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STUDY OF AGRICULTURAL ARCHITECTURE WITH ELEMENTS OF ENERGY-EFFICIENT TECHNOLOGY EXPERTISE OF KazGASA FACULTY OF ARCHITECTURE

In the context of the development of the agricultural sector, as one the elements of Kazakhstan's economic development, it is necessary to prepare professionals possessing the ability to design new types of agrarian facilities (agroparks, agrotourism complexes, vertical farms, conservatories, greenhouses) using energy-efficient technology. The article presents the results of implementing elements of designing energy-saving facilities in rural areas into the educational process in the the field of "Architecture" at the Faculty of Architecture of KazGASA.

Keywords: agricultural architecture, energy-efficient technology, agro-settlements, agrotourism, vertical farms

INTRODUCTION

Kazakhstan is traditionally an agrarian country ranking 9th in the world by its territory size - it has vast land resources and a geographical location that is advantageous for its logistics and is situated at the junction of world powers (China, Russia) and Central Asia. The climatic conditions of the country are favourable for cattle-breeding and plant cultivation, the production of meat and dairy, grains, fruit and berries.

Agriculture has always been the leading branch of the economy of Kazakhstan. However, in the post-Perestroika period due to country's shift from a planned economy to a market economy model, structural changes have taken place: large state agrarian associations were replaced by small private households which led to a reduction in the capacity of the agroindustrial sector of the country.

In the modern conditions of Kazakhstan, in order to revive the agricultural field some important state projects were enacted: "Program for development of agroindustrial complex in the Republic of Kazakhstan for years 2010-2014", "Program for development of agroindustrial complex in the Republic of Kazakhstan for years 2013-2020", "Development of export potential of cattle meat for years 2011-2020", and others.

In President N. Nazarbayev's message to the people of Kazakhstan "Third modernization of Kazakhstan: global competitiveness", one of the primary elements of the new economy model is the agricultural sector: "The agricultural sector has to

become the new driver of the economy. The agroindustrial complex of Kazakhstan has a promising future. On many fronts we could become one of the world's largest producers of exported agricultural goods. Especially in the production of environmentally friendly food. We have to ensure a shift from commodity production to producing quality processed goods" [1].

In these conditions the architectural school of Kazakhstan is assigned the task of forming the basis of the teaching disciplines that are focused on designing contemporary agrarian facilities, using innovative technology, and revitalizing suburban settlements.

1. RESEARCH METHODS

In order to form the methodical basis of studying agricultural architecture, in 2015-2017 studies were conducted as part of the funded research project 5585/GF4 "Designing architectural planning solutions of processing enterprises in the agroindustrial complex of the Almaty agglomeration" at the Faculty of Architecture of KazGASA. Seminars and workshops were run by the academic staff and practising architects in order to familiarize senior students with the agrarian topic. Interested students completed educational and diploma works, delivered results of their research at conferences, published articles in the collection of student works. All of them had the opportunity to consult with academic staff who conducted research within the funded project.

Study of the directions of modern architecture development was conducted based on the analysis of academic literature and project materials, foreign experience in designing agrarian facilities, including those with elements of energy-efficiency. In order to test the results of their research, KazGASA students as part of the funded research project completed master's theses and academic projects of public hubs of suburban settlements, agrotourism sites, cattle-breeding farms, greenhouses, vertical farms, etc. Articles on the students' projects were published in magazines included in the Scopus database [2, 3].

2. RESULTS AND DISCUSSION

At the modern stage of development, the world economy tends to focus on new trends: sustainable development and energy-efficiency. The sustainable development of the world is impossible without advanced agriculture: the land, water, air, sun and wind represent renewable sources of eternal energy.

During the course of carrying out academic and diploma projects, students study the history and traditions of local agriculture, international expertise of designing agrarian settlements, agroindustrial parks, agrotourism sites, facilities of small and medium business (greenhouses, conservatories, vertical farms, etc.) Comparative analysis is conducted on the climatic and technological conditions, agricultural specialization, state of economy, and logistic situation in the given region.

Foremost attention is paid to the effective use of renewable energy sources, that is sun, wind, biogas, etc. in the projects.

Existing technology allows agrarian production to be set up in such climatic conditions that previously were deemed unacceptable, for example, in the context of lifeless deserts. Solving the problems of populating territories unfriendly from the perspective of permanent settlement is also relevant in Kazakhstan. Completing projects of such a scale in the desert, semi-desert and prairie zones of our country could contribute to a growth of the quality of life for residents of suburban areas with a sharply continental climate, also would “cement” the space of unoccupied territories [4]. Students closely analyze the experience of Libia where an ambitious experiment was started in the 1970s on designing and building agricultural enterprises in the Kufra oasis. Equally interesting is the experience of designing kibbutzim and MASHAV centres in Israel. Historically and organizationally, the experience relevant for Kazakhstan is the one of Belarus on designing agricultural settlements on the basis of former Soviet collective farms (kolkhoz).

In their projects students turn to new trends as well: agroindustrial parks are a modern form of enterprises for producing, processing and selling agricultural commodities. Currently in line with plans for modernization, the government of Kazakhstan and local authorities are working to join more than 500 thousand households and small farms into cooperatives, as well as to improve the level of processing produce, and to create an efficient system of storing, transporting and selling commodities. Small farm households cannot provide quality storage and transportation, while including intermediaries in the production chain affects the final price of produce. Building a network of agroparks in key hubs of agglomerations would allow the formation of food safety zones around the cities of Kazakhstan, and would solve issues of the population’s unemployment. Agroindustrial parks can include full-cycle enterprises from the production to storing and selling of agricultural commodities.

Of great interest among students is the topic of agrotourism architecture. Agrotourism is presently a rapidly growing sector in Europe which involves tourism in rural territories, villages, and farm households. In Kazakhstan agrotourism is possible in different forms: visits to vegetable and fruit farms for a short-term rest combined with crop harvesting; full immersion into everyday village life, acquaintance with traditional types of farming - cattle-breeding, plant cultivation, grape growing, etc. [5].

Following the world-wide boom of vertical farms, students increasingly more often implement vertical farm projects including greenhouses, conservatories, and mushroom spawns.

“Vertical” farms are not necessarily high-rise buildings. They are high-tech greenhouses where plants are placed on vertical shelves, often without soil and sunlight, using artificial lighting, climate control and hydroponics. Such farms are designed as bio-climatic buildings combining a controlled environment with heat-production, ventilation and lighting [6]. In the urban milieu, farms can solve ecological issues as well: for example “green” facades of “vertical” farms allow

a building's temperature balance to be maintained and improve environmental ecology.

Foreign expertise analysis shows that medium-storey "vertical" farms represent realistic versions of placing agroproduction in the urban milieu: they require no complex engineering solutions and may be in demand in the near future. According to forecasts, "vertical" farms would be more economical than traditional ones: 95% less water would be used and the use of fertilizers would fall by 50%. "Vertical" farms are more efficient and occupy less land. They provide prompt delivery of fresh foods to the consumer because their location is practically within the city limits. However, the downsides of this technology are the high capital investments and energy consumption, as well as a tenfold increase in carbon emission levels.

The legislation of a number of foreign countries stipulates that all agricultural enterprises (production, processing and storing) have a closed wasteless technological process, use harmless types of energy - sun, wind, rejected heat of nuclear and hydropower plants, thermal power plants, boilers, etc. [6] Usually, at such enterprises facilities of different purposes are combined - livestock, plant cultivation, fish farming, etc. Moreover, shops for microbiological waste recycling are included; issues are solved on waste removal, enterprise ecology, and time savings in produce delivery. Lowering harmful emissions allows such enterprises to be placed adjacent to residential zones, which in turn allows land to be saved, cuts costs and gives an intriguing architectural effect.

Within the educational process, KazGASA students use contemporary approaches to design agroindustrial cluster buildings that stand out due to their innovations and high technological effectiveness. This can be seen in a number of student projects (Figs. 1-3) dedicated to designing recreational-agricultural facilities, vertical farms with accompanying services, cattle-breeding complexes, conservatories, etc. An essential condition for the projects is the use of energy efficient technologies - of wind, sun, water, biomass energies.

In order to adapt the agrarian sector to modern technological solutions, undergraduates and students in their projects model the architecture of the complexes, and plan the organization of agroindustrial enterprises based on innovative technology in the conditions of Kazakhstan.

The student projects are designed in line with standards and suggest the implementation of cutting-edge technology of agroindustrial production. The functional zones of the complexes include administrative buildings, a production area (cattle-breeding, feeding, fish farms, a greenhouse complex). The facilities are connected with one another into a single highly efficient complex which is supplied with bio-gas energy and uses sun collectors. When designing the master plan of the site, close attention is paid to active planting and watering of the territory taking into account local climatic conditions. Along with the production of commodities, many student projects envisage the provision of recreational services for families. This fact enhances the emphasis on solving ecological issues and demonstrates that agrarian enterprises are seen by the authors of student projects as elements of a safe environment which is suited for work as well as for recreation.

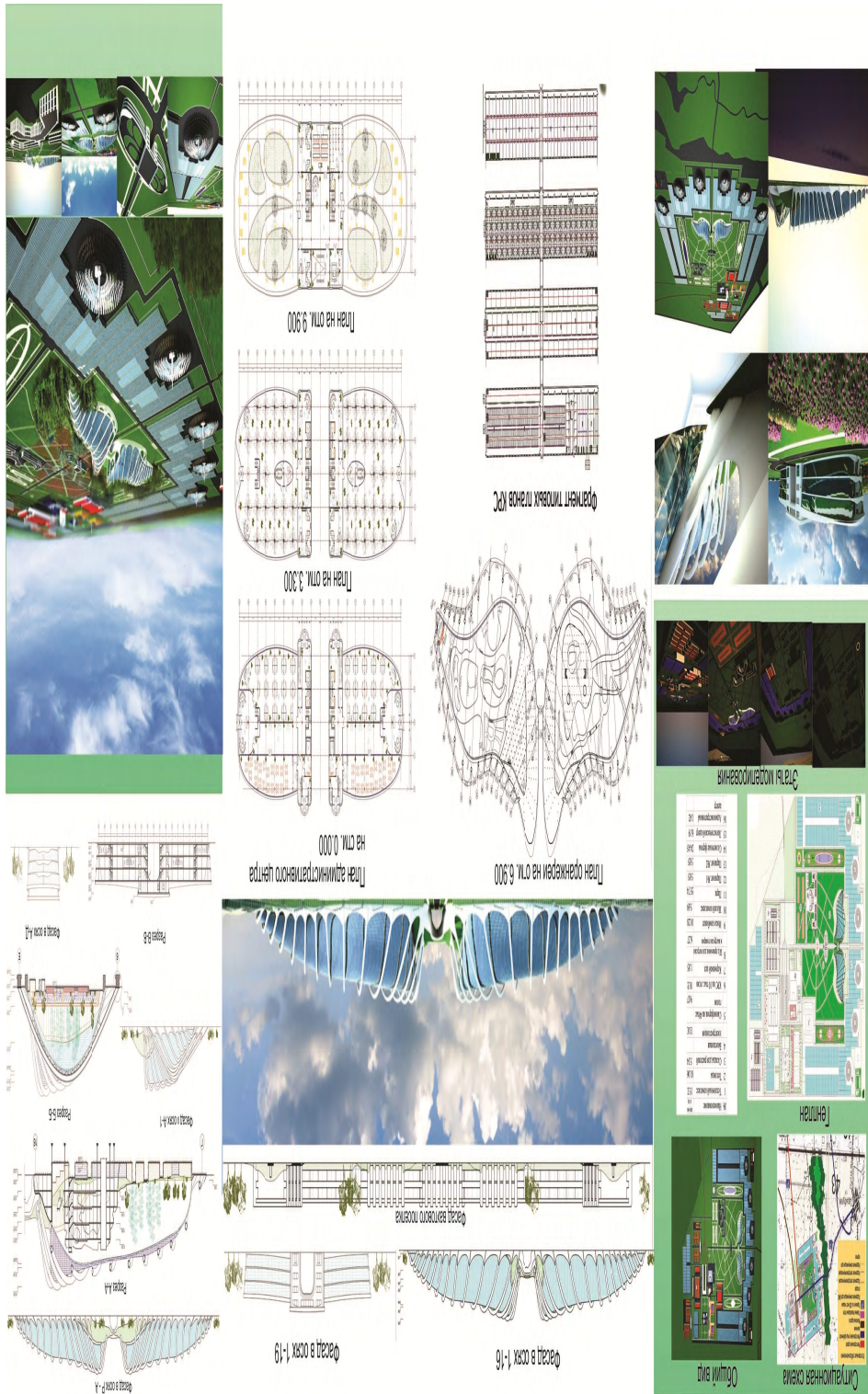


Fig. 1. "Agroindustrial complex in Boralday village" project. Student U. Baratov, academic advisor K.A. Kuandykov



Fig. 2. “Vertical farm in Almaty city” project. Student M. Bayseitov, academic advisor G.S. Abdrasilova



Fig. 3. “Agricultural complex with sports-recreational center” project. Student M. Zhakeyeva, academic advisor K.A. Kuandykov

Analysis of the student projects shows that innovative nature of the objects motivates authors to seek bold, groundbreaking solutions. In the architecture of the buildings individual approaches are used, a specific language of forms and shapes is evolving that raises agricultural architecture to a completely new level.

CONCLUSIONS

1. Kazakhstan has all the opportunities to elaborate its very own competitive agroindustrial complex: the presence of vast land resources and climatic conditions required for the production of meat and dairy, grains, fruits and berries; a logistically advantageous geographical location at the junction of world powers (China, Russia, Central Asia).
2. The focus of Kazakhstan's economy on increasing the effectiveness of the agriculture mandates universities to prepare specialists able to solve creative and technological tasks taking into account modern technologies in the field of agrarian production.
3. In order to modernize Kazakhstan's agricultural sector, a contemporary methodology must be created for studying and designing agrarian facilities that are in accordance with the technological requirements as well as with the convenience requirements of residential and production environments. In the higher architectural school it is necessary to conduct research and systematization of different types of agrarian architecture facilities in order to educate students on designing facilities of different purposes (agrosettlements, agroparks, agrotourism complexes, organic farms, cattle-breeding complexes, etc.).
4. Under the umbrella of modernization of Kazakhstan's economy, the architectural projects of and of KazGASA students and undergraduates contain suggestions on the primary directions of advancement for the agricultural sector of Kazakhstan, and establish a specific language of forms and shapes that raises agroindustrial architecture to a completely new level. The combination of research and project resources in the architecture-construction field will contribute to advancement of the agrarian sector as a driver of the economy of Kazakhstan.

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ARCHITEKTURA OBSZARÓW WIEJSKICH Z ELEMENTAMI ENERGOOSZCZĘDNYCH TECHNOLOGII - DOŚWIADCZENIE KazGASA, WYDZIAŁ ARCHITEKTURY

Biorąc pod uwagę rozwój sektora rolnego, jako jednego z elementów rozwoju gospodarki Kazachstanu, na kierunkach studiów architektonicznych konieczne staje się przygotowanie specjalistów posiadających umiejętność projektowania nowych typów obiektów agrarnych (tj. agroparki, gospodarstwa i kompleksy agroturystyczne, farmy, oranżerie, szklarnie) z wykorzystaniem technologii energooszczędnych. W artykule przedstawiono wyniki wdrożenia elementów projektowania energooszczędnych obiektów na obszarach wiejskich do procesu edukacyjnego na kierunku architektura na Wydziale Architektury KazGASA.

Słowa kluczowe: architektura obszarów wiejskich, technologia energooszczędna, agroobiekty, agroturystyka, gospodarstwa rolne