas of highly profitable cultures should be within reasonable limits and substantiated from the viewpoint of profitability, employment of the population, created added value and increase in foreign exchange revenues generated from the growth of exports. Support for rural development in this case should be addressed to processing, packaging and storage of agricultural production, which will allow farmers and dekhkan farmers receive the maximum revenues through the sale of production in the most auspicious time. Thus, the development of industry infrastructure for processing, drying, sorting, packaging and marketing (including the export of these cultures) contributes to the creation of additional workplaces, increased added value and foreign exchange revenues.

In recent years sown areas under vegetables and melons are increasing. If in 2017, the proportion of vegetables and melons in the acreage structure of agricultural production were respectively, 4.5% and 1.1%, then, in 2019 this indicator has increased correspondingly by 4.7 and 1.3%. There are potential opportunities to increase the area sown with vegetables and melons, such as reseeding after harvesting of wheat (depending on water availability on the area of 300-350 hectares) and the use of low-productive lands, where the productivity of a cotton is below 2 tons per hectare, and the productivity of wheat is lower than 2.5 tons per hectare, and revenues do not cover the costs. These lands constitute approximately 20% of the total irrigated area. As a result of climate changes and the increase in population throughout the world in recent years, the demand for horticultural production and other types of food is increasing. Uzbekistan has implemented

wide ranging measures to increase production for the saturation of the domestic market with the food products.

There is a tendency for the increase of crop productivity, however, in comparison with parameters of developed countries, and potential opportunities of soil and climatic conditions of the regions of the Republic, the progress indicators are low. To increase the amount of fruit and vegetable processing, the special Government Resolution has created "Agro-firms", which are intended to organize the procurement of fruit and vegetable products from farmers and dekhkan farmers, organize the processing and export of production. Their number across the country is currently 267 units.

Discussion. Economic relationships between the founders based on contracts for establishing of domestic prices for products and services. The local market of the Republic of Uzbekistan has gone through lots of development process which resulted in creation of competitive environment between domestic and foreign market. In both markets there exist many market participants and Intermediaries which will be deep discussed in the next following part. For farmers and dekhkan farmers, selling of fruits and vegetables in the domestic market involves the presence of many market intermediaries (speculators), and as a result, the price of goods from producer to consumer has a certain difference - the revenue, which is set by intermediaries.

Furthermore, the presence of large number of intermediaries when products are moving from producers to consumers makes it more difficult for producers to access the market. Absence of special vehicles for transportation of fruit and vegetable products, as well as no provision of packaging materials is also a sort of a barrier on the way out for farmers and dekhkan farmers to the domestic market.

Prices for fruit and vegetable products in the internal market during the mass crop ripening is drastically reduced, which does not allow producers to compensate for the costs, and in order to support the producers it evidently is necessary to consider the organization of interventional procurement.

The government periodically organizes fairground sales of horticultural products in cities and regional centers, timing it for the holidays. Prices at such fairs are usually set substantially lower than market; therefore producers are reluctant to participate in these fairs. Nevertheless, because of the absence of alternative in product sales, producers are forced to use this sales channel. Upward trend in prices for fruit and vegetable production is observed in all regions of the Republic. There are large fluctuations in the prices of fruits and vegetables among the regions (1.5 to 3.5 times).

All of this requires protecting the domestic market against the expansion of imports of horticultural products. Here, the Government should establish the necessary legal environment for the private sector in order to improve the quality and competitiveness of production, tighten the customs barriers in relation to those products, which are produced by local farmers within reasonable limits, to avoid creating deficiency in the domestic markets.

Development factors of the sector. *Corporation of Farms.* Unification of private and dekhkan farms into cooperatives, differing by kinds of cultures and scope of activities, plays an important role at enhancing the effectiveness of production, processing and marketing. It will consolidate the efforts and resources for the development of processing and infrastructure of the industry, dissemination of knowledge about the new technologies, marketing and management, improvement of products quality and their competitiveness.

Exporting Activities. An annual growth of exports of fruit and vegetable products is provided. Therefore, in 2018 the volume of exported vegetables amounted to 126.4 tons (2.4% of total volume), while in 2019 this indicator made 292.9 thousand tons, or 4.6% of total production. The share of exports of fruits in 2018 was 6.7% and in 2019, it was 10.1 percent of the volume of production, whereas grapes were respectively 10.5 and 9.7 percent [5]. From the data it is evident that the bulk of the fruit and vegetables produced are directed for domestic consumption.[2] A small proportion of products are directed for processing and export. Meanwhile, the yield of fruits and vegetables, melons and grapes is largely connected with added value creation (processing, prolonged storage, drying and export). However, these factors are not sufficiently used. (Ministry of Agriculture of the Republic of Uzbekistan, 2019)

During recent years, fruit and vegetable production export is increasing in total. In 2016, exports of fruit and vegetable production increased roughly to 373.3 million USD; in 2018, this trend indicated 1.15 billion USD and increased by more than 3 times (www.stat.uz, 2018). Only small amounts of products are exported to European markets because of the limitations on transportation, associated with the fact that Uzbekistan does not have access to the sea, and because of the considerable

Distances. Export of fruits and vegetables to the EU countries is also restricted because Uzbekistan still could not comply with the technical regulations of EU standards in relation to food safety or the sanitary control.

Development of export potential of agriculture requires an increase in quality indicators and the development of the system, aimed at ensuring the safety of food; for these purposes, it is necessary to organize the dissemination of knowledge for ensuring a high quality production for the entire cycle of production-processing-marketing

Development of fruit growing processing, including grapes, and drying of these products, as well as the increase in share of exports of fresh, processed and dried production can provide high profitability to producers and hard currency earnings for the country in general. Exports of dried fruits should become one of the important factors in increase of the export potential of horticultural sub complex of the country, and competitiveness improvement of fruit and grape sub complex of Uzbekistan. Using the foothills and unsuitable for tillage lands for these crops can provide employment of the foothill areas population, irrigation water saving using the latest in water conservation technologies.

Political Considerations. Policy concerning increasing the production and the use of fruits and vegetables, melons, fruits and grapes should be fundamentally reconsidered and include the following questions: stimulation of dekhkan and private farms to increase the fruit and vegetable production; consideration of the issues of allocating additional land area to producers, especially to dekhkan farmers; improvement of the exporting system of fruit and vegetable production by expansion of the number of private sector entities,

participating in the process of export of production; encouragement of producers for the introduction of scientific and technological progress and their involvement in agricultural R & D; support of the establishment of producers' cooperatives, procurers, processors and marketers.

Importing Activities. An important factor for the effectiveness of fruit and vegetable sub complex is the use of production capacity of the very early, early, middle and late growing season of vegetables, potatoes and melons, as well as the possibility of production of these cultures in greenhouses. Uzbekistan is divided into several zones, by soil and climatic conditions. (Ministry of Agriculture of the Republic of Uzbekistan). Many of fruit and vegetable plants provide high quality crop in certain areas. Historically, there was formed specialization of regions for certain types of crops. The advantageous factor of zonal specialization of fruit and vegetables by zones, placement of fruit and vegetables, melons and grapes contributes to lower production costs, improves the quality and competitiveness of production. Increase in production of ecologically clean horticultural products, the demand for which is constantly growing, must be one of the most promising destinations in horticulture.

It is the effective use of those factors, which promotes expansion of presence opportunities of fruit and vegetable sector of Uzbekistan on international markets, as well as a year-round provision of horticultural products to the population in fresh processed, frozen and dried condition. Exports of fruits, vegetables, melons and grapes are carried out on a contractual basis for freely convertible currency with strict control of their implementation, in accordance with applicable legislation on foreign exchange regulation.

Conclusion. It is important to develop an institutional mechanism, such as cooperation and integration of agricultural enterprises. Cooperative unions, farmers, dekhkan farmers and agricultural firms have more opportunities together than each farm individually to acquire advanced technological equipment, effectively implement the sale of products and its export, conduct an effective research of both internal and external markets, analyze and forecast customer demand overseas, identify new directions of cooperation, etc.

At the same time, it is necessary to provide the accumulation of funds for support and development of agricultural production (both on a no repayable and on a repayable basis). They should be directed at the development of agricultural science and training, support for elite seed production, improvement of soil fertility, subsidies for the production and sales of separate kinds of fruits and vegetables, etc. Funding for these areas is advisable to carry out by attracting international grants or reserve funds formed in accordance with intergovernmental agreements.

References:

1. Resolution of the President of the Republic of Uzbekistan "On measures to develop and strengthen the material-technical base of the storage of horticultural products for the period of 2011-2015" from April 7, 2011.
2. Decree of the President of the Republic of Uzbekistan "On major directions for deepening of reforms in agriculture" from March 24, 2016.
3. Decree of the President of the Republic of Uzbekistan №3709 "On measures to deepen economic reforms in the horticulture and viticulture" from January 9, 2016.
4. Ministry of Agriculture of the Republic of Uzbekistan, 2019 5th edition.
5. Resolution of the President of the Republic of Uzbekistan "On additional measures to increase food production and saturation of the domestic market» from January 26, 2019.
6. The Governmental portal of the Republic of Uzbekistan
7. http://www.gov.uz/uz/business/agriculture/
8. The State Committee of the Republic of Uzbekistan on Statistics.
9. http://www.stat.uz/
10. www.lex.uz
11. www.gov.uz

TEACHING METHODS AND WAYS OF DEVELOPING COMMUNICATIVE COMPETENCES OF STUDENTS

S.T.Kalandarova - PhD, Tashkent Institute of Irrigation and Agricultural Mechanization Engineers
O.A.Kulmamatov-senior teacher, Tashkent Institute of Architecture and Civil Engineering

Abstract

In this article, issues of developing language proficiency through interactions embedded in meaningful contexts are considered. This approach to teaching provides authentic opportunities for learning that go beyond repetition and memorization of grammatical patterns in isolation. The fact that psycho-pedagogical and psycholinguistic message calls speech production skills in language teaching methods qualify as speech skills. Their methodical in tradition can be divided into regulatory and communication skills. A central concept of the communicative approach to language teaching is communicative competence: the learner's ability to understand and use language appropriately to communicate in authentic (rather than simulated) social and school environments. Therefore, this article is devoted to reveal the mechanism of interdependence and relationships between the elements of the triad language – thinking – speech, the use of the term speech production skills in methods of teaching the English language.

Key words: communicative competence, types of speech, interpret, language material, knowledge gap, problem-solving, socialization, proficiency, sketches, psycholinguistic, production skills, communication.

Introduction. Communicative competence in foreign language teaching is the ability to learn the language means to carry out communication in various types of speech activity in accordance with the decisive communicative tasks, understand, interpret and produce coherent speech.

The methods of teaching the native language communicative competence – the ability and a real willingness to communicate adequately targets areas and situations of communication, a willingness to voice interaction and mutual understanding [2].

So, teaching methods, the result of which is always the educational products created by students: an idea, a hypothesis, a text work, a picture, an article, a plan of their studies, etc. are called heuristic. The method of empathy means to "feel" a person in the state of another object, "introducing" students into the studied objects of the surrounding world, an attempt to feel and know it from within.

For example, get used to the essence of wood, cats, clouds and other educational subjects. At the time of the student, the student asks questions to the object-self, trying to perceive, understand and see the answers at a sensual level. The thoughts, feelings, sensations that are born at the same time are the student's educational product, which can then be expressed in an oral, written, and pictorial form.

Example:

Teacher: - Imagine yourself that you are "Hurricane". How can you describe yourself, what are your feelings? Name your adjectives, verbs, your favorite season, places you occur, your weather.

Student: - I am Hurricane. I am the most terrible of all storms. I am dangerous, violent, strong, cruel, noisy and destructive. I destroy houses, carry away cars and telephone boxes. I occur in the springs, throughout the world, but mostly in the United States, especially in the central states. It occur in the afternoon or in the early evening in a hot day. Large clouds appear in the sky. They become darker and darker. The sounds of thunder, bright flashes of lighting! I form a funnel and begin to twist. My funnel touches the ground, it picks up everything it can [10].

The "Mind-Map" method is a simple technology for recording thoughts, ideas and conversations. The recording is quick, associative. The theme is in the center. First there is a word, an idea, a thought. There is a flow of ideas, their number is unlimited, they all are fixed. We start to write them from the top left and end right below [1].

The method is an individual product of one person or one group. Expresses individual opportunities, creates space for the manifestation of creative abilities of students [4].

The possibilities of using "Mind-Map"
When ordering, repeating the material;
When working with text;
If you repeat at the beginning of the lesson;
When you introduce the topic;
When collecting the necessary language material;
At the control.

Figure 1. The "Mind-Map" method

Materials. The basic ways of development of all components of communicative competence: Training is carried out through the following types: communication games (communicative games);

1. Communication games picture gap (the trainees have almost identical pictures, some images are different, and the differences need to be detected with the help of questions, without seeing the partner's picture – matching tasks); text gap (students have similar texts or fragments of the same text – of one student, not in the text of another student, and the lack of information needs to be filled-jig-saw reading)

– Knowledge gap (one student has information that the other does not have, and it needs to be completed with complete-the-table tasks);

– Belief gap (trainees have different beliefs, but need to work out a common opinion); Reasoning gap (schoolchildren have different proofs, which are important to gather together and compare).

2. Communicative stimulations in role-plays and problem-solving (communicative stimulation)

Role-playing games (assuming a certain number of characters, as well – as a game problem situation, in which the participants of the game act.) Each participant during the game organizes his behavior depending on the behavior of the partners and his communicative goal.

– Disputes (it is one of the forms of dispute as a verbal contest, it is an exchange of opinions on an object with the aim of achieving a unified view of the subject.) An obligatory condition for discussion is the existence of a contentious issue. For its successful conduct, participants should have knowledge about the subject of the discussion, have their own opinion on this issue).

– Roundtables (it is an exchange of opinions on any issue, a problem of interest to participants in communication.) Participating in the round table, the learner speaks out on his own behalf. The problems discussed at the round table can be very diverse: social, regional, moral Participation in the round table requires the student to have a sufficiently high level of language proficiency and the availability of certain knowledge on the problem.

– Sketches (this is a short scene played out for a given problem situation, indicating the actors, their social status, role behavior). In the form of sketches, small scenes related to social and everyday spheres on the topics "Food", "Shopping", "City and its sights").

3. Socialization (free communication)

Line-up (students try to line up as quickly as possible in accordance with the proposed feature);

– Strip-story (each student gets his / her own phrase and tries to take a faster place in the "story");

– Smile (students approach each other and exchange a cue with an obligatory smile);

– Merry-go-round (students form an outer and inner circle and, moving around in a circle, exchange replicas);

– Contact (participants approach each other and start a conversation); – kind words (students say any pleasant words to the interlocutor); – reflection (participants try to imagine what other students think of them); – listening (students listen attentively to the partner, nodding in agreement and agreeing with him) [2].

Discussion. In modern conditions it is naive to believe that a full-fledged communication is possible only on the basis of the ability to operate with linguistic material. For a successful communication process, it is necessary to have the total amount of knowledge that students receive by studying other subjects of the socio-humanitarian cycle of the social and humanitarian cycle.

English language is a subject whose content is more or less reflected in the subject of the program on a foreign language. Knowledge of regional studies and language history, obtained by students in foreign language lessons[5], are applied, in turn, in the lessons of the social and humanitarian cycle.

Along with the term competence, the term competence is used. These concepts are differentiated as follows: competence – it is complex knowledge, skills and abilities acquired during the course, and which constitutes a substantial component competence; it is the peculiarity of personality, determining its ability to perform activities on the basis of the generated competence.

Communicative competence in foreign language teaching – a combination of knowledge of the language system and its units, their construction and operation in a speech on how to formulate thoughts in the target language and understanding the judgments of others, on the national and cultural peculiarities of the carriers studied language [8], about the specifics of the different types of discourse; it is the ability to learn the language means to carry out communication in various types of speech activity in accordance with the decisive communicative tasks, understand, interpret and produce coherent speech.

The methods of teaching the native language communicative competence – the ability and a real willingness to communicate adequately targets areas and situations of communication, a willingness to voice interaction and mutual understanding.

Conclusions. Thus, communication skills form a dichotomous opposition, organizing science system of language: communication skills addressee opposed communicative skills of the author. Said opposition is neutralized in the language of the person, in some speech situations serving as the addressee, in others - its manufacturer. Therefore, the effectiveness of speech activity of a native speaker is directly dependent on the quality of formation as an intro-subjective and extra-subjective communicative abilities, as the communicative abilities of the recipient, and communicative skills of the author. As a kind of synthesis of substantive content of the term communicative competence perceived definition of belonging M.R. Lvov. In the dictionary-reference book on methods of teaching the English language, he writes: Communicative competence – a term denoting the knowledge of the language (native and non-native), its phonetics, vocabulary, grammar, style, speech culture, possession of these means of language and speech mechanisms – speaking, listening, reading and writing – in the range of social, professional and cultural needs of the person [7]. One of the most important characteristics of the language is personality. It is acquired as a result of natural speech and as a result of special education.

References:

1. Morozova A.L. Pedagogical basis for the development of foreign language communicative competence of students of non-language faculties of pedagogical high school (Unpublished candidate dissertation). Tomsk State University, Tomsk, Russian Federation, 2010. -26 p.
2. Peshnya I.S. Interactive learning technologies as tools of the professional competence of the student paramilitary institution. Irkutsk, 2010. -11 p.
3. Popova T.P. Formation of foreign language communicative competence of students of the 1st year correspondence department of language high school (English: Applications) (Unpublished candidate dissertation). Nizhny Novgorod State Linguistic University, Nizhny Novgorod, Russian Federation, 1999. - 85 p.
4. Verbitsky A.A. Competence-based approach and the theory of contextual learning: Proceedings of the fourth session of the methodological seminar Nov 16. 2004. Moscow, M: Research Center of the quality of training, 2004. -8 p.
5. Litnevskaya, E.I., Bagryanseva V.A. Methods of teaching the Russian language in secondary school: Textbook-manual for university students / Edited by Litnevskaya E.I. – M.: Academic project, 2006. – 588 c.
6. Fayzullaev R.Kh., Ismailova Z.K Problems of creating a new concept of educational work // Vocational education, scientific-methodical journal - Tashkent, 2009. №2. - B.17-18
7. Lvov M.R. Dictionary-guide on the methods of teaching the Russian language: A guide for students of pedagogical universities and colleges / Lvov M.R. – M.: Publishing Center "Academy"; Vysshaya shkola, 1999. – 272 c.
8. Antonova, E.S. Methodology for teaching the Russian language: communicative-activity approach: textbook / Antonova, E.S. – M.: KNORUS, 2007. – 460 c.
9. Yuldashev Z.Kh., Ashurova D.N. Innovative-didactic program complex and new formalized model of education. Malaysian Journal of Mathematical Sciences 6 (1):, P.: 97-103. (2012).
10. Galskova N.D., Gez N.I. Theory of teaching foreign languages. Linguodidactics and methodology: textbook-manual for university students / Galskova N.D., Gez N.I. – 3rd edition. – M.: Publishing Center "Academy", 2006. –336 c.

BIG DATA TECHNOLOGIES IN LEARNING MANAGEMENT SYSTEM

M.H. Primova - PhD student, Uzbekistan National University

Abstract

The article discusses the importance of Big Data technology and the opportunities for their use in higher education at the current stage of growth. In LMS, we can get the student's evaluation of the learning process, engagement in science, timely completion of science assignments, active status in the classroom, and other data through Bid data technology. In LMS, algorithms and data processing approaches are presented using Big Data technology. The LMS lists data mining applications.

Key words: Learning Management System (LMS), e-learning, big data, big data analysis (Data mining), Educational Data Mining (EDM), forecasting.

Introduction. Learning Management System (LMS) has recently grown rapidly around the world and the primary challenge is to provide students with quality knowledge in a timely manner. Without analyzing the large amount of data produced by LMS users (students, teachers, administration), this issue can not be solved. The LMS database contains structured and unstructured data which, using traditional statistical methods, is difficult to process.

Today, the use of LMS in the educational process has become a trend in the education system in many countries around the world. In the U.S., LMS has become the most promising strategy for the national education system.

You can see the statistics of several e-learning strategies in this article. Analysis by the Sloan American e-learning association (consortium) reveals that a total of 5.8 million students studied distance learning in the fall of 2014, of which 2.85 million took all online courses and 2.97 million took those courses [1].

Seven trillion dollars will be spent globally in 2019 to develop e-learning, and from next year, analysts predict that it will reach 25 percent annually.

Online reading in Russia was $1.8 trillion in 2016, up 1 percent (21 billion rubles). Experts from the groups IIDF, HSE and Netology predict that online reading will cost 2.6% (53 billion rubles) to 2 trillion rubles by 2021[2].

The Massive Open Online Courses (MOOC) information system was launched in 2012 and in less than a year gained more than 2 million users [3]. The online education market has risen from $165 billion in 2016 to $252 billion by 2020, according to forecasts by EdTechXGlobal and Global Market Insights. A vast volume of structured and unstructured data is generated in the LMS as a result of the large-scale implementation of e-learning.

LMS Big Data helps to process the knowledge of hundreds of thousands of teachers and students and offers an efficient analytical-based teaching approach. To date, this educational technique is becoming a product of mass experience.

In LMS, Big Data covers three areas: size, speed, and diversity. Speed is the rate of development , i.e. the high-speed processing of student data from an LMS database, their subject grades, classroom active status, and other outcomes. Diversity refers to the ability of students to process different types of structured and semi-structured data simultaneously. According to scientists, in the future there will be various changes in this feature. These are "four V's" (added veracity reliability, used in IBM promotional materials), "five V's" (viability added to this version), and even "seven V's" (added variability-variability and visualization).

LMS data can now be stored, analyzed and handled by BigData technology thanks to new information technology technologies. An overview of the available technologies for storing and processing BigData data in LMS used in prestigious universities around the world is given in this article. BigData in Education enables teachers to gain a range of information about the level of instruction, mastery of learning information, supervision, activities, and laboratory work of students. The formation of new data (data mining) in big data [7] is another important problem of LMS.

Materials and Methods. As a result of the implementation of LMS in higher education, a lot of knowledge on different aspects of the educational process has been collected over the years: students, their mastery and continuation, teachers and their scientific , educational and administrative practices, educational material (text , audio , video) and others.

It is essential that this information is efficiently stored, processed and analyzed. It is advisable to use Big Data Processing Technology (BigData) [4-6] to process vast volumes of information in archives. The term Big Data refers to a collection of data organized or unstructured and complex and takes up a very large amount of memory space. Big data analysis enables the solution to numerous research, scientific and pedagogical shortcomings to be accelerated. A lot of attention is paid to individual education when analyzing the statistics of the higher education system in the world. Nowadays, to solve such a problem where a student "falls asleep bored" during class, we use Big Data technology. That is, the student does not get bored during the lesson by using Big Data technology in LMS, we get the outcome we expect by using the "teacher designer" technology. This technology automates the LMS 's behaviour. Agar talabalar bir joyga jamlansa (guruh), bu texnologiya ularga aniq tavsiyalar va maslahatlarni beriadi. Using BigData technology allows you to determine the rate of change in the LMS, interactively manage the learning process and respond in a timely manner to any changes in the learning process. The use of interactive tests allows teachers to identify students who answered test questions incorrectly. The technology examines students 'incorrectly answered test results in real time, identifies incorrectly answered test topics, and provides advice

to students to help them learn those learning materials better. If these tips and hints do not help, the technology informs teachers and parents that such students need additional support [1; 5–8].

Another benefit of the technology is that the student receives a variety of information, i.e. analyzes how the student is studying the subject, summarizing the grades of the student in the learning process, interest in science, timely completion of science assignments, active classroom status, and other details. Here, through its algorithm, the technology analyses knowledge about students from a group of students and selects students. It tracks where the student made a mistake, which subject is slowly learning the subject, what he or she quickly or slowly solves, and produces a full comprehensive picture of the student: how much time and effort the student spent on the assignment, whether he or she made the right decision or not. He reports how long he's been working with the mouse on this task and how many times he's attempted to solve the problem.

BigData Analysis in LMS (Data Mining). Since the mid-20th century, data mining technologies have been evolving and it was only at the beginning of this century that these technologies started to be used in education. Ryan Baker, a professor at Columbia University, is one of the pioneers of the use of Data Mining technology in education.

EDM (Educational Data Mining) is the name of these technologies. During this time , the amount of data processed has increased significantly due to the growth of the use of information technology in education, and to date, data processing algorithms are being improved. EDM technology is focused on the behavior patterns and personal attributes of students[9].

The use of EDM technology in the field of education is a major challenge for students, whose roles are perfectly shaped, which types of classes they prefer, which subjects they are most interested in, and the curriculum for which the student has these skills. It enables him to learn how to maximize and what skills he needs in the area of potential professional practice.

Discussion. In LMS, the key tasks of using Data Mining are:

I. Classification - the assigning of objects to one of the predetermined classes (observations, events). Data Mining uses a variety of models for classification: neural networks, a solution tree, the k-close adjacent method [10]. The mathematical model of the classification problem can be written as follows. An object has some $\{X\}$ descriptions (properties) and a set of classes $\{Y\}$. Using the target function "f" {Xm} selects "X" to "Y". In this case, $X_m = \{(x_1, y_1), (x_2, y_2), ..., (x_m, y_m,)\}$, where $x_1, x_2, ... x_m$ are the characteristic vectors of the objects and $y_1, y_2, ..., y_m$ is the name of the corresponding class of objects in the corresponding selection. It is necessary to build an algorithm that reflects an arbitrary $x^0 \in X$ (not present in the sample) object to one of the Y classes. The degree of similarity of objects , for example, and therefore the probability that they belong to the same class, can be determined by the distance (k is the nearest adjacent method) between their points in space. The smaller the distance between vectors of the property, the more similar each other will be to the corresponding objects. The decision tree method is another method used for classification problems and is designed to group the initial data until a set of identical data is obtained.

Graphically, it can be interpreted as a (hierarchical) tree-like structure, decisions are made at their nodes, and selection is made-depending on the choice, divided into branches. The method is split into nodes , i.e. the nodes are called leaves in the branches, in which the final result (decision) is made. The end nodes of the data belong to the same class. Figure 1 provides examples of the use of a decision tree to classify problems in an LMS.

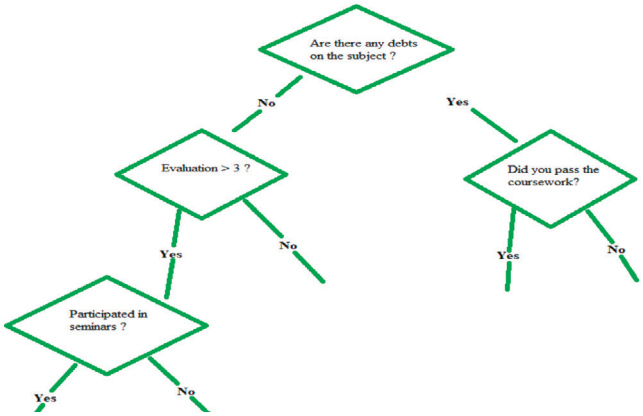

Figure 1. An example of a binary decision tree to classify a problem

Examples of using LMS functions:

- *Classification of LMS resources* (significance and location of educational resources in the learning process, organization of the report text according to the functional characteristics, characteristics of the information given, subject and object of the subject, presentation type, intent, etc.)

- *Classification of test tasks* (different levels of difficulty of testing: very difficult, difficult and very easy types. Test difficulty level is determined and the organization of individual test groups for students, taking into account the individual capabilities of the student). In solving this problem, it will be possible to adjust the number of tasks given depending on the development of the student's level of knowledge.

II. Regression, forecasting problems. Using regression methods, the effect of changing one parameter to another can be simulated and the dependency of the output parameters (objective functions) on the input parameters (factors) can be calculated.

This will let you know that the desired result can be obtained if you adjust the selected parameter values. The solution to the problem of regression makes it possible to predict the level of knowledge of graduates, the outcome of the final test, their labor market demand and their post-employment wage levels. The level of demand for specialists and the effect on the educational process can be calculated on this basis: university services (including funding), the implementation of information and telecommunications technology in the educational process, university staffing, wages for teachers and more.

In LMS, the forecasting method enables the combination of known data to predict the unknown desired. Different findings through internet access records, student systems, polls, social networks, and experiments gather a lot of information. It is a big responsibility to collect and process such data because you need to know what minutes you need to track and

define the information you need. We need a model for this. The model can be used to forecast the future (using previous classes), whether the student is currently interested in taking an online course, whether, using data from past student statistics, the student can solve the next problem.

Modern algorithms of Big Data technology take into account the effectiveness of the correct use of the student's education system. For example, if a student learns 0.05% of a course in one minute, the wrong forecasting "costs" him (her) one extra minute of study, and the correct one adds 0.03% [4; 6-8].

III. Clustering is the convergence of all objects (observations, events) which, in a sequence of characters or properties, are close to each other. Each cluster must have similar artifacts, and there must be different objects in different clusters.

The following tasks are solved by applying cluster analysis:

1. Choosing objects for the cluster
2. Identify several attributes for which objects are evaluated in the sample
3. Create groups of related objects (clusters) using one of the methods of cluster analysis.
4. Express the results of the analysis.

After extracting and analyzing the results from the database, it is possible to configure the selected metric and clustering method to obtain the optimal result. The function of a cluster in education includes psychological, physiological, behavioral, and intellectual characteristics. In LMS, clusters are used to determine the level of students 'mastery of similar psychological, physiological, behavioral, and intellectual topics. Using this cluster, it identifies how student behavior affects success in a variety of activities. It is effective for students with different thinking and mental stereotypes through teaching methods. Based on the cluster data, it will be possible to develop individual curricula for individual groups of students, taking into account the duration of lessons, the trajectory of material presentation, the level of difficulty of assignments and other features of the studied subject.

IV. Social network data analytics is another important field of big data research.

Students spend the majority of their time on social media outside of school. Students engage with each other through social networks and share information, provide enough required guidance, collaborate, work together, exchange learning materials, and more. They create a common network structure through which the learning process can be used. Because students are more comfortable using social media (not under the supervision of a teacher), information from social media may be more relevant than searching for information from other sources. On social networks, you can get information about a student's relationships with peers, interests, actions on the network, activities (time of access to the network, time of exit and time of his stay in the network), and more.

The analysis of social network data is based on the graph theory of mathematics, introduced in the work of Erdős, a Hungarian mathematician [11]. Mathematically, according to Erdős, a network is a collection of nodes that are linked by lines that define the relationship between nodes (these are students in educational institutions in our example). Multiple nodes are linked by any relationship. In 1979, the first foundational social media analysis was performed, and this research is expressed in the work of Velmana [12]. He has developed algorithms for cluster modeling and basic metrics for social network analysis.

Visualizing the data is the first step in data analysis within a network. The visualized data is transformed into graphs so that the closest nodes can be marked and the dense clusters that are active can be found. 'Degree centrality' is one of the key parameters of the graph, which is the ratio between the number of connections of a particular node and the total number of other nodes. If this parameter is equal to 1 for any node, then all other nodes in the network are connected to this node, and if this parameter is equal to 0, then this node is separated.

The level of "popularity" of the node is shown by this indicator, showing that the student has a significant influence on others. Part of the graph shown to examine student experiences on the social network is shown in figure 2. The user of the R1 network has a higher hub level than the R3 user, as can be seen from the figure.

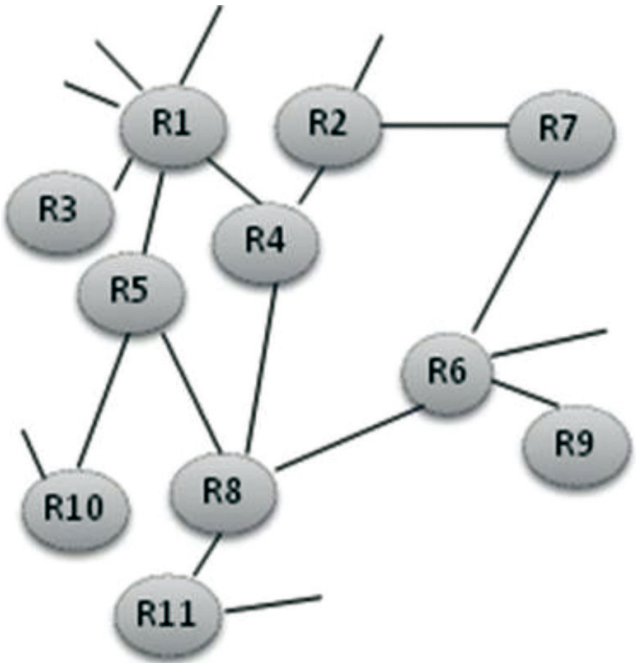

Figure 2. A fragment of the visualization of student interactions in the social network

Conclusions and suggestions. Big data has now emerged in a number of sectors in the fields of manufacturing, higher education, medicine, and management. Methods and algorithms for analyzing this information are currently being used. These technologies are used in LMS to process data, locate it easily and place data correctly, plan and monitor students financially, and analyze student data. Big data enables you to save LMS learning experience, i.e. to explain and student's interest in the subject, the timeliness of assignments, the state in which the control results were passed, the state of knowledge. Science teachers adapt the learning process to the needs of each student through the analysis of this data using Data Mining technology and establish individual learning paths for them. Analysis of data strengthens the student model. Teachers obtain comprehensive details about the details, features, and characteristics of the student. It also helps the student to

understand what factors influence the time they study the material and what hinders the process. Teachers receive information about students in a timely way through Data Mining technology in LMS and respond promptly to any changes in the learning process. This enables educators to make timely improvements to the content of education. In LMS, not only do teachers receive student information, this data is also passed on to the parents of the students.

The issues of using Big Data have not been properly discussed to date. For instance, to solve such problems, our country still does not have enough data and convenient collections. I hope Big Data pays close attention to our country. As for the methods used here, for an expert mathematician in data analysis, they are very standard.

The tasks related to Big Data in LMS are based on the methodology discussed in this article: automated analysis of learning outcomes, student evaluations, engagement in the course, creation of individual programs and recommendations, indicator forecasting, sociological research of student groups.

References:

1. URL: www.sloan.com
2. White book "E-learning in Russia" / Edited by N.V. Tikhomirova, Moscow: Ministry of Education and Science, 2014. p. 137 (in Russian).
3. URL: www.vedomosti.ru
4. Pat Nakamoto. BIG DATA: The revolution that is transforming our work, market and world. Data Analysis / Kindle Edition, 2013. P. 212.
5. Franks B., Taming the big data tidal wave. John Wiley & Sons, Inc. 2010. P. 341.
6. Mayer-Schenberger V., Kukier K. Big Data. A revolution that will change the way we live, work and think. M: Mann, Ivanov & Ferber Publishing House, 2014. p. 208 (in Russian).
7. Badarch Dendev. Information and communication technologies in education. M.: UNESCO IITO, 2013. p. 320 (in Russian).
8. Baker, R. S. Educational data mining: An advance for intelligent systems in education. IEEE Intelligent Systems, 2014. 29 (3). P. 78–82.
9. Bishop Ch. Pattern Recognition and Machine Learning. Series: Information Science and Statistics. 2006. T. XX. 740 p.
10. Duke V.A., Samoilenko A.P. Data Mining: training course. St. Petersburg: Peter, 2001. p. 312 (in Russian).
11. Erdos P., Renyi A. On the evolution of random graphs // Publication of Mathematics Institute Hungary Academy of the Science. 1960. V. 5. P. 17–61.
12. Wellman, B. The community question. American Journal of Sociology, 1979, 84, p. 1201– 1207.

HYDROCHEMICAL CHARACTERISTICS AND MACROPHYTES IN THE BETANA LAKE, EASTERN NEPAL

Ramesh Raj Pant, Nanu Babu Khanal - Central Department of Environmental Science, Tribhuvan University, Nepal
Khadka Bahadur Pal - Tri-Chandra Multiple Campus, Tribhuvan University Kathmandu, Nepal
Lal Bahadur Thapa - Central Department of Botany, Tribhuvan University, Kathmandu, Nepal
Richa Galaju, Satyam Kumar Chaudhari - Central Department of Environmental Science, Tribhuvan University, Kathmandu, Nepal,
Buddha Bahadur Basnet - Faculty of Science, Nepal Academy of Science and Technology, Khumaltar, Lalitpur, Nepal
Namraj Dhami - Faculty of Science and Technology, Pokhara University, Nepal
Khaydar Durdiev - Scientific Research Institute of Irrigation and Water Problems, Ministry of Water Resources, Uzbekistan
Kiran Bishwakarma - Key Laboratory of Tibetan Environment Changes and Land Surface Processes, Institute of Tibetan Plateau Research, Chinese Academy of Sciences, Beijing 100101, China, University of Chinese Academy of Sciences, Beijing 100049, China.

Abstract

Aquatic ecosystems provide a variety of goods and services and thus highly valuable for the livelihoods of people and sustainable development. This study aims to examine hydrochemical variables and macrophytes in one of the important wetlands in eastern Nepal 'Betana Lake'. Water samples were collected in pre-monsoon and post-monsoon seasons and water temperature, pH, dissolved oxygen (DO), free CO^2, and major ions including total hardness were analyzed to characterize the water quality of the lake. In addition, macrophytes found in the lake were also collected and identified. The results exhibited that the dominance order of chemical variables in terms of mean values *(mg/ L)* in the Betana Lake were $Cl\text{-} > TA > NH_4^+ > PO_4^{3-} > NO_3\text{-}$, *and* $TA > Cl\text{-} > NH_4^+ > NO_3\text{-} > PO_4^{3-}$ during the pre-monsoon and post-monsoon seasons, respectively with relatively higher concentrations of NH_4^+ *and* $NO_3\text{-}$ in post monsoon season. The low pH, alkalinity, and high value of dissolved oxygen (DO) in the post-monsoon season in the lake were related to the lower dominancy of submerged and floating macrophytes. In the lake, altogether 42 species of macrophytes (emergent, submerged, free-floating, and rooted) were reported. An invasive species Eichhornia crassipes, submerged Hydrilla verticillata and Ceretophyllum submersum were the ecologically significant macrophytes in the lake. The abundance of these species with other submerged and floating species in the lake is due to eutrophication, high silt load and sedimentation, and human encroachment. The higher dominancy of emergent macrophytes in the post-monsoon season indicated that higher nutrients content $(PO_4^{3-}, NO_3\text{-}$, *and* $NH_4^+)$ and total dissolved solids (TDS). Due to the promotion of the lake site as an eco-touristic area, anthropic activities could further deteriorate the lake water quality and biodiversity. Therefore, periodic evaluations of hydrochemical parameters with macrophytes are required for the maintenance and long-term protection of the Betana wetland.

Key words: Hydrochemical parameter, Macrophytes, wetland conservation, water quality, Betana Lake.

Introduction. Wetlands including rivers, lakes, swamps, marshes, and bogs are the most productive aquatic ecosystems in the world [1]–[3]. Contrasting to the lotic ecosystem the lentic ecosystem has limited natural purification and resilience. The anthropic discharges constitute a constant polluting source, whereas surface runoff is a seasonal phenomenon mostly affected by climate within the watershed [4], [5]. The alteration of hydrochemical characteristics due to various natural and anthropic factors may harm biodiversity and ecosystem productivity in the lentic environments. Thus, to maintain the ecological sustainability and prosperity of human beings, the wetlands act as a kidney of nature especially for the decontamination of the aquatic environment [6].

The studies on hydrochemistry and surface water quality in the low land of Nepal Himalaya (for example: Ghodaghodi and Betkot lakes) revealed that carbonate weathering has been the major regulating factors of hydrochemistry [7], [8]. By evaluating the water quality of the low land and core urban-based lakes and reservoirs (e.g., Beeshazari, Phewa, Jagadishpur, and Godaghodi) of Nepal identified the main pollutants as nitrate-containing compounds owing to the agricultural runoff, domestic wastes, and rampant urbanization[9], [10].

Wetlands of Nepal have different hydrogeological nature. The lentic environments are facing several threats including anthropogenic activities and natural hydraulic dynamics such as flash flood, debris from the construction roads, and local activities such as grazing, foraging, and firewood collection. Mostly, the ox-bow lakes and ponds occur in the Terai plain of Nepal which is eutrophic. There are many wetlands in eastern Nepal including Mai Pokhari, Gokyo Lake Complex, Rajarani Lake, Chimdi Lake, and Betana Lake. The Betana Lake is a biodiversity-rich major lake in the Morang district in eastern Nepal [11], [12]. The lake is also a popular touristic destination attracting local, national, and international visitors. The water quality and biodiversity of the wetlands are poorly explored, and thus, there are relatively few scientific documents available from the lowland regions of Nepal.

The increasing anthropogenic activities have imposed threats to the water quality and aquatic diversity of the Betana Lake, which demands regular monitoring of water quality and aquatic biodiversity in the lake. This study was conducted to determine the status of pollution and macrophytes in the Betana Lake, for the first time.

The aim of the present study to assess the hydrochemical characteristics and highlight their role in the abundance and composition of macrophytes in

the Betana Lake, Eastern Nepal. The findings of the study could provide indicators to develop strategic planning for the sustainable management of the lake.

Materials and methods. *Study area*

The Betana Lake is a natural lowland lake situated in the Belbari Municipality of the Morang district eastern Nepal, which is located at 26°39' N latitude and 87°25' E longitude in 115 m altitude above sea level and covers an area about 5.5 ha (Fig. 1). It is about 26 Km away in the northeast from Biratnagar Meteropolitan City, the capital city of Province No.1. The lake is divided into two parts by a check dam erected for the diversion of water for irrigation purposes. It is fed by the groundwater as well as natural precipitation and the water is drained out through outlets constructed at the southern and western banks, particularly during the rainy season when the lake is filled up to the designated level. The three sides of the lake are surrounded by a dense Shorea robusta forest and the southern part connects the East-West Highway (Fig. 1).

Betana Lake is one of the ecologically significant lakes in the lowland areas of Nepal having rich biological diversity as it has been a natural habitat for 85 aquatic plants and several animals [12]. The local government has prioritized the lake as one of the popular destinations for ecotourism. The geological materials in the lake watershed are principally derived from the erosion of the rocks in the Siwalik Hills. In addition, the erodible materials from the geologically weak region of the Bhabar is one of the major sources of a large proportion of coarse-grained material ranging from sand to boulders. The coarser size fractions appear to be lenticular in lithological successions. There are intercalated finer sediments as well and soil types vary from alluvial to clay [13]. The average annual rainfall in the region is nearly 1312 mm [11]. The climate of the lake basin is hot and humid summer, and cool and dry winter accompanied three distinct seasons such as winter (November-February), summer (March-May), and monsoon (June-September) in a year.

Water samples were collected during October-November in 2011 (post-monsoon samples) and in April 2012 (pre-monsoon samples) using a purposive sampling method. Altogether, 13 water samples were collected from seven locations of the lake including the inlet, outlet, and center portion for the analysis of the physicochemical parameters of water (Fig. 1). Site 1 was an inlet of the lake connected with the forest.

It was near to the Betana River but does not contribute regular water to the lake and intermittently support to water input because it has no regular flow and gets dry during less rainfall period. Site 2 lies on the northwest side of the lake. Water in this site was polluted due to waste thrown by visitors. Site 3 is the outlet (west) site of the lake which contains a dam/an earthen embankment which helps to trap a larger quantity of monsoon rain that significantly raises the water level in the lake. Site 4 is the outlet area of the lake which lacks vegetation. It is near to East-West Highway. Site 5 and 6 lie on the eastern side connected with the dense forest area. Site 7 is located at the center of the lake (Fig. 1).

The water samples were collected in 2 L high-density narrow-necked, clean polyethylene plastic bottles which were previously cleaned with metal-free shop, rinsed repeatedly with distilled water, soaked in 4% nitric acid for 24 hours. The water samples were maintained at 4°C in the field and during transportation, which was also stored at 4°C in the laboratory.

Water quality analysis. The physicochemical parameters such as water temperature, pH, electrical conductivity (EC), total dissolved solids (TDS), and dissolved oxygen (DO) were measured on-site by using a multi-parameter instrument HANNA and DO-meter. Total hardness (TH), free carbon dioxide (CO_2), ammonia (NH_4^+), nitrate (NO_3^-), phosphate (PO_4^{3-}), chloride (Cl^-), and total alkalinity were analyzed in the laboratory at the Central Department of Environmental Science, Institute of Science and Technology, Tribhuvan University (CDES-TU), Nepal. For all the analysis, the standard method prescribed by the APHA (2005) were used in this study [15].

Survey on macrophytes

The macrophytes were surveyed by sampling quadrats of size 1x1 m^2 in the littoral zone of the lake. Altogether 6 sampling sites were selected and five quadrates were sampled at each site. The macrophytes were identified using standard literatures and by consulting taxonomists. The herbarium specimens of the macrophytes were prepared and deposited at the Central Department of Environmental Sciences, Tribhuvan University, Nepal. The frequency, relative frequency, density, relative density, coverage, relative coverage, and important value index (IVI) of macrophytes were calculated using the following formulae [16].

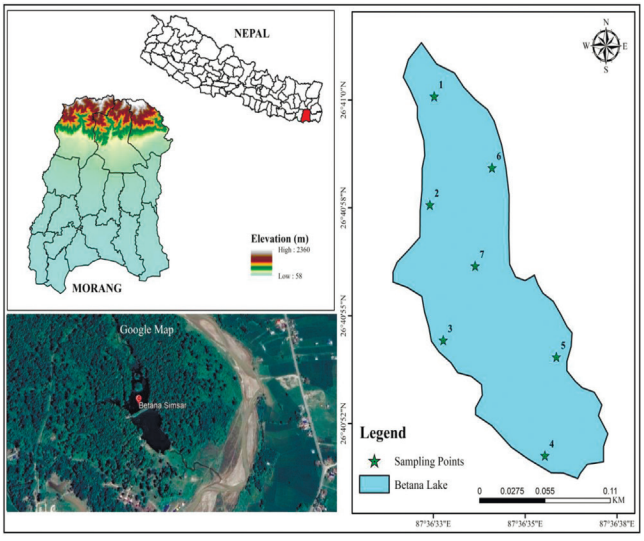

Figure 1. Study area showing the Betana Lake, Morang district, eastern Nepal

$$\text{Frequency (F)\%} = \frac{\text{Number of quadrate with the species}}{\text{Total no. of quadrates studied}} \times 100 \quad (1)$$

$$\text{Relative Frequency (\%)} = \frac{\text{Frequency of species A}}{\text{Total frequency of all species}} \times 100 \quad (2)$$

$$\text{Density (individual/m}^2\text{)} = \frac{\text{Total no. of individuals of species in all quadrates}}{\text{Total no. of quadrates studied}} \times 100 \quad (3)$$

$$\text{Relative Density (\%)} = \frac{\text{Density of species A}}{\text{Total density of all species}} \times 100 \quad (4)$$

$$\text{Coverage (\%)} = \frac{\text{Total approximate area covered by species}}{\text{Total no. of quatrate studied}} \times 100 \quad (5)$$

$$\text{Relative coverage (\%)} = \frac{\text{Coverage of species A}}{\text{Total coverage of all species}} \times 100 \quad (6)$$

$$\text{IVI} = \text{Relative Frequency} + \text{Relative Density} + \text{Relative Coverage} \quad (7)$$

Results and discussion. *Hydrochemical characteristics*

The results of the hydrochemical parameters of the Betana wetland for two seasons are illustrated in Table 1 and Fig. 2. The temperature of the lake ranged from

25^{0}C to 33^{0}C. A high temperature of surface water was observed in the pre-monsoon season, which could be due to the influence of atmospheric temperature. In lentic environments, the temperature is one of the important limiting factors that affect the chemical and biological reactions in the water [14]. Nevertheless, the water temperature in the lentic environments, determine the growth rate of algae and aquatic plants, and their interactions with aquatic animals. In addition, higher water temperature increases the solubility of gases; followed by an increase in pH and conductivity [17].

The pH in the present study ranged from 5.6 to 6.9. The pH has a major role in both lentic and lotic environments for determining the speciation of inorganic chemicals and influencing biotic life. The value of pH is higher during the pre-monsoon season might be due to higher temperatures and other geochemical processes [18]. The pH value generally fluctuates daily due to complex interaction of alkalinity, hardness, carbon dioxide, photosynthesis, respiration, and the low fluctuation of pH in the lake may be due to the presence of a sufficient

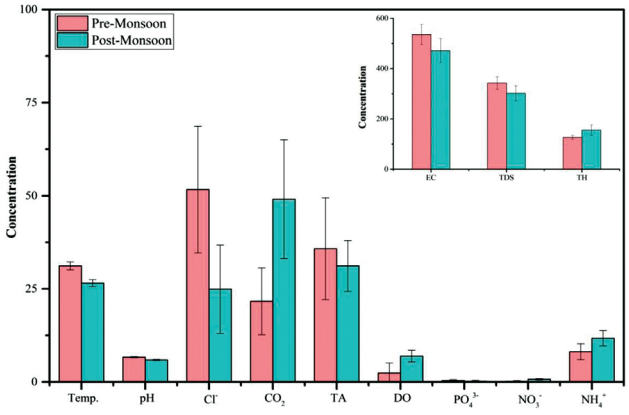

Figure 2. The concentration of major physicochemical parameters in the Betana Lake during the pre- and post-monsoon seasons. {Concentrations are express in mg/L except WT (°C), pH, and EC (µS/cm).

amount of bicarbonate alkalinity and phosphate.

The value of electrical conductivity (EC) in the lake was ranged from 398 µS/cm to 616 µS/cm. Principally, the EC is a measurement of ionic strength and it depends on the presence of ions, their concentrations, mobility, and temperature. Especially, the temperature in the lake waters has a significant positive relation with the EC values as if the EC values of water increase by 2-3%, which increased 1lake water temperature [21]. Similarly, EC displayed an increasing trend with TDS during the study periods showing that EC is a function of TDS. High EC value in the pre-monsoon season might be due to a decrease in water level in the lake, whereas the low value of EC in the post-monsoon season might be due to consumption of the electrolytes and ions by aquatic plants [10]. The relatively high value of EC is due to agricultural runoff and other anthropic interferences from the vicinity.

Total hardness in water affects the hydrochemical as well as biological characteristics in the lentic environment. The hardness of the Betana Lake was found to be greater than the 15 mg/L on both the seasons. Relatively, higher values of total hardness in the post-monsoon season might be due to the addition of calcium and magnesium content from surrounding Churia and Siwalik Hills [19]. Freshwater can be classified into the following groups based on hardness: soft: 0-60 mg/L, moderate hard: 61-120 mg/L, hard: 121-160 mg/L, and very hard: >180 mg/L. Using these criteria, the water quality of the Betana Lake was found to be in the hard category. The hardness of the lake indicates that the waters in the lake were suitable for aquatic organisms.

DO level below 5 mg/L is considered to be insufficient for the survivability of many organisms. DO in the water sample of the Betana Lake ranged from 0.81 to 9.32 mg/L. It is one of the key factors in determining the health of the lentic environments including the survival of the aquatic organisms. During the pre-monsoon season, the DO level showed somewhat decreased that might be due to a high temperature in the environment. It is because the high atmosphere temperature is responsible for the high rate of decomposition of organic matters involving the utilization of oxygen [22]. It is reported the DO below the 2.5 mg/L is considered lethal to the fish community existing in the water body [23]. The mean values of DO in both the seasons were below the guideline values but the maximum concentrations in both the seasons were within the satisfactory level.

The total alkalinity of the lake ranged from 20 mg/L

Table 1

Descriptive statistical summary of water quality parameters in the Betana Lake and its comparison with other studies

Parameter	Pre-monsoon				Post monsoon				Grand mean	Comparison with other studies					
	Min	Max	Mean	SD	Min	Max	Mean	SD		Betana[1]	Betkot[2]	Jagadishpur[3]	Beeshazari[4]	Rampur Ghol[5]	WHO[6]
Temp.	30	33	31.15	1.07	25	28	26.54	0.97	28.85	24.65	18.3		30.25	27.55	-
pH	6.42	6.9	6.66	0.15	5.57	6.11	5.91	0.15	6.29	7.36	7.7	6.9	7.38	-	6.5-8.5
EC	498	616	535.77	39.81	398	592	471.08	48	503.43	-	337	379	48.49	247.5	800-1000
TDS	318.72	394.24	342.89	25.48	254.72	378.88	301.49	30.72	322.19	-	168	-	-	-	500
TA	20	65	35.77	13.67	20	45	31.15	6.82	33.46	123.19	-	-	62.5	-	600
Cl^-	25.5	75.2	51.66	17.01	10.2	45.4	24.93	11.86	38.30	3.765	12.2	9.7	-	-	250
TH	116	142	126.46	7.58	126	198	155.77	20.19	141.12	110.74	188	-	53.5	-	80-120
DO	0.81	11.2	2.4	2.7	3.7	9.32	6.96	1.59	4.68	5.9	3	7.3	5.16	5.95	6
CO_2	11	41.8	21.66	8.97	32.2	73.5	49.1	15.95	35.38	23.78	7.33	25.8	70.92		6
PO_4^{3-}	0.12	0.82	0.42	0.2	0.01	0.7	0.23	0.25	0.33	0.37	0.5	0.28	2.5	0.18	0.8
NO_3^-	0.01	0.95	0.18	0.24	0.28	0.97	0.74	0.17	0.46	-	0.06	-	4.41	0.35	50
NH_4^+	5.6	12.8	8.12	2.15	8.97	15.3	11.73	2.05	9.93	-	-	-	-	0.47	

to 65 mg/L. It was observed low in post-monsoon as compared with pre-monsoon. Such kind of seasonal variation could be due to the flushing and dilution by late monsoon rainfall along with surface runoff (Table 1). Since, the water bodies are divided into three categories according to total alkalinity value i.e. poor nutrient (1 mg/L to 15 mg/L), moderately rich nutrient (16 mg/L to 60 mg/L), and rich nutrient (>60 mg/L) (Pant, 2013). Thus, the lake was found to have a moderately rich nutrient in terms of alkalinity concentration.

Chloride in water influences salinity in the water and ion exchange due to the dissolution of salt deposits, sewage discharge, effluents from chemical industries, and agricultural runoff to natural waters [7], [25]. The chloride concentration in this study was ranged from 10.25 mg/L to 75.26 mg/L. The highest value in the post-monsoon season is mainly attributed to the dissolution of ions, especially Cl^-, SO_4^{2-} from the surrounding rocks and sediment which release into the water. Most of the rocks in the catchment areas were phyllite but these rocks contain a high amount of muscovite-seriate-chlorite. These minerals contain low hardness and get easily weathered and eroded by geological agents and easily transported to the downstream lake basin [26]. In both the season four sites have higher chloride value might be the pollution caused by anthropogenic interference. The maximum level of chloride to survive an aquatic organism is 250 mg/L [20]. The chloride content in the lake was within the limit indicating the suitability of waters for the aquatic organisms.

The source of free carbon dioxide in an aquatic environment has atmospheric diffusion, respiration by the aquatic organisms, and microbial decomposition. Besides, free carbon dioxide content in water increase with an increase in temperature, depth of water, the chemical nature of the bottom sediments, and other environmental features of the terrain. In this study free CO_2 varies from 11 mg/L to 73.5 mg/L with a higher value in the pre-monsoon season. This may be attributed to the combined effect of higher temperatures and microbial decomposition. The aquatic organisms are greatly affected when free CO_2 concentration exceeds 25 mg/L [27]. In the present study, the free CO_2 crosses the limit particularly during the pre-monsoon season which could be the issue of sustainability of aquatic organisms.

Phosphorous is commonly accepted as the most controlling nutrient in the freshwater lake ecosystem [24]. In this study, the phosphate value ranges from 0.0037 mg/L to 0.40 mg/L. The phosphate value found to be lower in the post-monsoon season might be due to the use of the nutrient by phytoplankton and might be due to the microbial degradation of total phosphorous by bacteria [28]. High seasonal variations impacted the phosphorus contents which could be attributed due to surface run-off, weathering of rocks, soil decay, and mineralization of the plant and animal residue [29]. Nepal Water Quality Guideline reported that 0.6 mg/L of phosphate is suitable for aquaculture point of view [30]. As per the guideline, the phosphorus contents in the Betana Lake was less than this limit.

Nitrate in the lentic environment is due to the denitrification of the atmospheric nitrogen, surface runoff of sewage, fertilizer, and pesticides from the nearby watershed and agriculture area [31]. The highest value of nitrate in this study was observed in the post-monsoon season which might be due to the decomposition and degradation of the organic nitrogen contents. The lower values recorded during pre-monsoon season in the present study may be related to the denitrification of NO_3- into NO^2- and NH_3 by bacterial activities. Usually, nitrate is not harmful to fish and aquatic life but precisely >50 mg/L may be stressful for some of the species resulting in excess algal growth eutrophication. In this study, ammonia ranged from 5.6 mg/L to 15.3 mg/L where the post-monsoon season had higher values. This might be due to the high addition of nutrients from the vicinity and agriculture runoff [19]. The amount of ammonia in both pre-monsoon and post-monsoon season in the Betana Lake showed a high-value range to some extent which may be harmful to aquatic animals and amphibians.

Overall, the dominancy order of major chemical variables follow the trend of $Cl^- > TA > NH_4^+ > PO_4^{3-} > NO_3^-$, *and* $TA > Cl^- > NH_4^+ > NO3_- > PO_4^{3-}$ during the pre-monsoon and post-monsoon seasons, respectively with relatively higher concentrations of NH_4^+ and NO_3- in post monsoon season. Also, the measured hydrochemical parameters showed that the water quality of the lake was found to be deteriorated by anthropogenic activities like washing clothes, excessive use of pesticides and fertilizers in the vicinity, and waste disposed off by the visitors.

Macrophyte diversity. Environmental gradients including hydrochemical variables have a vital role in determining the abundance and diversity of the aquatic macrophytes [32]. Altogether 42 species of macrophytes were reported in this study. Among them, 32 species were collected during the post-monsoon season and 29 species in the pre-monsoon season. By growth forms, 26, 6, 5, and 5 species were found to be emergent, submerged, free-floating, and rooted floating leaf, respectively. The list of macrophytes reported from the lake has been given in Table 2 and Table 3. Similarly, out of 32 species reported during the post-monsoon season, 3, 4, 4, and 21 were submerged, free-floating, and rooted floating and emergent species, respectively (Table 2). Eichhornia crassipes was the most frequent species (73.33%) and Ludwigia octovalvis, Cassia tora, Saccharum spontaneum, Paspalum distichum, and Axonopus compressus were the less frequent species. Meanwhile, submerged Hydrilla verticillata has the highest density (6.43 plants per quadrat), whereas Saccharum spontaneum and Paspalum distichum have the lowest density. Additionally, the submerged Ceratophyllum demersum showed the highest cover as compared to other species whereas the Hydrilla verticillata has the highest IVI (27.05). It was the most significant species found in the lake during the post-monsoon season (Table 2).

Among 29 species reported during the pre-monsoon season 5, 2, 4, and 18 were submerged, free-floating, rooted floating, and the emergent species, respectively (Table 3). Similar to the post-monsoon season, Eichhornia crassipes was the most frequent species (86.66%) in the pre-monsoon season as well, and the least frequency was found in Ipomoea carnea subsp. The highly dense species were also E. crassipes while the density was the lowest in Potamogeton pectinatus and Ipomoea carnea subsp. The cover was also the highest in E. crassipes (7.47) and it represented the most significant species in the lake during pre-monsoon season (Table 2).

The macrophytes reported in the lakes (Table 2 and Table 3) during both the seasons indicate the shallow

Table 2

List of macrophytes reported from the Betana Lake during post-monsoon season

S.N.	Species	F	RF	D	RD	C	RC	IVI
Submerged species								
1	Ceratophyllum demersum L.	26.6	3.25	1.93	3.84	6.2	6.57	13.66
2	Ceratophyllum submersum L.	36.66	4.48	2.43	4.84	3.4	3.6	12.92
3	Hydrilla verticillate (L.f.) Royle	76.66	9.8	6.43	12.8	4.2	4.45	27.05
Free floating species								
4	Eichhornia crassipes Mart.	73.33	8.97	6.23	12.41	4.2	4.45	25.83
5	Pistia stratiotes L.	20	2.44	1.6	3.18	4.1	4.3	9.92
6	Lemna perpusilla Torr.	16.66	2.03	0.9	1.79	2.5	2.65	6.47
7	Spirea sp.	13.33	1.63	0.8	1.59	3	3.18	6.4
Rooted floating leaved species								
8	Trapa aqudrispinosa Roxb.	40	4.89	1.33	2.64	1.7	1.8	9.33
9	Nymphoides hydrophylla (Lour.) Kuntze	10	1.22	0.5	0.99	4.1	4.3	6.51
10	Ipomoea aquatica Forssk.	23.33	2.85	0.76	1.51	3.2	3.38	7.74
11	Ludwigia octovalvis (Jacq.) P.H.Raven	3.33	0.4	0.1	0.19	2.1	2.22	2.81
Emergent species								
12	Alternanthera sessilis (L.) R.Br. ex DC.	63.66	7.74	4.7	9.36	3.5	3.71	20.81
13	Cassia tora (L.) Roxb.	3.33	0.4	0.33	0.65	4.2	4.45	5.5
14	Cyperus iria L.	30	3.67	1.43	2.84	3.4	3.6	10.11
15	Echinochloa crus-galli	33.33	4.07	2.06	4.11	3.2	3.38	11.56
16	Hemarthria compressa	20	2.44	1	1.99	1.5	1.59	6.02
17	Imperata cylindrica	43.33	5.3	2.06	4.1	3.2	3.38	12.78
18	Leersia hexandra	63.66	7.79	4.33	8.62	4.2	3.6	20.01
19	Paspalum distichum	3.33	0.4	0.06	0.11	2.1	2.22	1.61
20	Persicaria hydropiper	20	2.44	1.06	2.11	3.5	3.71	7.5
21	Typha angustifolia	20	2.44	0.93	1.85	3.6	3.81	6.87
22	Mikania micrantha	23.33	2.85	1.43	2.84	3.6	3.81	9.09
23	Spilanthes sp.	20	2.44	1.46	2.9	2.2	2.33	9.4
24	Azzola imbricate	13.33	1.63	0.7	1.39	2.8	2.96	5.93
25	Cynodon dactylon	50	6.11	1.96	3.9	1.2	1.27	12.18
26	Acorus calamus	13.33	1.63	1.23	2.45	4.8	5.09	9.21
27	Diplazium esculentum	10	1.22	0.36	0.71	1.9	2.01	2.96
28	Saccharum spontaneum	3.33	0.4	0.03	0.05	1.2	1.27	1
29	Oenanthe javanica	10	1.22	0.3	0.59	1.8	1.9	3.47
30	Panicum repen	20	2.44	1.2	2.39	2.2	2.33	8.15
31	Ipomoea carnea	10	1.22	0.3	0.59	1.9	2.01	3.47
32	Axonopus compressus	3.33	0.4	0.26	0.51	2.6	2.75	5.35

Notes: F - frequency, RF - Relative Frequency, D- Density, RD – Relative density, C – Cover, RC – Relative cover, IVI – Important value index

Table 3

List of macrophytes from Betana Lake during pre-monsoon season

S.N.	Name of species	F	RF	D	RD	C	RC	IVI
Submerged species								
1	Vallisneria natans	33.33	3.73	2.4	5.1	4.6	4.84	13.67
2	Utricularia aurea	26.66	2.98	1.56	3.31	3.97	4.17	10.46
3	Hydrilla verticillate	80	8.95	3.6	7.65	6.14	6.46	24.13
4	Ceratophyllum submersum	23.33	2.61	0.96	2.04	2.64	2.77	7.42
5	Potamogeton pectinatus	6.66	0.74	0.1	0.21	0.6	0.63	1.58
Free-floating species								
6	Eichhornia crassipes	86.66	9.7	5.1	10.84	7.47	7.86	28.4
7	Azolla pinnata	56.66	6.34	3.3	7.01	5.28	5.55	18.9
Rooted floating leaves species								
8	Ipomoea aquatica	56.66	6.34	3.06	6.5	5.11	5.38	18.22
9	Nelumbo nucifera	30	3.35	1.6	3.4	2.63	2.76	9.51
10	Trapa quadrispinosa	46.66	5.22	2.13	4.53	2.56	2.69	12.44
11	Nymphoides hydrophylla	6.66	0.74	0.43	0.91	3.5	3.68	4.85
Emergent species								
12	Leersia hexandra	63.33	7.09	4.2	8.93	4.83	5.08	21.1
13	Centella asiatica	66.66	7.46	3.7	7.87	4.55	4.79	20.12
14	Cyperus alternifolius	23.33	2.61	1.9	4.03	4.14	4.35	10.99
15	Alternanthera sessilis	53.33	5.97	2.46	5.23	3.82	4.02	15.22
16	Imperata cylindrica	36.66	4.1	1.8	3.82	3.7	3.89	11.81
17	Hemarthria compressa	13.33	1.49	1.2	2.55	4.5	4.73	8.77
18	Ageratum houstonianum	23.33	2.61	1.26	2.68	2.42	2.54	7.83
19	Echinochloa colona	13.33	1.49	0.36	0.76	1.95	2.05	4.3
20	Echinochloa crus-galli	6.66	0.74	0.2	0.43	1.9	2	3.17
21	Ipomoea carnea subsp. Fistulosa	3.33	0.37	0.13	0.27	2.03	2.13	2.77
22	Panicum sp.	10	1.11	0.26	0.55	1.86	1.95	3.61
23	Cynodon dactylon	26.66	2.98	1.1	2.33	2.92	3.07	8.38
24	Trifolium repens	23.33	2.61	0.76	1.61	1.88	1.97	6.19
25	Rorippa nasturtium-aquaticum	16.66	1.86	0.86	1.82	2.2	2.31	5.99
26	Thelypteridaceae dentana	26.66	2.98	1.36	2.89	2.62	2.75	8.62
27	Ottelia alismoides	16.66	1.86	0.8	1.7	2.4	2.52	6.08
28	Mikania micrantha	10	1.11	0.26	0.55	1.36	1.43	3.09
29	Eclipta prostrata	6.66	0.74	0.2	0.42	1.4	1.47	2.63

Notes: F - frequency, RF - Relative Frequency, D- Density, RD – Relative density, C – Cover, RC – Relative cover, IVI – Important value index.

water with low silt but high organic nutrient loads in the lakes. As one of the invasive species, E. crassipes was the most frequent species during the post-monsoon and pre-monsoon season. It was reported as the most significant species the lake is going to be threatened by this species. Lesser number of the free-floating species during pre-monsoon might be due to disturbance or by removal of them to clean the lake.

The dense growth of submerged species such as Hydrilla verticillta and Ceretophyllum submersum may be due to eutrophication, high silt load, and sedimentation. The luxuriant growth of E. crassipes with these two species and other macrophytes indicates the eutrophic condition of the Lake and encroachment of the littoral vegetation. From the study, it is found that all the parameters except nitrate and ammonia in the post-monsoon season were found applicable for the aquatic organism. Also, it can be summarized that most of the hydrochemical variables under the standard limits for the growth and development of the aquatic macrophytes in the Betana Lake.

Conclusion. Hydrochemical characteristics have a vital role for the growth and diversity of aquatic ecosystems. The Betana Lake water is widely used for multiple purposes such as domestic, irrigation, tourism, recreation, and other ecological and aesthetic purposes. In the pre-monsoon season, the pH, alkalinity, hardness, and suspended solid parameters were found applicable for the aquatic biota. The Cl^- and total alkalinity were the most abundant, whereas the NO_3- and PO_4^{3}- found to be the least abundant hydrochemical variables during pre-monsoon and post-monsoon seasons in the Betana Lake. The dominance order of chemical variables in terms of mean values (mg/ L) in the Betana Lake were $Cl^- > TA > NH_4^+ > PO_4^{3}- > NO^{3}-$, *and* $TA > Cl^- > NH_4^+ > NO_3- > PO_4^{3}-$ during the pre-monsoon and post-monsoon seasons, respectively with relatively higher concentrations of NH_4^+ and NO_3- in post monsoon season.

In the lake, altogether 42 species of macrophytes (emergent, submerged, free-floating, and rooted) were reported in both the sampling seasons. The invasive species Eichhornia crassipes, Hydrilla verticillata, and Ceretophyllum submersum were the ecologically significant macrophytes in the lake. The abundance of these species with other submerged and floating species might be due to the eutrophication, high loading of silts, and human encroachments. Due to the promotion of the lake site as an ecotourism area, anthropic activities could further deteriorate the lentic quality and biodiversity of the lake. Precisely, the main regulating factors of hydrochemistry in the lake include commercial fishing, excessive use of pesticides and chemical fertilizer, irrigation, bathing, washing cloth, waste disposed of by the tourists, and ultimately impacts the abundance and composition of the macrophytes. Therefore, periodic evaluations of hydrochemical parameters with macrophytes are required for the protection and long-term sustainability of the Betana wetland.

Acknowledgments. The authors would like to acknowledge the guidance and support of providing laboratory facilities from the Central Department of Environmental (CDES-TU). We are thankful to Dr. Gyan Kumar Shrestha for his suggestions and guidance during the study. Many thanks also to the professors of CDES-TU, diligent reviewers, and the editors for their insights and supports. We would like to acknowledge the local people, citizens, and stakeholders who helped in the study area and the preparation of the research article.

References:

1. R. R. Pant et al., "Water Quality Assessment of Begnas and Rupa Lakes, Lesser Himalaya Pokhara, Nepal," J. Inst. Eng., vol. 15, no. 2, pp. 113–122, 2019, doi: 10.3126/jie.v15i2.27655.
2. R. R. Pant and N. L. Adhikari., "Water Quality Assessment of Phewa Lake, Pokhara Nepal," Cogn. Transdiscipl. Res. J., vol. 1, no. June, pp. 130–140, 2015.
3. D. Rupakheti, L. Tripathee, S. Kang, C. M. Sharma, R. Paudyal, and M. Sillanpää, "Assessment of water quality and health risks for toxic trace elements in urban Phewa and remote Gosainkunda lakes, Nepal," Hum. Ecol. Risk Assess., vol. 23, no. 5, pp. 959–973, 2017, doi: 10.1080/10807039.2017.1292117.
4. K. P. Singh, A. Malik, D. Mohan, and S. Sinha, "Multivariate statistical techniques for the evaluation of spatial and temporal variations in water quality of Gomti River (India) - A case study," Water Res., vol. 38, no. 18, pp. 3980–3992, 2004, doi: 10.1016/j.watres.2004.06.011.
5. K. P. Singh, A. Malik, and V. K. Singh, "Chemometric analysis of hydro-chemical data of an alluvial river - A case study," Water. Air. Soil Pollut., vol. 170, no. 1–4, pp. 383–404, 2006, doi: 10.1007/s11270-005-9010-0.
6. B. Gautam, R. Maskey, R. P. Sapkota, and D. R. Dangol, "Aquatic Macro-invertebrates as Bio-indicators: An Approach for Wetland Water Quality Assessment of Rampur Ghol, Chitwan, Nepal," J. Inst. Sci. Technol., vol. 19, no. 2, pp. 58–64, 2015, doi: 10.3126/jist.v19i2.13853.
7. R. Bhatta et al., Inorganic components in lake waters in the Third Pole, vol. 2, no. 3. Elsevier Inc., 2020.
8. R. R. Pant et al., "Water Quality Assessment of the Betkot Lake, Sudurpaschim Province, Nepal," North Am. Acad. Res., no. December, 2019, doi: https://doi.org/10.5281/zenodo.3566682.
9. R. Niraula, "Evaluation of the Limnological Status of Beeshazar Lake, a Ramsar Site in Central Nepal," J. Water Resour. Prot., vol. 04, no. 05, pp. 256–263, 2012, doi: 10.4236/jwarp.2012.45028.
10. J. B. Thapa and T. B. Saund, "Water Quality Parameters and Bird Diversity in Jagdishpur Reservoir, Nepal," Nepal J. Sci. Technol., vol. 13, no. 1, pp. 143–155, 2013, doi: 10.3126/njst.v13i1.7453.
11. S. K. Rai, "Algal flora of Betana wetland, Morang, Nepal," Nepal. J. Biosci., vol. 1, no. February, pp. 104–113, 2013, doi: 10.3126/njbs.v1i0.7477.

12. B. Niroula and K. L. . Singh, "Aquatic Plant Resources of Betana Wetland, Morang, Nepal," Our Nat., vol. 9, no. 1, pp. 146–155, 2011, doi: 10.3126/on.v9i1.5745.
13. M. R. Dhital, "Geology of the Nepal Himalaya: regional perspective of the classic collided orogen," Springer, 2015, doi: 10.3126/ije.v3i2.10502.
14. APHA, "Standard Methods for the Examination of Water and Wastewater. 21st ed. American Public Health Association, Washington DC.," Stand. Methods Exam. Water Wastewater. 21st ed. Am. Public Heal. Assoc. Washingt. DC., p. 1220, 2005.
15. A. Acharya et al., "Chemical Characteristics of the Karmanasha River Water and Its Appropriateness for Irrigational Usage," J. Nepal Chem. Soc., vol. 41, no. June, pp. 94–102, 2020, doi: 10.3126/jncs.v41i1.30494.
16. D. B. Zobel, P. K. Jha, M. J. Behan, and U. K. R. Yadav, "A practical manual for ecology," Ratna Book Distributors, Kathmandu, Nepal. 1987.
17. L. R. Bhatt, P. Lacoul, H. D. Lekhak, and P. K. Jha, "Physico-chemical characteristics and phytoplanktons of Taudaha lake, Kathmandu," Pollution Research, vol. 18, no. 4. pp. 353–358, 1999.
18. F. U. Rehman Qaisar, F. Zhang, R. R. Pant, G. Wang, S. Khan, and C. Zeng, "Spatial variation, source identification, and quality assessment of surface water geochemical composition in the Indus River Basin, Pakistan," Environ. Sci. Pollut. Res., vol. 25, no. 13, pp. 12749–12763, 2018, doi: 10.1007/s11356-018-1519-z.
19. G. Thapa and J. Pal, "Physico-chemical features of water in Betana wetland, Belbari, Morang, Nepal," Himal. J. Sci. Technol., vol. 2, pp. 66–75, 2018.
20. WHO, "Guidelines for Drinking-water Quality," 2011.
21. A. K. Shrestha and N. Basnet, "The Correlation and Regression Analysis of Physicochemical Parameters of River Water for the Evaluation of Percentage Contribution to Electrical Conductivity," J. Chem., vol. 2018, no. July, 2018, doi: 10.1155/2018/8369613.
22. U. S. Badge and A. K. Verma, "Limnological studies on JNU Lake, New Delhi, India." 1995.
23. K. Oli, "Environmental study of Nepal's Begnas and Rupa Lakes." p. 152, 1996.
24. R. R. Pant, "Water Quality Assessment of Nagdaha Lake , Lalitpur , Nepal," J. TUTA Univ. Campus, vol. 8, no. November, pp. 52–56, 2013.
25. R. R. Pant et al., "Spatiotemporal variations of hydrogeochemistry and its controlling factors in the Gandaki River Basin, Central Himalaya Nepal," Sci. Total Environ., vol. 622–623, no. January 2018, pp. 770–782, 2018, doi: 10.1016/j.scitotenv.2017.12.063.
26. T. Bhattarai and G. Rao, "HYDROGEOLOGICAL CONDITIONS IN THE TERAI PLAIN OF MORANG DISTRICT, EASTERN NEPAL." 1989.
27. J. Thomas, S. Joseph, and K. P. Thrivikramji, "Hydrochemical variations of a tropical mountain river system in a rain shadow region of the southern Western Ghats, Kerala, India," Appl. Geochemistry, vol. 63, pp. 456–471, 2015, doi: 10.1016/j.apgeochem.2015.03.018.
28. S. Li, Z. Xu, H. Wang, J. Wang, and Q. Zhang, "Geochemistry of the upper Han River basin, China. 3: Anthropogenic inputs and chemical weathering to the dissolved load," Chem. Geol., vol. 264, no. 1–4, pp. 89–95, 2009, doi: 10.1016/j.chemgeo.2009.02.021.
29. K. B. Pal, R. R. Pant, B. Rimal, A. D. Mishar, and A. D. Pal, K.B., Pant, R.R., Rimal, B., Mishra, "Comparative Assessment of Water Quality in the Bagmati River Basin , Nepal," vol. 5, no. December, pp. 68–78, 2019.
30. NDWQS, "Ministry of Physical Planning and Works Singhadarbar kathmandu National Drinking Water Quality Standards , 2005 Implementation Directives for National Drinking Water Quality Standards , 2005 Government of Nepal Notice issued by Ministry of Physical Planni," 2005.
31. O. Lind, "Handbook of Common Methods in Limnology," Saint Louis C.V. Mosby Co., p. 1974, 1974.
32. N. Takamura, Y. Kadono, M. Fukushima, M. Nakagawa, and B. H. O. Kim, "Effects of aquatic macrophytes on water quality and phytoplankton communities in shallow lakes," Ecol. Res., vol. 18, no. 4, pp. 381–395, 2003, doi: 10.1046/j.1440-1703.2003.00563.x.

A REVIEW OF CLIMATE CHANGE IMPACTS ON WHEAT CROP IN UZBEKISTAN

M.M. Babadjanova - PhD student, Tashkent State Agrarian University

Abstract

Starting from the early years of the Post-Soviet Union, wheat is considered one of the major crops in Central Asia, being a central point of many policy discussions. Wheat was the second crop occupied agricultural land which is the most important cereal crop. Recent years have witnessed growing negative climate variability that has impacted agricultural production by effecting soil fertility, water scarcity, or causing wheat diseases. The goal of this paper is to examine by reviewing the recent literature related to the impact of climate variability on wheat production in Central Asia. Different agronomic and economic methodology, also, approaches used to analyze Climate Change's negative impacts. The review results show that there are adaptive recommendations by researchers. Agricultural policy actions are one of the main leaders to enhance adaption and mitigation. Also, continuing agricultural researches could be key for opening new doors of solutions.

Key words: Agriculture, winter wheat, productivity, climate change

Introduction. Uzbekistan is located in Central Asia (CA) and considered as a heart, bordering with Turkmenistan, Kazakhstan, Afghanistan, Tajikistan, and Kyrgyzstan. The administrative-territorial division of the Republic of Uzbekistan has divided into 14 provinces which include 12 provinces, Tashkent city, and the Republic of Karakalpakstan. Also, it consists of a total of 1071 small cities [4].

Agricultural production is the backbone of the economy of Uzbekistan. About 60 percent of Uzbekistan's population lives in villages and for them agriculture is one of the main sources of income and labor market [11]. Since agriculture is a source of inputs for other sectors as well, perspectives of related sectors to some extent rest on agriculture and its development tendencies. After independence in 1991, the government has been reforming the agricultural sector to find out the best options and maximize the profit of the sector. Agricultural policies began to wheat production for food security [1]. The main important reform was to be replaced by state and collective farms by private farms and shirkats. For the Uzbek government cotton and wheat stayed as main crops in agriculture and led to remain state control on procurement volume and price for those crops [12]. At present private (individual) farms are considered as dominant producers of winter wheat about 84 percent, dekhkan farms cultivate the remaining 16 percent of the wheat area that is the second most important crop after cotton with an annual production of more than 7 million tons [18, 7, 10].

In the Soviet period, central planning provided with wheat production, mainly from Kazakhstan. The import decreased when Uzbekistan has become a wheat producer for local needs. Domestic wheat production satisfied more than 70 percent of the domestic consumption of food and feed wheat in 2017-2018, comparing to 16 percent in 1991 [7].

Uzbekistan exports wheat grain to Afghanistan, Iran, and a few CIS countries, 500 000 tons annually [1]. Moreover, still there is a legal and illegal import from Kazakhstan for high-quality flour with gluten content which bakers willing to pay a higher price.

Recently, new Decrees focused [8,9,10] on encouraging and increasing of grain production, promoting farmers to increase the yield, effective using land and water resources, ensuring high yields through the step-by-step implementation of the cluster system in grain production. However, its productivity has declined considerably in the last two decades due to various factors including unstable climate conditions. In an attempt to understand declining productivity in wheat harvesting, the study goal is investigating the role of climate variable changes and other related factors on wheat production in Uzbekistan and reviews literature on Climate Change impacts.

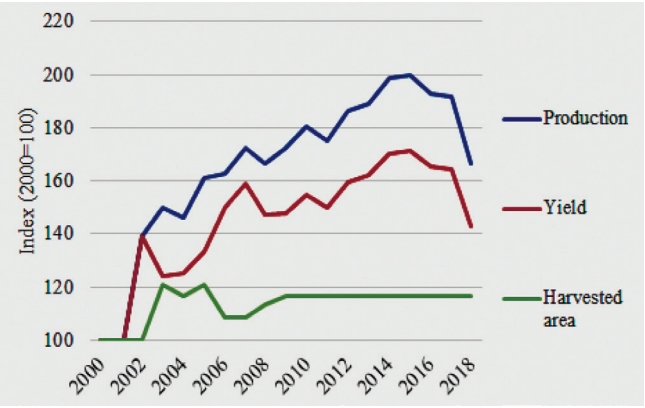

Figure 1: Uzbekistan: Wheat area, yield, and production, 2000-2018

Climate Change. Climate Change (CC) is rising temperature and melting of ice due to increasing greenhouse gases (GHG - Carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), and fluorinated gases). Those gases catch and interrupt coming direct sunlight to earth. There are two reasons which are responsible for CC. First, natural causes such as the earth's stilt, Continental drift, Volcanic eruptions, and Variation in the earth's orbital characteristics. Second, humans are an anthropogenic factor increasingly influencing the climate and the earth's temperature by burning fossil fuels, cutting down rainforests (sequestrates CO2), and farming livestock. This adds enormous amounts of GHG to those naturally occurring in the atmosphere, increasing the greenhouse effect and those global warming.

Intergovernmental panel on climate change

projected consequences of increased anthropogenic GHGs will exist for centuries; global temperatures – increase by 0,3 and 4,8°C till the end of the 21st Century; an increase of 26 and 82 cm till the end of the century due to ice melting [28]. CC has been observed and analyzed in the agricultural area in vast literature in many countries. But still, there is not much information about CC effects on crops in Central Asia. However, following analyzed exist literature.

Recent relevant literature on Climate Change. There is huge evidence suggesting that CC has a significant long-term impact on agricultural productivity rates through severe variability of temperature and precipitation degrees, particularly across CA countries [2, 21, 5, 6, 14, 15]. There is six rain feed area out of thirteen provinces which is irrigation is a dominant and large amount of wheat growth under irrigated land in Uzbekistan. According to a study [26], if the temperature is rising water availability of the water resources to satisfy crop water demands by 2070-2099 would be declined and it directly affects crop growth as well as its yield. Therefore, the factors explaining climate change are of major significance during the cultivation of agricultural crops. Starting from the early years of the Post-Soviet Union, wheat is considered one of the major crops in Central Asia, being a central point of many policy discussions. The budget in most CA countries still relies on domestically produced wheat.

In terms of winter wheat (Triticum aestivum L), production, a researcher [19] found that temperature from 1980 to 2008 has risen above one standard deviation of historic year-to-year reference which has led to a decrease in global production of wheat by 5.5%. An investigator [16] mentioned that future projections of climate change show the temperature will increase. Total biomass and grain yield were reduced by the nearly two-thirds effect of the temperature extremes under the conditions of excess water [22]. Weather changes may effect in negatively on crop yield. Low temperatures or excessive-high temperatures will lead to flower sterility problems during flowering stages and decrease the yield [23, 21,24].

CC impacts on crop yield may reduce productivity in critical temperature areas. The temperature becomes higher it also affects crop water productivity. Soil content and fertility are some of the major indicators which can roughly predict yields. Soil moisture and nutrient availability for crop growth totally depend on temperature and water. The amount of humus less than 1% in the soil of 76% of arable areas in Uzbekistan. Organic matter content from 1 % to 2% in 22% and contains from 2% to 3% only about 1% of the irrigated arable lands. This organic matter improvement can be reached by rotation of crops. During rotations, the crop remains to allow the accumulation of nutrients which can reduce the rate of using mineral fertilizers for the next plant. Also, it reduces using different chemicals that contaminate soil and water [13]. For a long time, farms have been using agricultural practices and technologies which are not adapted to climate change. Interestingly, most agricultural producers are either skeptical or not aware of climate change impacts. Inappropriate land and water management practices have been causing unsustainable natural resources use and economic loss in agriculture. There is a necessity for improvement farmers' knowledge for sustainable practices, efficient management and adequate yield [18].

According to prediction [6], temperature and precipitation will be positive for crop growth during 2010-2040, in Uzbekistan. But in the period 2070-2100 the yield will decrease due to unfavorable weather conditions such as high temperature and water deficiency, especially in irrigated land. As a result, farmers' income declines. Investigation of land and water use on-farm revenue in western Uzbekistan shows that 3.20 C temperature increase, farmers' utility decline by 25%, and 15% decline in irrigation water [5].

By effecting weather changes in the case of CA central transect in the weather changes affected more positively, vice-versa in western and desertic areas around the drying Aral Sea, and the eastern part affected less positively, in some areas excessive precipitation may lead to wheat diseases [14]. Importantly, recent years have witnessed growing negative climate variabilities that have impacted agricultural production by effecting soil fertility, water scarcity, or causing wheat diseases in Uzbekistan. Furthermore, wheat producers (i.e. farms) have to deal with challenges such as decreasing irrigation water supplies, land degradation, fertilizer use intensity, low soil organic matter contents, etc. which are constrained to wheat production in Uzbekistan [29].

Material and methods. In this study, the literature reviewed wheat productivity and climate variability during the last decades in Central Asia. Also, methodologies reviewed globally. Following considered models and results done by researchers used different approaches (crop, econometric) to predict wheat production and future actions. According to literature, first, in economic analyzes of the effects of climate change on the wheat productivity production function approach is used. In this way, the Cobb-Douglas production function used to wheat yield sector is important to analyze and understand what the core of wheat production is and from stakeholders' perspective what should be done to improve the sector. Second, following [14] and [3] use mean temperature and precipitation as independent variables on panel data to assess the impact of climate change on crop yield in econometric models.

Results and Discussions. As described by Mirzabaev, 2013 using a panel approach with a fixed-effect model is more appropriate to see weather impacts and climate changes on agricultural production or revenues in Central Asia than the other three approaches, such as integrated assessment, statistical regression models, and Ricardian method. In the result, all seasonal weather variables were statistically significant that temperature and precipitation are positively united with higher crop revenue. It implies, weather variability impacted on crop production revenue. Following researcher [3], tested the use of mean temperature and precipitation as independent variables to assess the impact of climate change on wheat yield in Pakistan. In one of study an agronomic model used with weather conditions, soil parameters, and other natural factors on wheat crop and found the impact of Climate Change in Central Asian case [21]. But statistical regression models have more advantages to cover agronomic, social, institutional, and economic factors [14,3,30].

Another researcher [30] analyzed the relationships between crop yield area under cultivation, annual rainfall, and food price index which contributes to the

yield. There is used the structured approach or Regression analysis to identify influences on yield. According to a result annual rainfall (AR), area under cultivation (AUC), food price index (FPI) three factors have an average of 70% influences in the crop yield. They express this work can be extended by considering more factors too, such as weather conditions, soil parameters, etc.

According to one of research [25] concluded that winter and spring runoff increases 44-107% and decreases in summer 12-42% are projected for the future period 2071-2100 in Fergana, Uzbekistan. Under climate changes available water for irrigation would be reduced in Amu Darya Basin If current irrigation practices not enhanced by 2070-2099. The worst-case scenario 20% reduction flows is estimated to lose 35-55% of the irrigated area, it is about 1.0 to 2.3 million ha of agricultural land [26].

Conclusion.

The impact of temperature on crop production can be explained by the fact that in recent years, Uzbekistan has sown new wheat varieties that are specialized to a particular region's climate and soil content [14, 27]. Therefore there was Climate variability least effected in agriculture, than comparing to other CC is sharply visible countries.

In the future adaptation measures may include change crop choice which resistant to water scarcity or high temperature, water reservoirs construction, and water reuse or improvement of the current irrigation systems to reduce water loss [25].

An alternative and necessary solution for the region is the improvement of land and water use efficiency in the agricultural sector. The efficiency improvement can be achieved by adopting innovative technologies, which can further enhance agricultural productivity. Further, improved resource use can induce conditions for health improvement, food nutrition security, environment, and socio-economic development in Uzbekistan.

As mentioned above CC forcing all levels of agriculture that they must make new adapted strategies. In near future, there needs to be a new policy on all types of crops in agriculture. Furthermore, intensive interaction between stakeholders, liberalization of wheat production, and implementation of CC adaptation and mitigation policies could be key to the future development of agriculture.

References:

1. Abdullaev, I., De Fraiture, C., Giordano, M., Yakubov, M., &Rasulov, A. Agricultural water use and trade in Uzbekistan: Situation and potential impacts of market liberalization //International Journal of Water Resources Development. – 2009. – T. 25. – №. 1. – C. 47-63.
2. Ashley L., Ershova N. Climate change trends, impacts, and adaptation in Kara Kulja District, Southern Kyrgyzstan //Oecologia Montana. – 2012. – T. 21. – №. 1. – C. 1-10.
3. Ahmad M., Siftain H., Iqbal M. Impact of climate change on wheat productivity in Pakistan: A district level analysis. – 2014.
4. Annual statistics of Provinces of Uzbekistan. 2018. The state committee on statistics of the Republic of Uzbekistan . (further Statistics 2018)
5. Bobojonov I. et al. Income and irrigation water use efficiency under climate change: An application of spatial stochastic crop and water allocation model to Western Uzbekistan //Climate Risk Management. – 2016. – T. 13. – C. 19-30.
6. Bobojonov I., Aw-Hassan A. Impacts of climate change on farm income security in Central Asia: An integrated modeling approach //Agriculture, ecosystems & environment. – 2014. – T. 188. – C. 245-255.
7. Zorya S., Djanibekov N., Petrick M. Farm Restructuring in Uzbekistan: How Did It Go and What is Next?. – The World Bank, 2019. – №. 134322. – C. 1-63.
8. Decree of Cabinet of Ministers of the Republic of Uzbekistan dated back on 20 December 2019 No 1025 "Effective Use of Land and Water Resources, Rationalization of agriculture for 2020 harvest and about prospects of product" https://lex.uz/docs/4660031
9. Decree of Cabinet of Ministers of the Republic of Uzbekistan dated back on 27 November 2019 No 959 "Action measures for further encouraging of grain production" http://www.lex.uz/docs/4082248
10. Decree of Cabinet of Ministers of the Republic of Uzbekistan dated back on 24 September 2019 No 806 "On additional measures to ensure high yields through the step-by-step implementation of the cluster system in grain production" https://www.lex.uz/docs/4529920
11. Djanibekov N. et al. Pros and cons of cotton production in Uzbekistan. Case study # 7-9 // Food Policy for Developing Countries: Case Studies. - 2010 .-- P. 13.
12. Hasanov S., Nomman A. Agricultural efficiency under resources scarcity in Uzbekistan: A Data Envelopment Analysis //Business and Economic Horizons (BEH). – 2011. – T. 4. – №. 1232-2016-101147. – C. 81-87.
13. Nazarkulov, U.,Rustamova, I., Nishanov,N. Introducing ecosystem service evaluation indicators in monitoring of irrigated agriculture in Uzbekistan.The project ELD Central Asia. ICAS VII Seventh International Conference on Agricultural Statistics. Rome 2016.
14. Mirzabaev A. Impacts of weather variability and climate change on agricultural revenues in Central Asia //Quarterly journal of international agriculture. – 2013. – T. 52. – №. 892-2016-65182. – C. 237-252.
15. Mirzabaev A. Improving the resilience of Central Asian agriculture to weather variability and climate change //Climate Smart Agriculture. – Springer, Cham, 2018. – C. 477-495.

16. Kang Y., Khan S., Ma X. Climate change impacts on crop yield, crop water productivity and food security–A review //Progress in natural Science. – 2009. – T. 19. – №. 12. – C. 1665-1674.
17. Karimov A., Niño Zarazúa M. Assessing efficiency of input utilization in wheat production in Uzbekistan //Lamers, JP, Khamzina, A., Rudenko, I., & Vlek, PL Restructuring land allocation, water use and agricultural value chains, Technologies, policies and practices for the lower Amudarya region. – 2015.
18. Kienzler K. M., Djanibekov N., Lamers J. P. A. An agronomic, economic and behavioral analysis of N application to cotton and wheat in post-Soviet Uzbekistan //Agricultural Systems. – 2011. – T. 104. – №. 5. – C. 411-418.
19. Lobell D. B., Schlenker W., Costa-Roberts J. Climate trends and global crop production since 1980 // Science. – 2011. – T. 333. – №. 6042. – C. 616-620.
20. Sellam V., Poovammal E. Prediction of crop yield using regression analysis //Indian Journal of Science and Technology. – 2016. – T. 9. – №. 38. – C. 1-5.
21. Sommer R. et al. Impact of climate change on wheat productivity in Central Asia //Agriculture, ecosystems & environment. – 2013. – T. 178. – C. 78-99.
22. Hatfield J. L., Prueger J. H. Temperature extremes: Effect on plant growth and development // Weather and climate extremes. – 2015. – T. 10. – C. 4-10.
23. Smith A. R., Zhao D. Sterility caused by floral organ degeneration and abiotic stresses in Arabidopsis and cereal grains //Frontiers in Plant Science. – 2016. – T. 7. – C. 1503.
24. Chakrabarti B. et al. Impact of temperature on phenology and pollen sterility of wheat varieties // Australian Journal of Crop Science. – 2011. – T. 5. – №. 8. – C. 1039.
25. Radchenko I. et al. Climate change impacts on runoff in the Ferghana Valley (Central Asia) //Water Resources. – 2017. – T. 44. – №. 5. – C. 707-730.
26. White C. J., Tanton T. W., Rycroft D. W. The impact of climate change on the water resources of the Amu Darya Basin in Central Asia //Water Resources Management. – 2014. – T. 28. – №. 15. – C. 5267-5281.
27. Report by Research Institute of Grain and Leguminous Crops, 2019. Near Ministry of Agriculture and Tashkent state agrarian University.
28. Stocker T. F. et al. Climate Change 2013. The Physical Science Basis. Working Group I Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change-Abstract for decision-makers; Changements climatiques 2013. Les elements scientifiques. Contribution du groupe de travail I au cinquieme rapport d'evaluation du groupe d'experts intergouvernemental sur l'evolution du CLIMAT-Resume a l'intention des decideurs. – 2013.
29. Djumaniyazova Y. et al. Simulating water use and N response of winter wheat in the irrigated floodplains of Northwest Uzbekistan //Field Crops Research. – 2010. – T. 116. – №. 3. – C. 239-251.
30. Sellam V., Poovammal E. Prediction of crop yield using regression analysis //Indian Journal of Science and Technology. – 2016. – T. 9. – №. 38. – C. 1-5.

HEXAVALENT CHROMIUM REMOVAL FROM AQUEOUS SOLUTION AND NATURAL ATTENUATION IN SOIL BY ADSORPTION

S.Musayev - Department of Civil and Environmental Engineering, University of Connecticut, Storrs, CT, USA
I.Musaev - Tashkent Institute of Irrigation and Agricultural Mechanization Engineers

Abstract

Rapid industrialization and population growth bring forward to use heavy metals in the environment and food chain. Discharge of untreated or partially treated wastewater having these toxic metals even cause more problems to water bodies and human health. Distribution of adsorbate molecules between the solid and liquid at equilibrium can be studied by adsorption isotherm models (Tella et al., 2014). Equilibrium is when concentration of adsorbate in solution is in balance with on the liquid adsorbate interface. The results show that Cr(VI) removal rate increased with adsorbent dosage till it reached equilibrium. Contact time also indicate efficiency within 60 to 70 minutes. Under certain conditions chromium hexavalent can be reduced to less toxic states in the soil by natural attenuation. Relying on this natural attenuation chromium contaminated sites can be remediated with less expense. If this method is applied, then what natural reductants are available within the aquifer should also be thoroughly studied. Reducing capacity should not prevail oxidation capacity. To study Cr (VI) reducing capacity of the aquifer by mass balances when relying on the aqueous concentrations from monitoring wells, the network must be sufficiently dense to estimate the correct Cr(VI).

Key words: Natural attenuation, food chain, heavy metals, toxic metals, adsorbent dose, adsorption isotherm, groundwater and soils.

Introduction. Rapid industrialization and population growth bring forward to use heavy metals in the environment and food chain. Discharge of untreated or partially treated wastewater having these toxic metals even cause more problems to water bodies and human health (Tewaria, 2005). Chromium (VI), being one of the heavy metals widely used in electroplating, leather tanning, dye, cement and photography industries is considered toxic metal (Raji and Anirudhan, 1998). The recommended concentration of Cr (VI) in drinking water is 0.05 mg/l (Selvaraj et al., 2003). Overcoming this limit causes health problems especially when it is classified as carcinogenic in nature (Oguz, 2005). Hence, non-systematic discharge of Cr (VI) into water bodies and potable water sources should be thoroughly controlled with legal standards and regulation mechanisms (Garg et al., 2004).

There are many treatment technologies developed to remove Cr (VI) from water, wastewater and soil. The adsorption method remains the most preferred compared to other methods due to its efficiency and low cost (Li et al., 2007). Adsorption of effect of adsorbent dose, initial concentration, contact time, pH and isotherm model analysis of carbon slurry and treated waste newspaper (TWNP have been studied for this project.

The adsorption Cr (VI) capacity per unit mass was calculated according to the following expression:

$$q = \frac{Ci - Cf}{Cs} V$$

where Ci and Cf are the initial and final chromium concentrations (mg/L), respectively, q is the amount of Cr (VI) adsorbed onto material (mg/g), V is the total volume of solution (L), and Cs is the mass of the dosage (g) (Dehghani et al., 2016).

Effect of adsorbent dose. It is interesting to know how much one should add to remove Cr (VI) the most of it from the solution. The more one adds the more one removes might not be the optimal solution under optimized conditions, pH, contact time and temperature. As per study of treated waste newspaper, the extent of Cr(VI) removal was found to be 3% for 0.5 g/L of adsorbent and significantly increased to 65% for 4 g/L of adsorbent, respectively depicted in Fig.1a (Dehghani et al., 2016). However, for carbon slurry there was only a slow change when the dose was over 4g/L (fig.1b). At a low dose, all types of sites are entirely exposed and the adsorption on the surface is saturated faster, showing a higher qe value (Gupta et al., 2010).

For both cases aggregates formed as the dose

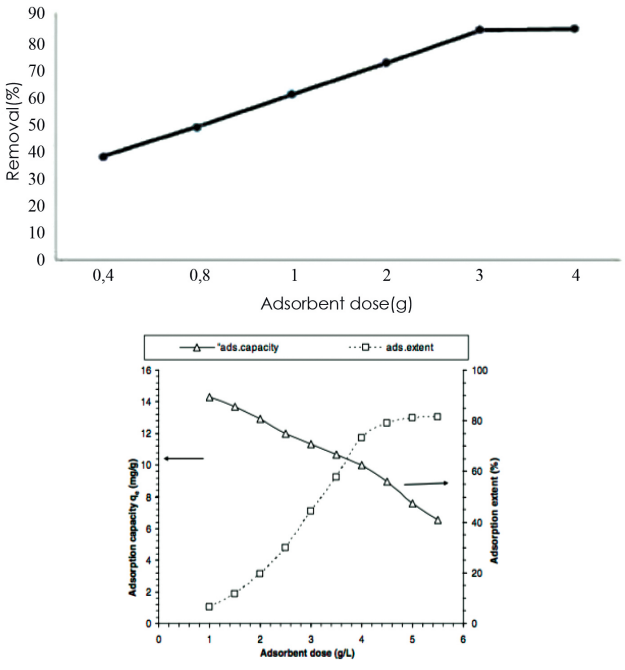

Fig.1a and Fig 1b. Plot of effect of adsorbent concentrations on Cr (VI) adsorption by TWNP and carbon slurry (Dehghani et al., 2016; Gupta et al., 2010)

increased with reduced effectiveness of adsorption. Fig.1a shows efficiency adsorption within the range of 0.4 to 3 g/100 mL, which might explain the equilibrium concentration was lower in the presence of high adsorbent concentrations (Dehghani et al., 2016).

Effect of contact time. The effect of contact time shows whether adsorption rate of chromium (VI) increased or decreased with time until equilibrium is reached. Availability of plenty of sorption sites and concentration gradient shows the rate of adsorption was higher for TWNP and carbon slurry within the first 60 and 70 min, respectively (Dehghani et al., 2016; Gupta et al., 2010). This is where the saturation level reached completely to the equilibrium point (Fig. 2).

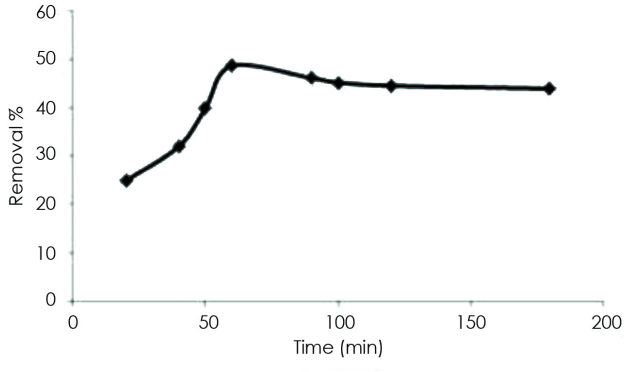

Fig.2. Effect contact time on Cr (VI) removal under initial concentration 20 mg/l, adsorbent dose 0.4 g/100ml, pH 3 for TWNP (Dehghani et al., 2016) and initial concentration 50 and 100 mg/L, adsorbent dose 4 g/L under pH 2 for carbon slurry (Gupta et al., 2010).

Effect of pH. pH of solution is one of the important adsorption characteristics controls the adsorption behavior of metal ions due to its influence to the surface properties. Species of $Cr_2O_7^-$, $HCrO_4^-$, $Cr_3O_{10}^{2-}$ and $Cr_4O_{13}^{2-}$ exist in *pH 1-6* and species of CrO_4^{2-}, $Cr_2O_7^{2-}$ predominant as pH of the solution increases. More H^+ ions in lower pH, acidic environment, shows higher adsorption is due to strong electrostatic attraction between positively charged adsorbent surface and chromate ions (Dehghani et al., 2016). As pH increases greater than 6 where OH^- is dominant, less adsorption is observed due to competition of both CrO_4^{2-} and OH^- ions to the same site (Fig.3).

It has also been stated that under acidic conditions, Cr(VI) could be reduced to Cr(III) in the presence of an adsorbent (Gupta et al., 2010).

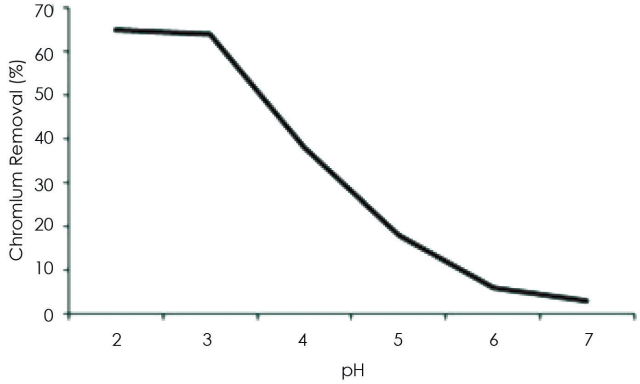

Fig.3. Adsorption profile of Cr (VI) onto treated waste newspaper at different pH values (Dehghani et al., 2016)

$$Cr_2O_7^{2-} + 14H + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$$

Cr(III) is not toxic in nature, hence, reducing it from $Cr_2O_7^{2-}$ *to* Cr^{3+} might not need further removing process of chromium from the solution.

Adsorption isotherm. Distribution of adsorbate molecules between the solid and liquid at equilibrium can be studied by adsorption isotherm models (Tella et al., 2014). Equilibrium is when concentration of adsorbate in solution is in balance with on the liquid adsorbate interface (Aksu, 2002). Langmuir and Freundlich adsorption isotherm models help to understand by fitting equilibrium adsorption data (Freundlich, 1906; Langmuir, 1918).

Langmuir isotherm:

The experimental data were fitted to the Langmuir equation:

$$q = qmax \frac{Kads * C\,fin}{1 + Kads * C\,fin}$$

where, *C fin (mg/L)* is the equilibrium concentration of the adsorbate, q (mg/g) is the amount of the adsorbate adsorbed at equilibrium, qmax is the maximum adsorption capacity, and K ads is the adsorption coefficient.

Freundlich adsorption isotherm is an empirical equation employed to describe the data for heterogeneous adsorbents (Freundlich, 1906).

$$q = K_f C_{fin}^{1/n}$$

where, Kf = Freundlich adsorption capacity parameter, 1/n = Freundlich adsorption intensity parameter (Dehghani et al., 2016).

Above figure depicts Cr (VI) Langmuir adsorption isotherm plots of Cr (VI) on TWNP shows the best fit where maximum adsorption can be achieved to be 59.88 mg/g.

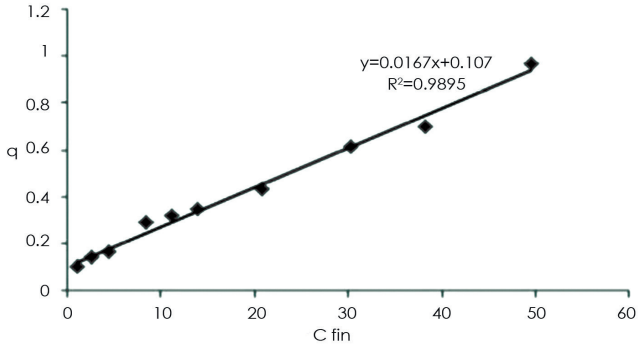

Fig.4. Langmuir isotherm plot for the removal of Cr (VI) by treated waste newspaper (Dehghani et al., 2016)

Natural attenuation of Cr (VI) in groundwater and soils.

Within the environment Cr is found primarily in two oxidation states: Cr (VI) which is mobile and toxic whereas Cr (III) is immobile under alkine and slightly acidic conditions (Weerelt et al., 1984). It puts the risk if it enters into groundwater flow system. There are costly methods to remove it from the soil but researchers have identified natural reductants which can transform the toxic one into less toxic form. Cr (VI) is a strong oxidant and gets reduced under the presence of electron donors. Commonly known ones are Fe (II), ferrous iron minerals, reduced sulfur and soil organic matter. Reduction with ferrous iron is follows:

$$HCrO_4^- + 3Fe^{2+}\ 7H^+ \rightarrow Cr^{3+} + 3Fe^{3+} + 4H_2O$$

This reaction takes places in 5 mins in the presence of DO (Eary and Rai, 1998). Numerous minerals in geologic materials contain ferrous iron which can reduce Cr (VI) into Cr (III). Cr(VI) reduction in the presence of iron oxides has been studied in several experiments. White and Hochella (1989) found that magnetite and ilmenite reduced Cr (VI) to Cr (III). Another important reducing agent in soils is organic matter (Walkey and Black, 1934). Dichromate can react with soil organic carbon as follows:

$$2Cr_2O_7^{2-} + 3C + 16H^+ \rightarrow 4Cr^{3+} + 3CO_2 + 8H_2O$$

Cr^{3+} could hydrolyze and then precipitate as Cr-hydroxide or it may bind to the remaining soil organic carbon. Martin et al., 1994 also studied Cr(VI) reduction by microbes with more common reduction by anaerobic microbes. However, the reduction mechanism is not well known. The study assumes the fungus in contaminated soil due to detoxification mechanism occurs intracellularly can reduce with excreted waste products such as H2S (Palmer and Puls, 1994).

The potential reductants of Cr (VI) include aqueous species, adsorbed ions, mineral constituents and organic matter (Palmer and Puls, 1994). When a contaminated plume of chromium hexavalent enters groundwater, it mixes by molecular diffusion with immobile soil matrix. This triggers the desorption of $Fe2+$ from mineral surface and results direct or indirect surface redox reactions between Cr (VI) and mineral surfaces, soil organic matter (Barcelona and Holm, 1991). Hence, it is soil matrix plays an important role to redox transformations in subsurface. Some factors should be addressed using natural attenuation of Cr (VI) in subsurface such as reducing capacity of aquifer where in x distance the mass of chromium hexavalent should be less. Time for reduction reaction to decrease from the initial concentration is also important.

If the oxidizing capacity of the soil is higher than reducing it may exhaust soil reductant and ultimately

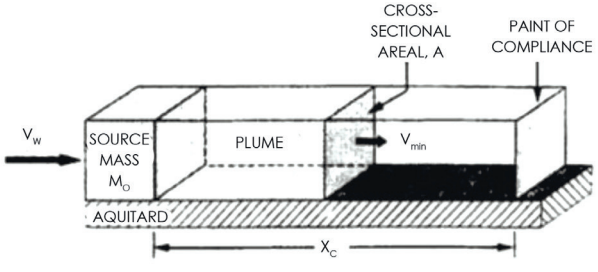

Fig.5. Cr-plume moving from the source area to the point of compliance (Palmer and Puls, 1994)

mobilized in the soil. Therefore, to determine the capacity of the aquifer to oxidize Cr(III) is important. Cr (VI) reduction can be estimated from the decrease of chromium hexavalent mass in the aquifer (Henderson, 1994). The total mass of Cr (VI) in the aquifer is the sum of the mass in the solution, the mass adsorbed to the aquifer matrix and precipitated mass in the aquifer (Palmer and Puls, 1994).

Simulation of metal ion adsorption through soil

The purpose of this project to see how contaminant movement from recharge zone into groundwater behaves under no adsorption and adsorption in simulated aquifer using Visual MODFLOW 4.2 program. Project assumes some parameters of soil, hydraulic conductivity, recharge characteristics within boundary conditions Table 1. For adsorption study, linear isotherm equilibrium controlled model is used with initial concentration and Kd values.

Table 1

Adsorption simulation study parameters

Name	Abbr	Value	Units
Specific storage	Ss	1.00E-05	1/m
Hydraulic conductivity, horizontal	Kx	8.64	m/d
Hydraulic conductivity, lateral	Ky	8.64	m/d
Hydraulic conductivity, vertical	Kz	0.864	m/d
Specific yield	Sy	0.2	
Effective porosity	Eff. Por	0.15	
Total porosity	Tot. por	0.3	
Steady state simulation time		1000	day
Longitudinal dispersivity		10	m
Horiz. / Long dispersivity		0.1	
Vert./Long. Dispersivity		0.01	
Boundary Conditions, column		40	
Boundary Conditions, X max		2000	m
Boundary Conditions, Y max		1000	m
Boundary Conditions, Z max		20	m
Constant Head, Z1		550	m
Constant Head, Z2		500	m
Recharge		2	m/d
Recharge concentration, pulse input (30 d)		10	mg/l
Monitoring well depth		10	m
Linear Isotherm (equilibrium –controlled)			
Initial concentration		10	mg/l
Distribution coefficient	Kd	0.025	1/(mg/l)

Simulation study compares with and without adsorption, the contaminant concentration at 10 mg/l was given during the first 30 days and stopped within the range of 1000 day span.

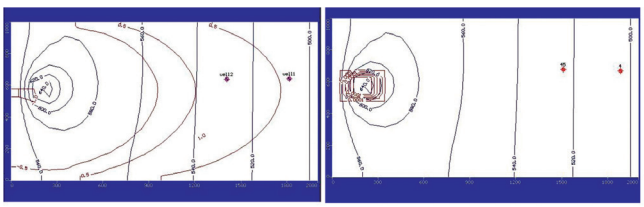

Fig.6. Plume behavior in 250 days without and with adsorption

Contaminant plume with initial concentration of 10 mg/l reached well#1 at 135 days and well#2 at 256 days, whereas the simulation with adsorption values did not move further distance from the recharge zone.

First figure in Fig.7 shows the metal ion concentration in two monitoring wells without adsorption over time of the pulse input concentration. Contaminant is removed from the boundary area about 500 days. Second graph depicts concentration gradient in the study area. 10 mg/l persists in 30 days and degrades due to adsorption. Contaminant is attenuated in soil within 145 days. Simulation model shows the time difference between adsorption and no adsorption behavior of contaminant plume.

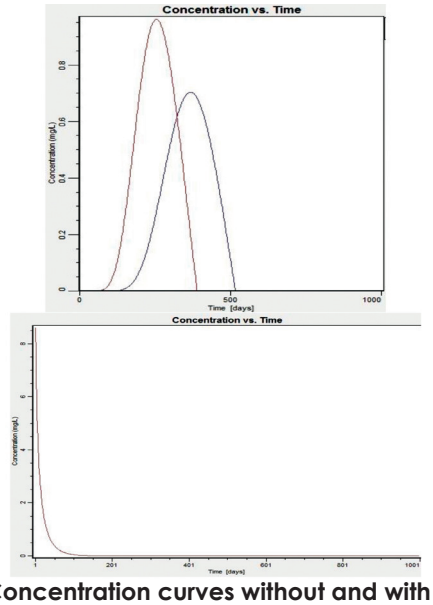

Fig.7. Concentration curves without and with adsorption

Conclusion. Due to easy availability and high efficiency for removal of Cr(VI), the adsorbent proposes cost-effective method (Dehghani et al., 2016). The studied TWNP and carbon slurry show an effective, low-cost adsorbent for the removal of toxic Cr (VI) from aqueous solution. The results show that Cr(VI) removal rate increased with adsorbent dosage till it reached equilibrium. Contact time also indicate efficiency within 60 to 70 minutes. Langmuir adsorption model used to describe adsorption of Cr (VI) onto treated newspaper waste products was found the equilibrium data well fitted to this model. Under certain conditions chromium hexavalent can be reduced to less toxic states in the soil by natural attenuation. Relying on this natural attenuation chromium contaminated sites can be remediated with less expense. If this method is applied, then what natural reductants are available within the aquifer should also be thoroughly studied. Reducing capacity should not prevail oxidation capacity. To study Cr (VI) reducing capacity of the aquifer by mass balances when relying on the aqueous concentrations from monitoring wells, the network must be sufficiently dense to estimate the correct Cr(VI).

References:

1. Aksu Z. Determination of the equilibrium, kinetic and thermodynamic parameters of the batch biosorption of nickel(II) ions onto Chlorella vulgaris. Process Biochem (2002) 38:89–99.
2. C. Raji, T.S. Anirudhan, Batch Cr(VI) removal by polyacrylamide-grafted sawdust: Kinetics and thermodynamics. Water Res. 32 (1998) 3772.
3. Carl D. Palmer and Robert W. Puls, Natural Attenuation of Hexavalent Chromium in Groundwater and Soils, EPA Groundwater Issue, EPA (1994) /540/5-94/505.
4. D. Aggarwal, M. Goyal, R. C. Bansal, Adsorption of chromium by activated carbon from aqueous solution, Carbon 37 (1999) 1989–1997.
5. E. Oguz, Adsorption characteristics and the kinetics of the Cr(VI) on the Thuja oriantalis, Colloids Surf. A: Physicochem. Eng. Aspects 252 (2005) 121–128.
6. L.E. Eary, D. Rai, Chromate removal from aqueous wastes by reduction with ferrous ion Environ. Sci. Technol., 22 (1988), pp. 972-977.
7. Freundlich HMF. Over the adsorption in solution. J Phys Chem 1906; 57:385–471.
8. J.M. Philipot, F. Chaffange, J. Sibony, Hexavalent Chromium Removal from Drinking Water Sci. Technol. 17 (1984) 1121–1132.
9. J.W. Patterson, Waste water treatment technology, Water Treatment Technology (1978), 3rd ed., Ann Arbor Science, Ann Arbor Michigan, MI.
10. K. Selvaraj, S. Manonmani, S. Pattabhi, Removal of hexavalent chromium using distillery sludge, Bioresour. Technol (2003) 89: 207–211.
11. Langmuir I. The adsorption of gases on plane surfaces of glass, mica and platinum. J Am Chem Soc 1918; 40:1361–403.
12. Li Q, Zhai J, Zhang W, Wang M, Zhou J. Kinetic studies of adsorption of Pb(II), Cr(III) and Cu(II) from aqueous solution by sawdust and modified peanut husk. J Hazard Mater 2007; 144:163-7.
13. Mohammad Hadi Dehghani, Daryoush Sanaei, Imran Ali, Amit Bhatnagar, Removal of chromium(VI) from aqueous solution using treated waste newspaper as a low-cost adsorbent: Kinetic modeling and isotherm studies, Journal of Molecular Liquids 2016; 215:671-679.
14. N. Tewaria, P. Vasudevana, B.K. Guhab, Study on biosorption of Cr(VI) by Mucor hiemalis, Biochem. Eng. J. 23 (2005) 185–192.
15. S.E. Jorgensen, Ind. Wastewater Manage. Book, series # 7 (1979) 81–92.
16. S.S. Baral, S.N. Das, P. Rath, Hexavalent chromium removal from aqueous solution by adsorption on treated sawdust, Biochem. Eng. J. 31 (3) (2006) 216–222.
17. Tella AC, Owalude SO, Ojekanmi CA, Oluwafemi OS. Synthesis of copper–isonicotinate metal–organic frameworks simply by mixing solid reactants and investigation of their adsorptive properties for the removal of the fluorescein dye. New J Chem 2014; 38:4494–500.
18. V.K. Garg, Renuka Gupta, Rakesh Kumar and R.K. Gupta, Adsorption of chromium from aqueous solution on treated sawdust, Bioresource Technology. 92 (2004) 79-81.
19. Van Weerelt, M., Pfeiffer, W.C. & Fiszman, M, Uptake and release of Cr(VI) and Cr(III) by barnacles. Marine Environment Research, 1984; 11, 201–211.
20. Vinod K. Gupta, Arshi Rastogi, Arunima Nayak, Adsorption studies on the removal of hexavalent chromium from aqueous solution using a low-cost fertilizer industry waste material, Journal of Colloid and Interface Science 2010; 342: 135-141.
21. Walkey A and Black, An examination of different method for determination of soil organic matter and a proposed modification of the chromic acid in soil analysis, Journal of Soil Science 1934; 37: 549.

ASSESSMENT OF WATER CONTENT IN HYDROLOGIC TIME SERIES BY USING DIFFERENCE INTEGRAL CURVES (IN THE EXAMPLE OF PSKEM RIVER)

S.M.Kodirov, S.R. Mansurov
Tashkent institute of Irrigation and Agricultural Mechanization Engineers, Tashkent, Uzbekistan

Abstract

The Pskem River (mean annual flow rate 79.6 m3/s) is one of the biggest tributaries of The Chirchik River. The Chirchik River is the biggest right tributary of The Sirdarya River in the territory of Uzbekistan. On the basis of long-term data from hydrological and station (The Pskem River, at hydrological station Mullala, 85 years of observation), long-term fluctuations was evaluated in terms of watery of the year i.e. how changes mean annual flow rate from year to year. The data set of statistical characteristics and their standard errors are estimated, for average flow rates statistical error does not exceed 2.5 %, for the coefficient of variation; the error does not exceed 6 %. To describe long-term fluctuations in water content for a given period method of normalized values appied.

Key words: The Pskem River, The Chirchik River, hydrology, long-term fluctuations, average flow rate.

Introduction. *General information about focusing area.* The article considers feature of the hydrological regime of the Pskem River which is located in the territory of Uzbekistan. Pskem – is a mountain river and it begins from Talas Alatau Mountains in Kazakhstan [1]. It flows mainly to the south-west between Pskem and Ugom Mountain Ranges. Near to the Mullala village (Tashkent region, Uzbekistan), it flows into The Charvak reservoir. The length of the river is 70 km and catchment area is 2540 km 2. The study of the hydrological regime of The Pskem River is important for rational regulation of water resources of the region. The objective of the research is to overview the hydrological regime of The Pskem River and to evaluate the long-term fluctuations in the hydrological time series in terms of watery.

As initial data, we used a series of hydrological dataset for 85 years of observations. The place where our hydrological station located is considered to be high mountain stations in terms of altitude.

General nature of atmospheric circulation in the mountains of study area remains similar to relevant processes specific for plains and foothills in Central Asia, nevertheless the distribution pattern of climatic elements in conditions of rugged terrain considerably changes. Thus, mount ridges located on the way of humid air masses transportation produce sharpening of fronts and create spaces of intensive moisture on leeward slopes while the parts exposed to the wind remain weakly moistened [4]. Distribution patterns of other climatic elements depend on varieties of terrain elevations and exposure peculiarities of slopes. Local circulation also produces considerable impacts on formation of climate. This type of circulation is determined by a complex system of mountain-plain winds, fan draughts and fan-like winds. Temperature inversions are also should be considered, since in some places this phenomenon induces rise in temperature in winter and at night [7].

Snow cover appears in the foothill zone mainly in the second decade of November. At higher altitudes snow cover appears in the mountains earlier. At the altitude of 2000 m (the Angren plateau) snow cover appears in the middle of October. Dates when appearance of snow cover is registered deviate notably from year to year. Formation of sustained snow cover usually takes place in December; at the altitude of about 1000 m in the northern part of the area this development is registered in the second decade of December. At higher altitudes sustained snow cover appears in early December or in the end of November. At the altitudes higher than 2000 m sustained snow cover is formed as early as by the end of October. Analysis of observation series with regard to snow cover shows that for the last 10-15 years the tendency towards its diminution has taken shape. At that, synchronous changes are registered as to numbers of days with snow cover and its maximum depth [6].

Materials and Methods.

Initial data and methods.

To estimate long-term fluctuations of the annual flow rates of analyzing rivers, the difference integral curves are plotted (DIC).

In order to plot the curves, at very beginning of the dataset we need to add one more years and indicate it as a first serial number 0-zero. Because curve is always starts with zero and ends at zero. For example, assuming for a certain year, the annual stream flow is higher than the expected value, then the DIC rises. If lower than the average value, then it decreases respectively [2].

Afterwards mean annual flow rate and its standard deviation of the hydrological dataset must be determined.

The following equation is used to calculate normalized annual flow rates:

$$t=Q_i - \bar{Q}/\delta \quad (1)$$

Where: t - normalized values of mean water discharge; Q_i - annual flow rates; $\bar{Q}$ - mean long-term flow rates; δ - standard deviation of hydrological time series.

The values for δ - are calculated as the square root from variances:

$$\delta = \sqrt{D} \quad (2)$$

Results. The evaluation of the long-term fluctuations Figure 1 depicts the average annual flow rates from 1934 to 1940 rises relatively to the average value-0, and from 1940 to 1957, the DIC remains stable that refers during this period is close to mean flow rates (annual flow rates are relatively close to the expected value). And from 1958 till 1974, the average annual water discharge rises again relatively to the average value. And, consequently, this considered as a high water period.

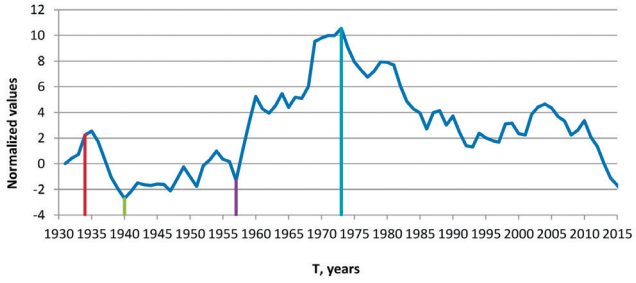

Figure 1. Difference integral curves of annual flow rates of The Pskem River- at Mullala hydrological station

However, from 1975 till nowadays we are observing long duration of low watery interval. The intra-annual distribution of precipitation is shown in Figure 2. As can be seen from this figure, 64-65% of the annual amount of precipitation falls from January to May, the smallest part (5-6%) falls during the period of June-September months [3]. This figure provides the information relating watershed characteristics such as elevation influences to formation of more liquid precipitation. The analysis of seasonal patterns of precipitation for a period of 1981-2010 at lower stations Yangikurgan and Brichmull shows the increase during spring months.

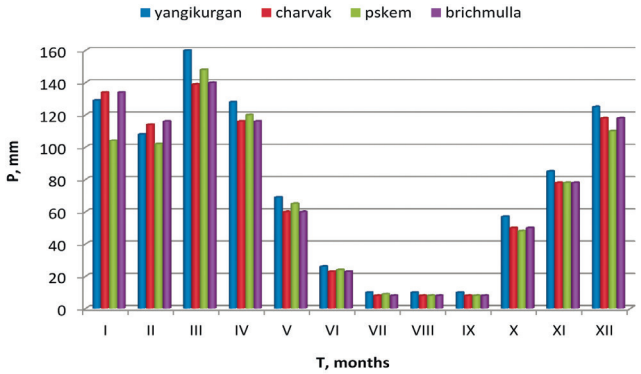

Figure 2. Average long-term monthly precipitation at Pskem meteorological station

The average long-term amount of annual precipitation for each meteorological station is presented in the table 1.

Table 1

Average long-term annual precipitation, mm.

№	Meteorological station	Precipitation, mm	
		For a period of 1961- 1990	For a period of 1981- 2010
1	Chatkal	555	574
2	Chimgan	533	559
3	Pskem	546	572
4	Oigaing	523	538

For all the stations during 1981-2010 precipitation is increasing in the hot season (May-August). But this growth is within 3-5%, which does not exceed 9% statistical error. It was also determined about 44% of the annual amount of precipitation falls in liquid form, 26% mixed precipitation and 30% in the form of snow.

Conclusions. Difference integral curves provide a compact graphical summary of long-term streamflow variability. It is simple and effective way of evaluating long-term hydrological time series. For example, they illustrate how watery of the time interval for a taken period. For our focusing area starting from 1975 till 2016 low water content period is observing. This can be explained with precipitation characteristics i.e. during this time the overall amount of precipitation is changing statistically insignificant (3-5 %) however alteration of type of the precipitation is occurring. This refers to observation of more rainfall than snowfall processes. Hence less snow cover remains in catchment area and it corresponds to shift of the type of the river from snow-glacier nourishment to snow (mostly seasonal not permanent) nourishment by classification of Shultz V.L. [5]. The analysis of long-term precipitation patterns show the change of precipitation form from snow to liquid which is rain due to climate change process.

References:

1. Information Portal of Wikipedia [Electronic resource]. URL:https://en.wikipedia.org/wiki/Pskem_River (The last date of access on 14.05.2018).
2. Sikan A.V., Malisheva N.G., Vinokourov I.O. Statistical methods of analyzing Hydrometeorological information. Laboratory practices. For fields «Hydrology». Specialty «Hydrometeorology». – Saint-Petersburg.: Publishing House of RSHU. 2014.–pp. 75. (in Russian).
3. Sikan A.V. Methods of statistical processing of hydrometeorological information. Tutorial. For fields «Ecology and Environment». Specialty «Geoecology». – Saint-Petersburg.: Publishing House of RSHU. 2007, – p. 278. (in Russian).
4. Orlov V.G., Sikan A.V. Basics of engineering hydrology. Tutorial. For fields «Ecology and Environment». Specialty «Geoecology». – Saint-Petersburg.: Publishing House of RSHU. 2003, – pp. 187. (in Russian).
5. Shults V.L. The rivers of the Central Asia. – Leningrad: Publishing House of Hydrometeorology, 1965. – pp.691. (in Russian).
6. Glacier Catalogue of USSR. Volume 14, the Central Asia, Edition 1. The Chatkal River basin. – Leningrad: Publishing House of Hydrometeorology, 1970. – 41 pp. (in Russian).
7. Gulomov P.N., Vakhobov H., Barotov P., Mamatkulov M. «Physical geography of Uzbekistan and The Central Asia», Publishing and polygraph creative house «O'qituvchi», Tashkent – 2013. – 160 pp. (in Uzbek)

REQUIREMENTS ON REGISTRATION OF ARTICLES FOR PUBLICATION IN THE JOURNAL "SUSTAINABLE AGRICULTURE"

• There are published original experimental scientific articles in the journal "Sustainable Agriculture"They are about the sustainability of agriculture during a period of significant decline in water situation and increase of water sources pollution in anthropogenic climate change in the short and long term.

• There are not published articles that expound individual stages of research, which do not allow us to draw certain conclusions.

• All articles are published in English.

• All data must be accompanied by covering letter, which consists of 500 or fewer words, a summary of the significance of research, author's consent to publication, a number of pictures and tables, support for manuscripts (articles) and additional information. In addition, it should be indicated the current telephone and fax numbers, postal address and e-mail address of the respective author to keep in touch.

• For submitting documents (articles), you must send an electronic version to the editorial office, Brussels classification is necessary. The data should follow the recommendations "requirements for registration…" The authors are fully liable for the originality of the article and its subjective and formal correctness.

• Articles are presented carefully edited, typed in Microsoft Word and Times New Roman Font (Eurotimes font will not be accepted). (*.doc or *.rtf files) in the font size of 12 Times New Roman with A4 sheet format, after 1.15 interval, the size of the text restrictions: the margins at the top and bottom are 2.0 cm, on the left is 3.0 cm, on the right is 1.5 cm. Manuscripts of articles must be signed by authors and have a stamped reference from the institution where the work is done. It confirms that the materials are published for the first time. Moreover, all authors must submit a certificate (from each scientific institution in which the research was carried out).

• Abstract (summary) is a brief overview of all work, including the scheme, objectives, methods, result, and conclusions from the article. It should describe all significant facts of a scientific article and basic numerical data, including any statistical evaluation.

• Abstract (summary) should not exceed 300 words (1-1.5 pages), it should be used as the standard nomenclature. There are not recommended to use any abbreviations in the title of the article or in the abstract. Keywords should be included.

• When you prepare articles containing experimental data, the following scheme should be adhered to literature review, research objective, methodology, results, and conclusions. A Capacity of experimental articles is 15 pages, including a list of references, pictures, photographs, and tables. The title of the article should be short and understandable.

• About the text: the introduction should contain the main reasons for research, review and analysis of the appropriate literature on the subject of research and the proposed approach or solution.

• The title of the section should be accompanied by some text preceding any heading of the subsection. All headings and subheadings in the article should be on the same level. There should be short headings for each section and subsection. Section headings should be in bold, subsections - in italics.

• Data and methods. There all preliminary data, conducted experiments, their degree and conditions of carrying out should be described in detail in this section. All original procedures that were used for the processing of experimental material and all analytical methods used for the evaluation should also be detailed. The whole methodology should be described if it is original. In other cases, it is sufficient to show the author of the method and mention some special differences. You should also indicate the methods of statistical processing, including the used software.

• Results and discussion. The results obtained from the experiments, including their statistical evaluation and commentary, should be presented graphically or in tabular form, the author must comment on the results and compare them with data published at other places (other authors), results should be written in the past tense. Results and discussion can be combined or given in a separate section. Detailed interpretation of the data should be included in the discussion section, not in the results section.

It is necessary to clearly use capital (uppercase) and lowercase letters and also upper and lower indices in formulas, equations, dependencies, etc. This prevents errors. Mathematical formulas are created as separate objects in the formula editor and placed on center. Formulas referenced in the text must have continuous numbering. The formula number is placed in parentheses near the edge of the right margin. The size of the symbols in the formulas is normal is 14 pt, large is 18 pt, small is 7 pt, small index is 5 pt.

• References: only published or accepted manuscripts (articles) should be included in the list of references. Do not refer to abstracts, conferences or documents that were submitted but have not accepted yet. References should be listed and numbered in the order in which they appear in the text. Also, they should be indicated by a reference number in square brackets, multiple references in one set of parentheses must be separated by commas, for example: [1,5,7,28]. The list of references must be at least 20 names. It should be indicated the surnames and initials of all authors separated by comma. After they follows the year of publication in parentheses, the title of the article, the full title of the journal, the volume and page numbers. The names of the author (s) and year of publication should be listed by including them in the text directly, for example: "… as published by Chertovitsky A.S. (2017) or indirectly with the reference on the name (names) and on the year of publication in brackets (Chertovitsky A.S. and Ramazanov A. 2017), (Mirsaidov M.M. and others 2016). Below you can observe the rules and examples of the design of the list of literature in English. The list of references at the first time serves for tracking the authors' and journals' quotations. A correct description of the used sources at the list of literature is a guarantee that quoted publication will be taken into account at the assessment of its authors' scientific activities, and therefore organization, region, state. By quoting, the journal there is determined its scientific level, credibility, the effectiveness of its editorial council, etc.

The structure of the list of literature n English differs from that prescribed by the Russian GOST. A dash, as well as a symbol // are not used in the description in English.

• Tables and pictures should be presented separately to the text, on a separate page at the end of the article, including their names and used units. The units of physical quantities are given in accordance with the International SI system. The names of chemical compounds, taxonomic names are given in accordance with the international nomenclature. Enables should be made in MS Word format (format. Doc), graphics in MS Excel files (data files, xls), photos in jpg / .tiff format (resolution is not less than 300 dpi), all graphics and photos must be numbered, according to the order in which they are included in the text, using Arabic numerals. If any abbreviations are used in the articles first time, they should be explained accordingly.

Each table and picture must have a legend. It means the name along with a description that the reader can find useful for understanding the content. The legends for the tables are placed at the top of the table, the legends for the pictures are at the bottom. The headings of the tables and pictures should be completely descriptive, hidden to the left and bold. For the legend of the table, the first letters in each main word are written with the capital letter, for the legend of the picture the capital letters are written only for the first letter of the first word together with own nouns and adjectives. For example Table 1. Total natural river runoff in the Aral Sea basin (average annual runoff, km3 per year is SIC ICWC estimate) from 2001 to 2016. Picture 1. Areas of irrigated land suspended from the South Fergana Channel. In the text, there are used a small letter for the words "table" and "figure" if they do not appear at the beginning of the sentence.

Tables should be numbered according to the order of the reference and refer to them in the text. The tables should not contain empty graphs, dashes or abbreviated words. The digest of the table is typed in Times New Roman font is 9 pt, the head of the table is 8.5 pt. The digital material in the tables is printed at double intervals, the text of the head and outset is with a single one.

• Footnotes for tables. There are used small English letter for attaching footnotes to certain elements of the table, footnotes are placed below the bottom line of the table in the form of a paragraph (without indents). For general explanatory notes, you must use the "Note" header.

The parameter "Note" can identify the use of an asterisk (for example, one asterisk (*) is in the Syrdarya region (1970) and a double asterisk (**) is for some notations according to CANIIRI (Central Asian Research Institute of Irrigation), from 1980 to 1983.

Color images, figures can be played only in color mode (with a black and white printed version). If during the presentation of the article the author knows that color on the Internet is the preferred method of publication, in this case, there must be presented two files with figures: the black and white version must be marked for printing, and the color version must be marked online in the picture name file.

• Through separate application, there must provide information about the full names of all manuscript's authors, address (telephone, fax, and e-mail), the official name of the institution. The editorial staff reviews all received articles and the period of consideration of the article is 6 months.

• It is expected that the article is written in literate and well readable English. If it is necessary, authors should consult with the interpreter before sending an article. The article will not be checked in detail by the editorial board for the existence of linguistic mistakes. At the same time, the editors reserve the right to reject the article if there is a great number of linguistic mistakes.

• Each article that comes to the editorial office of the journal is sent for consideration to experts of the appropriate profile. As a rule, two experts are appointed for each article. The experts report their conclusions and assessments to the editor-in-chief of the journal, besides that, at least two conclusions must come to every article. Remarks and suggestions of experts are brought to the attention of the article author, after that he makes all necessary changes.

• A copy of the journal with the published article is not sent to the authors and this journal is distributed only by subscription, the fee is not paid.

«Note: Only the author of the article is responsible for the content and information of the article. Editorial staff does not respond to the content of the article!»

Editorial address: 100000, Tashkent, Kary-Niyazov Street, 39. Tashkent Institute of Irrigation and Agricultural Mechanization Engineers,
telephone number is (998 71) 237-19-78, (998 71) 237-19-58 E-mail: admin@tiiame.uz, tohir-zs@mail.ru.