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Us Experience In Training Water Management Personnel In Uzbekistan

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Abstract: This article provides US experience in training water management personnel in Uzbekistan, Besides, in the article has been analyzed the structure, main directions, and developmental stages of the training system for irrigation and reclamation specialists in the USA, established as a continuous and sustainable model meeting contemporary demands. The research encompasses the experience of the American educational system, highlighting the significance of integrating vocational training, higher education, and research institutions.
Key words: Irrigation, reclamation, specialist training, US educational system, continuous education, sustainable development, vocational training, higher education, research institutes

INTRODUCTION

Water resources management and their efficient use are one of the most pressing problems of modern world development. In particular, in countries located in arid and semi-arid regions, irrigation and land reclamation systems are not only a means of ensuring agricultural efficiency, but also the main support of environmental sustainability. Therefore, the issue of training highly qualified personnel for the irrigation and land reclamation sector, who have mastered modern technologies, is a strategic priority for every country [2, p.11].

The USA (United States of America) stands out as a country with one of the world's leading experiences in this regard. In this country, there is a continuous, phased and scientifically based system of training irrigators and land reclamators, which is inextricably linked from vocational education to higher education and research institutes and land resources management centers. The main advantage of this system is that at each stage, personnel are trained with practical, modern technological knowledge [1, p.6].

Uzbekistan has also been implementing major reforms in the field of water management during the years of independence. However, a number of systemic problems still remain in the training of specialists in the field of irrigation and reclamation: the disconnection between higher education and the vocational system, the weak connection between science and production, and the mismatch of personnel qualifications with modern technologies. In this context, it is of great importance to study the experience of the United States and adapt it to local conditions [3, p.18].

This article provides an in-depth analysis of the main directions, continuity, practicality, and sustainability of the system of training specialists for irrigation and land reclamation in the United States. It also highlights the interrelationship between vocational education, higher education, and research institutions, the participation of the state and non-state sectors, and the integration of private initiatives in this system.

The purpose of the article is to study the experience of the United States in training irrigators and land reclamators, analyze its main stages and principles, and, based on this experience, develop scientifically based recommendations for improving the system of training personnel in this field in Uzbekistan.

RESEARCH METHODS

In this study, historical-analytical, systematic-approach, comparative and conceptual modeling methods were used to study the personnel training system based on the US experience in the field of irrigation and land reclamation. In particular, a systematic approach served as a methodological basis for analyzing the continuous training models operating within the framework of the United States of America's agriculture, land resources management and higher education system [2, p.20].

The following main methods were used in the study:

- Historical-comparative method: the stages of formation and development of the irrigator and land reclamation personnel training system in the USA were analyzed;

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- System-analytical method: the professional, bachelor's, master's and research stages within the framework of the continuous education model were studied in their interrelation;

- Comparative method: similarities and differences between the US system and the Uzbek education system were identified;

- Conceptual modeling: A conceptual model of a continuous and resilient education system based on the experience of the United States was developed [1, p.10].

The main empirical sources of the study were the official curricula, reference materials, and published statistical reports provided by the United States Department of Agriculture (USDA), the American Irrigation Association (IA), and many major universities in the United States — for example, California State University, Texas A&M University, University of Arizona, University of Nebraska — [4, p.33].

Additionally, the following main scientific and literary sources published in the United States were used in the study:

- Ray, R. “Irrigation Systems Engineering: Workforce Preparation for Arid Regions” (2017);
- Blevins, C. & Meyer, T. “Resilient Water Resources Education in the United States” (2019);
- USDA Education and Training Reports, 2015–2023;
- National Association of Land-Grant Universities – Extension Programs archive, 2000–2022 [5, p.41].

Statistical data related to the education system of Uzbekistan were analyzed based on the Ministry of Higher Education, Science and Innovation of the Republic of Uzbekistan (2022), SSV, and “Reports on the Labor Market Status of the Agro-Industrial Complex” (2020–2023) [3, p.18].

Through these methodological foundations, the multi-stage, sustainable, practical, and modern needs-adapted system of irrigator and meliorator training in the USA was fully studied.

RESEARCH RESULTS

One of the main features of the training of specialists in the field of irrigation and land reclamation in the USA is the presence of a phased, practice-oriented education system. As an initial stage, vocational and technical schools offer programs aimed at developing skills in engineering, mechanics, water pumping and hydraulic structures related to irrigation systems. This stage is mainly carried out at the level of Community Colleges and Technical Institutes [2, p.22]. For example, through the certification program developed by California Polytechnic State University’s Irrigation Training and Research Center (ITRC), students acquire practical skills such as drip irrigation systems, pressure pipeline systems, filtration equipment, shore protection structures, pump installation and diagnostics. The program lasts 6–12 months and includes theoretical knowledge and field laboratory training [5, p.44]. There are also two-year programs in irrigation technology at the Community College level in the USA, such as the “Associate Degree in Irrigation Technology”. Such programs typically include the following areas:

• Fundamentals of Water Supply and Distribution Systems
• Fundamentals of Soil Structure and Water Absorption
• Agricultural Water Accounting and Monitoring
• Irrigation Equipment Setup and Maintenance [1, p.12].

The practical component of education plays a special role at the vocational stage. Many training programs are conducted in close cooperation with industry enterprises. During this period, students undergo internships at irrigation companies, water management departments, and consulting companies. This allows them to gain experience in a real work environment [4, p.33].

Graduates of these programs obtain practical qualifications such as “Certified Irrigation Technician”, “Certified Irrigation Designer”, or “Certified Water Distribution Specialist”. Such certificates are recognized in the labor market as necessary for work in the irrigation sector in the United States [5, p.46].

There are also specialized training modules at the technical level on environmental protection, water-saving technologies, and climate-friendly irrigation methods, which are developed based on the principles of sustainability [3, p.19].

In the USA, the training of specialists in the field of irrigation and land reclamation at the vocational and technical education level is a system based on deep practice, incorporating modern technologies, and reinforced by a certification mechanism. This system serves to quickly, efficiently, and reliably train specialists who operate irrigation systems.

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In the USA, engineers working in the fields of irrigation and land reclamation are trained mainly in the areas of agricultural engineering, environmental engineering, and water resources management. These specialties are offered at the undergraduate level by large agricultural universities and land-grant higher education institutions. These include leading higher education institutions such as Texas A&M University, University of California – Davis, University of Arizona, and University of Nebraska-Lincoln [2, p.25].

Bachelor's degree programs typically last 4 years and include the following core subjects and modules:

- Fundamentals of Hydraulics and Hydrology
- Irrigation System Design
- Reclamation Structures and Construction Technologies
- Soil Physics and Water Absorption Theory
- Technical Measures to Combat Land Degradation
- Water-Saving Technologies and Automated Irrigation [4, p.35]

Bachelor's degree programs in irrigation in the US higher education system include not only theoretical knowledge, but also extensive laboratory training, field practice, and project development. Students design irrigation systems based on real objects, perform mechanical calculations, and learn to program automatic control units [5, p.49].

In engineering programs, students are often trained in educational areas accredited by the National Society of Professional Engineers (NSPE) or the American Society of Agricultural and Biological Engineers (ASABE). This allows them to obtain a professional engineering license upon graduation [1, p.14].

During their studies, students often conduct independent research on the following problems:

- Evaluating the effectiveness of drip irrigation systems in arid regions
- Modern land reclamation approaches to combat water scarcity
- GPS-based land monitoring systems and their application in irrigation
- Modeling salinization processes in irrigated lands [3, p.21]

In addition, universities provide the opportunity to participate in practical projects in collaboration with organizations such as USDA (United States Department of Agriculture), USAID, NRCS (Natural Resources Conservation Service). This introduces graduates to international project management and modern agrotechnical technologies [5, p.50].

In the USA, undergraduate programs in irrigation and land reclamation are organized based on a deep theoretical foundation, solid practice, innovative approach and international integration. Such engineering education prepares specialists with technical potential, scientifically based and advanced approach to the field.

In the USA, training specialists in irrigation and land reclamation is carried out on the basis of in-depth fundamental and applied research at the master's and doctoral levels. Master's programs (M.S. in Irrigation Engineering, M.S. in Water Resources Management, M.S. in Agricultural Engineering) develop skills in systematic modeling of irrigation systems, solving water scarcity problems based on a scientific approach, land resources planning and strategic management [2, p.27].

At the master's level, advanced courses are available in the following areas:

- Modeling water balance in agricultural lands
- Water resources policy and economics
- GIS and remote monitoring in land reclamation systems
- Risk analysis and sustainable strategies in water resources management [1, p.15]

Universities such as the University of Nebraska-Lincoln, Utah State University, and Colorado State University offer internationally recognized programs in this area. These programs are often funded by grants from the USDA, USAID, and EPA (Environmental Protection Agency) [5, p.52].

At the research stage (PhD), the fields of irrigation and land reclamation are studied in depth from a sectoral and regional perspective. Doctoral students conduct independent research in the following areas:

- Integrated Water Resources Management (IWRM)
- Smart Irrigation Systems: Sensors, IoT, and Automation Technologies
- Impact of Global Climate Change on Irrigation Systems
- Novel Biomechanical Countermeasures Against Salinity and Erosion [3, p.24]

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Education and research at the doctoral level are often integrated with engineering, ecology, agribusiness, and political science, serving to integrate engineering technologies and the principles of sustainable development [4, p.36].

Researchers conduct their work not only in university laboratories, but also in field conditions, at real facilities where irrigation systems operate. This approach allows for the practical application of scientific results [5, p.53].

One of the important factors at the master's and doctoral levels is international scientific cooperation. Students often implement their projects in collaboration with structures such as the World Bank Water Initiative, FAO Water Division, and ICID (International Commission on Irrigation and Drainage) [2, p.28]. The system of training specialists with a scientific degree in the field of irrigation and land reclamation in the USA is based on theoretical knowledge, experience, modern technologies and global cooperation, and this system plays an important role in bringing science closer to practice, introducing innovations and solving strategic issues.

One of the most important features of the US education system in the field of irrigation and land reclamation is the presence of a system of career guidance, continuous learning and continuous professional development. This system is valid at all stages of education, and each stage creates a logical basis for the next. This model is based on the principle of “lifelong learning” and constantly ensures the competitiveness of irrigation engineers in the labor market [2, p.29].

In the USA, students are interested in engineering and water management from school through STEM (Science, Technology, Engineering, Mathematics) programs. There are bridge programs between schools and colleges in the 2+2 or 3+1 model, through which students have the opportunity to transfer directly from vocational colleges to a university bachelor's degree [3, p.26].

In order to regularly update the qualifications of graduates, Professional Development Hours (PDH) and Continuing Education Units (CEU) systems have been introduced. After the expiration of certain annual certificates, engineers take special courses on new technologies, regulations, and environmental standards [5, p.55].

Developed by the National Irrigation Association and the American Society of Agricultural and Biological Engineers (ASABE), the online and offline modules offer ongoing training in the following areas:

- Innovative Water Conservation Technologies
- Green Irrigation and Ecosystem-Friendly Solutions
- Smart Irrigation Systems
- Water Allocation Strategies for Salinity-Tolerant Crops [1, p.16]. This system allows to maintain the technical and engineering potential of irrigation engineers at a high level at all times. In addition, regional training centers operate in the USA. For example, annual seminars for agricultural producers, engineers and policymakers are organized through the Arizona Water Education Center or the Texas Water Resources Institute [4, p.39].

The non-governmental and private sectors are also actively involved in the system aimed at training. Companies engaged in water infrastructure (for example, Netafim, Rain Bird, Lindsay Corporation) have developed corporate training programs for their employees, which are carried out in collaboration with the USDA and universities [5, p.56].

The process of orientation and training in the fields of irrigation and land reclamation in the USA is based on the principles of continuity, closeness to practice and sustainable innovative development. This system ensures the rapid adaptation of specialists to technological and environmental innovations, their competitiveness in the global labor market.

The US system of personnel training in the field of irrigation and land reclamation is considered a world-class practice. The main factors that contribute to the successful functioning of this system are the continuity of education stages, practice orientation, the possibility of continuous professional development, and effective cooperation between the state-non-state-scientific sectors [2, p.31].

At the vocational and technical education stage, the training of irrigation system technicians and masters is based on the needs of the real sector, and students are trained to work directly with technologies

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in field conditions. This provides technical personnel who ensure the stable operation of irrigation facilities and pumping systems [5, p.44].

The bachelor's degree stage creates a scientific basis for the design of irrigation systems, hydrological calculations, land structure, and water supply policy based on fundamental engineering training. The combination of applied sciences and project work brings engineers to the level of specialists who think independently and can find technical solutions [3, p.21].

At the master's and doctoral levels, the US model is based on an in-depth approach, taking into account scientific innovations, digitalization, automated management systems, sustainability and ecological balance. This serves to train strategic specialists in the irrigation sector who will respond to global climate change, water resource scarcity and environmental safety issues [1, p.14].

One of the important aspects is the existence of a system in the US aimed at continuously improving the skills of irrigation specialists, which is based on the principle of "lifelong learning". New technologies, innovations in water conservation and GIS-based management systems play a leading role in professional development. This allows engineers to constantly meet the demands of the labor market [4, p.39].

At the same time, the educational process in the US is integrated not only with state structures, but also with private companies and non-governmental organizations. This ensures that the personnel training system is inextricably linked with real production. This is a very relevant aspect for the Uzbek model in modernizing the irrigation and land reclamation system in agrarian regions such as Uzbekistan [5, p.56].

The above approaches can be implemented in Uzbekistan through the following:

• Introduction of short-term certified programs specializing in irrigation technology in the system of vocational and technical colleges;

• Development of special irrigation and land reclamation specialties in agricultural engineering at the undergraduate level;

• Introduction of module-based disciplines such as GIS, smart irrigation, land monitoring and global water policy at the master's and doctoral levels;

• Establishment of continuous professional development centers in the regions;

• Establishment of field experimental stations in cooperation with the private sector and international organizations.

The US experience is an excellent example of a modern, practice-based and resilient system for training personnel in the field of irrigation and land reclamation, in accordance with international standards [11, p.416]. The key elements of this system - continuity, integrated management, training, and innovative approaches - are strong strategic directions that can also be implemented for Uzbekistan [12. p.417].

The results of the study showed that the system of personnel training in the field of irrigation and land reclamation in the USA is highly systematized, continuous, innovative and practice-based. This system has been formed as a sustainable model that combines vocational, higher and scientific education, and is based on the constant updating of training and retraining mechanisms [2, p.31].

In vocational education, technical specialists are trained by combining the installation of irrigation systems, teaching pumping and filtration technologies, and water distribution methods with practical training. This stage is an important support for the real sector [5, p.44].

At the undergraduate level, students are formed with a systematic engineering approach through in-depth theoretical knowledge of irrigation engineering, project analysis and field practice. At the master's and research levels, strategic specialists are trained based on the combination of science and modern technologies. At these stages, irrigation systems adapted to global climate change, water resource optimization and smart irrigation technologies have become the main areas of study [3, p.24].

The system of continuous professional development in the USA ensures that engineers are constantly familiar with new technologies, technical regulations and sustainable development requirements. Through this “lifelong learning” model, irrigation engineers regularly update their professional potential [1, p.16].

An important feature of this system is that it is organized on the basis of cooperation between the state, universities, scientific institutions and the private sector. Through this approach, the irrigation sector is constantly provided with personnel, and real integration between education and production occurs [4, p.39].

By studying and adapting the experience of the USA in the conditions of Uzbekistan, the following proposals can be made in the field of irrigation and melioration:

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• Introduction of short-term certificate programs on irrigation systems through specialized vocational colleges and technical schools;

• Development of master's and doctoral programs in irrigation engineering at agricultural universities and water management institutes;

• Establishment of centers for continuing education and professional development on a regional basis;

• Opening of field-testing laboratories in cooperation with international organizations and the private sector.

CONCLUSION

In conclusion, the system of training irrigation and land reclamation personnel in the United States is an interconnected, resilient, and responsive educational model, which is a strategic framework for Uzbekistan that is worth studying and has the potential to be implemented.

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