METHODS

The important role of intelligent water conservancy in the construction of high-standard farmland

Guo Zhen[1,2,3,4*] and Zhang Haiou[1,2,3,4]

[1]Shaanxi Provincial Land Engineering Construction Group Co., Ltd., Xi'an, China
[2]Institute of Land Engineering and Technology, Shaanxi Provincial Land Engineering Construction Group Co., Ltd., Xi'an, China
[3]Key Laboratory of Degraded and Unused Land Consolidation Engineering, Ministry of Natural Resources, Xi'an, China
[4]Land Engineering Technology Innovation Center, Ministry of Natural Resources, Xi'an, China

*Correspondence:
Guo Zhen,
675334047@qq.com

Farmland is the basis of food production, and also the key and difficult point of agricultural development in China. At present, China's farmland is generally characterized by small scale, scattered distribution, weak infrastructure, and low level of informatization. High-standard farmland construction is an important policy formulated at the national level to ensure food security and promote agricultural transformation and upgrading. It is based on farmland water conservancy and combines information technology and communication technology with high-standard farmland construction, realizing the whole process of information perception, transmission, and management from field to market. However, China's farmland water conservancy has problems such as backward irrigation conditions and technology, imperfect supervision and management mechanism, and lack of information professionals. The contradiction between agricultural modernization and high-quality development and insufficient demand for farmland water conservancy has gradually become prominent. Therefore, it is necessary to strengthen the construction of smart water conservancy, and strengthen the use of Internet of Things, cloud computing, big data, artificial intelligence, and other technologies to achieve information sharing and data sharing of high-standard farmland construction, to realize the efficient, accurate, and scientific management of high-standard farmland, and to ensure China's food security.

Keywords: intelligent water conservancy, high-standard farmland, water conservancy informatization, agricultural informatization, food security

1. Introduction

With the rapid and efficient development of China's economy, information has penetrated into all walks of life; it has become an important part of all walks of life. The application of information technology to the management of agricultural water resources can not only make better use of water resources, but also make reasonable management of water resources, achieve fine management, and promote water conservancy reform (1, 2). This is not only related to the safe operation of water conservancy hub, but also related to the development of modern water conservancy undertakings in our country (3).

As a country, China attaches great importance to the development of agriculture, but also very concerned about the development of rural areas. High-level farmland water conservancy projects are of great significance in promoting comprehensive rural development (4). The construction of high-standard farmland is a major measure to consolidate and improve the comprehensive grain production capacity and ensure national food security, and is of great significance to the comprehensive implementation of the rural revitalization strategy (5).

At present, China's agriculture is in an important stage of transformation of development mode, optimization of industrial structure, transformation of growth power and high-quality development, transforming the traditional extensive mode of production and management, accelerating the construction of China's agricultural modernization industrial system, production system, and management system. The core objective of high-quality agricultural development in our country is to achieve high-quality agricultural products, high industrial benefits, high production efficiency, high managerial efficiency, and strong international competitiveness (6). Farmland water conservancy is the lifeline of high-level farmland and high-quality development, as well as a key project for sustainable agricultural development in China, which is related to China's food production and agricultural modernization, and the high-quality development of farmland water conservancy determines the process of high-quality agricultural development and construction of high-standard farmland (7, 8).

Due to the uneven distribution of water resources, large population density and low per capita water resources, China attaches great importance to the rational development, utilization, and protection of water resources. China has more people and less water, and the per capita water resource is only 1/3 of the world average (9). There are still water shortages in some areas. Measures such as high-standard farmland construction and water-saving irrigation can effectively improve irrigation water efficiency, water production efficiency, and agricultural resource utilization efficiency. In high-level agricultural construction, its role is drought resistance and drainage, which is a very convenient and highly efficient agricultural project (10). In addition, in high-level farmland water conservancy projects, according to the change of agricultural water use to improve agricultural output, in the development of new rural areas, we must adhere to green development as the center, and vigorously promote the development of new rural areas, under the new historical conditions, China's high-level farmland irrigation projects in the development of problems encountered in the process of development should fundamentally promote the development of high-level farmland irrigation.

2. Problems faced by current high-standard farmland water conservancy project

2.1. Insufficient project supervision

The project of construction of water conservancy facilities is large in scale and involves many participants, which are usually dominated by enterprises and need to rely on the strong support of local governments. The contradiction between project construction quality and investment management is also prominent (11). In the construction of high-standard farmland, most of the projects are under the control of the agricultural department, but many projects are difficult to operate and managed in the later stages due to the imperfect supervision mechanism and project management system, which has an impact on project safety.

2.2. Inefficient information processing

In the construction of water conservancy informatization, the diversity of information makes it more difficult to process data, and the current data processing capacity can no longer meet the actual needs of water resources (12). At the same time, because the technical personnel of the water conservancy department did not introduce modern management ideas and methods into the development, the management of water resources did not improve significantly.

2.3. Inefficient use of agricultural irrigation

At present, most of our country mainly relies on traditional extensive irrigation areas and traditional water-saving technologies, which leads to the decline of water-saving efficiency of rural water conservancy of cultivated land. By 2020, water-saving effect will reach 0.559, but a lot of it will be wasted in water-saving irrigation (13).

2.4. Lack of specialized information technology personnel

In the management of water resources, the use of water information technology needs to have specialized technical personnel to support, and the current water resources management work obviously lacks high-level, high-quality expert team, so the management of water resources has not been effectively improved. The main reason for this problem is that at present, domestic informatization technicians have a serious tendency of "specialization," which overemphasizes the cultivation of information technology skills in work, training and learning, and neglects the operation and management of enterprises (14).

3. Measures for the development of high-standard farmland water conservancy projects

3.1. Strengthen water conservancy information construction

Through the innovation and integration of basic research, technology and equipment of water resources, the research and development of water resources needs to be strengthened. It is necessary to strengthen the construction and application of agricultural irrigation informatization, comprehensively implement planning, design, construction, investment and operation, implement the operation of information system, and carry out timely information update, dynamic monitoring and evaluation, so as to further improve the informatization and modernization level of agricultural irrigation (15, 16).

3.2. Strengthen the training of professionals

Water resources management professionals must strengthen their awareness and attention to the application of water resources information technology; only in this way can they consciously improve the efficiency and quality of water resources management and promote the smooth development of water resources management (17, 18).

3.3. Improve the supervision system of water conservancy projects

For high-level farmland irrigation projects, due to regional differences, construction methods and construction teams are quite different. In order to ensure the construction of high-quality agricultural irrigation projects, supervision must be strengthened. For high-level agricultural irrigation, close monitoring must be carried out from the start of construction to completion. It is also necessary to supervise the main body of engineering construction to ensure that it has high-quality engineering construction (19, 20).

4. Construction of smart water conservancy

Digitalization is to simulate the entity in the computer, and to promote the reconstruction of model innovation process with digital technology (21, 22). Network refers to the computer and various electronic terminal devices scattered in different places through communication and

computer technology to connect together, according to a specific network protocol communication, software, hardware, data sharing. Intelligence is to enable the subject to have acute and accurate perception function, correct thinking and judgment ability, adaptive learning function and efficient executive function (23, 24). Intelligence is the development from artificial and automatic to autonomous. It provides a solid basis for the figures and provides a basis for the data acquired and accumulated; Build a network platform to facilitate the flow and aggregation of information and help people better understand and deal with problems (25, 26).

The mathematical model includes physical geography, tributary water system, basic data of water conservancy engineering, monitoring data, operation and management data, geospatial data, economic and social data, etc., including water conservancy professional model, intelligent identification model, visual model and water conservancy object correlation, forecast scheduling scheme, business rules, historical scenes, and expert experience. Computing power is the basis for realizing efficient and stable operation of digital twin watershed, including computing resources, storage resources, network communication resources, and meeting environment (27).

5. Technical advantages of smart water conservancy in the construction of high-standard farmland

5.1. Monitoring of crop water consumption and water requirements

It can know the water demand information and planting area of crops in real time, as well as the changes in water consumption and water demand during the growth of crops. When constructing high-standard farmland, farmland should be planned according to crop varieties and planting methods. If there is a shortage of irrigation water, crop growth will be affected (28).

5.2. Monitoring of farmland drainage status

Intelligent water conservancy can monitor farmland drainage by monitoring soil moisture content, pH value, electrical conductivity and other data, and manage field drainage by analyzing relevant data (**Figure 1**). When constructing high-standard farmland, corresponding evaluation criteria should be established according to planting methods of different crops and environmental conditions (29).
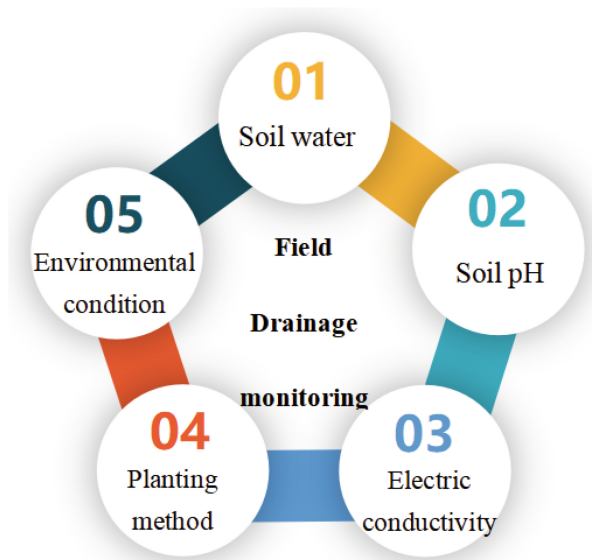
FIGURE 1 | Flow chart of farmland drainage monitoring elements.

5.3. Balance between supply and demand of water resources

In the process of high-standard farmland construction, it is necessary to carry out reasonable planning and allocation of water resources in the region (**Figure 2**). Smart water conservancy achieves reasonable allocation and management of water resources by collecting data such as user usage habits and irrigation system (30).

6. Application of smart water conservancy in the construction of high-standard farmland

In terms of farmland irrigation, mobile communication technology and sensor technology can be used to monitor farmland environment information and information in the irrigation process, and three-dimensional modeling of farmland can be carried out by UAV image, remote sensing image, and other technologies to assist agricultural managers to make scientific decisions.

In terms of soil and water conservation, ground shape and vegetation cover can be monitored by remote sensing images. Vegetation cover was monitored based on drone images. Using GPS positioning and RTK (real-time dynamic) technology, the terrain is modeled in 3D. The ground condition, vegetation distribution and soil type were analyzed by geographic information system, and scientific and reasonable suggestions on soil and water conservation measures were given according to the hydrological conditions in different regions.

FIGURE 2 | Real picture of farmland water resource supply and demand balance.

Strengthen the protection and restoration of farmland ecosystem, collect and transmit field soil, surface vegetation, water and other ecological environment elements digitally to the intelligent water conservancy platform through information technology, and conduct three-dimensional modeling of high-standard farmland through remote sensing technology.

The combination of intelligent water conservancy and geographic information system can realize real-time monitoring and evaluation of soil moisture and crop growth environment by integrating multi-source heterogeneous data such as land resources, agricultural production data, and meteorological information. In addition, automatic irrigation equipment and farmland irrigation system control equipment can be deployed in high-standard farmland construction areas to achieve remote automatic control. At the same time, the system can support intelligent irrigation decision and water-saving decision.

7. Conclusion

In the new era, the construction of high-standard farmland and the promotion of information construction of agricultural water conservancy are inevitable requirements for high-quality development of agriculture. However, due to the weak links such as the backward level of agricultural information technology, the imperfect supervision mechanism, and the shortage of information technology personnel, the constraints on the promotion of agricultural modernization, the high-quality development of agriculture, and the construction of high-standard farmland have gradually emerged. Strengthen the research and development of water resources technology through the innovation and integration of water resources basic research and technical equipment; According to the reality of agricultural irrigation projects, formulate and improve

the relevant reward system. Training water conservancy technical personnel to ensure the efficient operation of water conservancy information management system. At the same time, it is necessary to strengthen the monitoring of agricultural irrigation projects to ensure the good quality of their construction. Using water conservancy information technology to develop high-level cultivated land can realize the perfection of information feedback mechanism, better management of irrigation area, and promote the comprehensive utilization of water resources. It is of great significance to agricultural modernization, high-level development of agriculture, and high-level farmland construction.

With the coming of the "14th Five-Year Plan" period, China will further increase the investment in the construction of high-standard farmland, and the construction of high-standard farmland in China will also enter a new stage. New high-efficiency water-saving irrigation projects should give priority to new agricultural management subjects and areas with better large-scale agricultural development, give full play to project benefits, so that farmers can get more value-added benefits, and the project will be better maintained. With the continuous development of water conservancy information technology and sensor technology, intelligent terminals and sensor networks will continue to develop, providing new ideas and new means for the research of water conservancy information technology.

Author contributions

GZ: design idea, literature review, outline revision, and first draft and revision. ZH: literature consultation and the first draft.

Acknowledgments

References

1. Sheng DM. Application of water conservancy information technology in water-saving irrigation project in irrigation district. *Jiangxi Build Mater.* (2016) 24:118+121.

2. Qin XM, Wen J, Chen WZ, et al. Application of information technology in farmland water conservancy. *Agr Eng Tech.* (2015) 33:43–6.

3. Xu CZ. Study on management and protection of small-scale farmland water conservancy project in Feixian County. *Water Conser Tech Super.* (2022) 12:92–5.

4. Hao SR, Ding T, Wang X, et al. Effects of different irrigation and drainage modes on lodging resistance of super rice Japonica 9108. *Agronomy.* (2022) 12:2407.

5. Pu LM, Zhang SW, Yang JC, Yan F, Chang L. Assessment of high-standard farmland construction effectiveness in Liaoning province during 2011–2015. *Chin Geogra Sci.* (2019) 29:667–78.

6. Jiang W. The key to promote agricultural modernization in the "13th Five-Year Plan" period is to change the agricultural development mode. *China Dev Rev.* (2016) 3:31+40.

7. Yuan B. Feasibility analysis study on the construction of high-standard farmland water conservancy project in Red SLATE area of Weifang City. *China Agr Compr Dev.* (2021) 10:39–41.

8. Fan SY, Lin YG. Design of high-standard farmland water conservancy project in Yanpu area of Cangnan County. *Water Sci Eng Tech.* (2018) 3:31–3.

9. Dang P, Zou TF. Carry out in-depth irrigation district water efficiency leaders to lead actions to promote agricultural water efficiency. *China Water Res.* (2021) 17:24–6.

10. Han LG, Wang Y, Wang QW, et al. Objective, strategy and feasibility study of comprehensive agricultural development and management in the new era. *Econ Res Ref.* (2018) 40:3–67.

11. Amosah J, Tanko DD. Improving the management and use of water resources for small-scale irrigation farming in the garu tempane district of ghana. *J Sus Dev.* (2014) 7:214–22.

12. Liu HK, Xue TS, Lu C, et al. Information management technology and application of farmland water conservancy. *China Rural Water Res Hydro.* (2014) 11:15–8.

13. Zhou Q, Zheng LY. Construction of rural grass-roots water control system from the perspective of rule flow: a case study of management and protection reform of farmland water conservancy facilities in Yongchun County, Fujian Province. *China Rural Obser.* (2020) 2:2–15.

14. Ju WQ. Application measures of water conservancy information technology in water resources management. *Agr Sci Inf.* (2021) 24:18–9.

15. Wang AG. Accelerating the construction of farmland water conservancy and consolidating the water conservancy foundation of national food security. *China Water Res.* (2011) 15:6–9+25.

16. Liu HY, Liu XM, Wan Z. Study on water conservancy information system based on cloud computing. *Appl Mech Mater.* (2014) 3147:1488–92.

17. Hodgettse D, Rua M, Groot S, Hopner V, Drew N, King P, et al. Relational ethics meets principled practice in community research engagements to understand and address homelessness. *J Com Psy.* (2021) 50:1980–92.

18. Karen W, Robin K, Simon O, Emma F. Facebook as soft infrastructure: producing and performing community in a mixed tenure housing development. *Hous Stud.* (2020) 36:1345–63.

19. Er JP. Deeply practicing the general tone of water conservancy reform and development, writing a new chapter in water management from a new historical starting point–speech at the 2021 National Water Conservancy Work Conference. *Water Res Dev Res.* (2021) 21:1–14.

20. Xiao YB. Practice and understanding of quality supervision and management of hydraulic engineering. *China Stand.* (2019) 8:161–2.

21. Wu YDW. Role and application of water conservancy information technology in water-saving irrigation projects in farmland irrigation area. *J Agr Eng Tech.* (2021) 41:48+50.

22. Dai QP. *Design of Remote Water-saving Irrigation Monitoring System for Ma'ao Grape Demonstration Garden. PhD thesis.* Zhoushan: Zhejiang Ocean University (2016).

23. Yang H. *Research on Management System Reform Experience and Extensibility of Small Water Conservancy Project in Gaoyou City. PhD thesis.* Yangzhou: Yangzhou University (2018).

24. Wang ZK, Jia WN, Wang KN, Wang Y, Hua Q. Digital twins supported equipment maintenance model in intelligent water conservancy. *Com Elec Eng.* (2022) 101:108033.

25. Hua LT, Zhu C, Xue CS, et al. Application research of digital twin system of hydraulic engineering based on BIM+GIS technology. *Zhejiang Water Sci Tec.* (2022) 50:14–7.

26. Song LX, Zhang W, Tian ZW, et al. Construction and discussion on digital twin and "four pre-planning" system for flood control in Xizhijiang Basin. *China Flood Con Dro Re.* (2022) 32:12–8.

27. Li YH, Yuan LG. Analysis on the role of 5G communication technology in the construction of smart water conservancy under the background of informatization. *Pro Water Res Hydro Sci Tech.* (2022) 42:132–3.

28. Camporese M, Gumiere SJ, Putti M, Botter G. Efficient irrigation of maize through soil moisture monitoring and modeling. *Fron Water.* (2021) 3:627551.

29. Saturday A, Lyimo TJ, Machiwa J, Pamba S. Spatial and temporal variations of trophic state conditions of Lake Bunyonyi, south-western Uganda. *App Water Sci.* (2022) 13:694.

30. Hama ZQ, Hiscock KM, Cooper RJ. Indirect nitrous oxide emission factors for agricultural field drains and headwater streams. *Environ Sci Tech.* (2017) 51:301–7.