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A Research on Dry Farming and Rain-Fed Fruit Tree Cultivation in Groundwater over-Exploitation Areas in Hebei Province

【**Abstract**】 In order to resolve the problem of water resources shortage, specifically the problem of groundwater over-exploitation, and to open up a new method of groundwater pressure exploitation, the qualitative analysis method is used in this paper, from the aspects of environmental protection, enhancing income and technical support. The paper demonstrates the significance and feasibility of carrying out dry rain-farming for fruit trees in Hebei province, after which it proposes the plan of making the pilot project, carrying out the innovation research of tree species and field management, providing the extension of science and technology, and establishing the cultivation system of fruit trees suitable for water cultivation.

【**Key words**】Groundwater over-exploitation; Dry Farming and Rain-Fed; Optimum Water Planting

1. Research Background and Significance of Dry Farming and Rain-Fed Fruit Tree Cultivation

(1) Explanation of Related Terms

Dry farming and rain-fed refers to an agricultural cultivation method that allows plants to survive and grow for a long time through natural precipitation in the absence of above-ground water or irrigation water sources in the environment. Its goal is to coordinate the relationship between water and fertilizer under the conditions of limited climate, water source, soil, and technology, make full use of the precipitation link of the water cycle, promote the sustainable growth of plants, and obtain relevant economic, social and ecological benefits.

Groundwater over-exploitation refers to the behavior that excessive exploitation of groundwater leads to the decline of groundwater level, the increasingly serious phenomenon of the underground funnel, and finally leads to land subsidence, deterioration of hydrological conditions, and other problems.

Optimum water planting is based on the characteristics of precipitation to arrange reasonably, adjust crop planting structure, promote the application of water-friendly planting structure optimization technology, properly compress and control the area of crops with high water consumption, control areas of high water-consuming crops, and expand the crop area with good water demand and

precipitation, with the same period of rain and heat, with drought tolerance, and with high water utilization rate to realize the planting technology of sustainable utilization of agricultural water resources.[1]

(2) The Necessity of Implementing Water-Saving Agriculture

The over-exploitation of groundwater in Hebei Province is a serious problem. The cumulative area has reached 150 billion cubic meters, and the total area of the over-exploitation area is 67,000 square kilometers, accounting for one-third of the national total.[2] It is the province with the most serious groundwater over-exploitation. Heilonggang,with other 48 counties (cities and districts) including Hengshui, Cangzhou, Xingtai, and Handan, has formed a large compound funnel area of serious over-exploitation of deep groundwater. The groundwater level continues to decline, the aquifer is drained with land subsidence, local collapse, seawater intrusion, and other problems highlighted.

China has a long-term practice of dry farming and rain-fed for fruit trees. In northwest China, such as Gansu and Shaanxi, the annual rainfall is less than 400 mm due to drought, and there is a long history of dry farming and rain-fed fruit trees. Researchers have carried out a large number of experimental studies on reducing surface evaporation, reducing plant transpiration, and scientific fertilization. By using water to adjust fertilizer and using fertilizer to promote water, the efficiency of water use, as well as the quality and efficiency of fruit trees, have improved. A series of cultivation systems and management measures for dry farming and rain-fed fruit trees have been proposed as well.

Hebei Province has practiced dry farming and rain-fed of grain crops. Hengshui, Hebei Province, has promoted water-saving agriculture in dry farming, popularized the technical mode of dry farming and rain-fed cultivation for drought-tolerant crops in more than 100000 mu of fields, and achieved remarkable results.

(3) The Significance of Research on Dry Farming and Rain-Fed Fruit Tree Cultivation

It has obvious ecological benefits to implement the dry farming and rain-fed fruit trees.
Dry farming and rain-fed of fruit trees are beneficial to groundwater storage, alleviate groundwater shortage and prevent land subsidence. The stored groundwater can continue to be used for the planting of food crops, further promoting the production and harvest of food crops, that is, the increase of production and income of the planting industry. Through dry farming and rain-fed, fruit

[1] Zhao, Junwei. (2014). Promotion and application of water-appropriate planting structure optimization technology. Hebei Water Resources (08), 31.
[2] Feng, Z.H. & Su, J.P.. (2022). Multi-measures to promote groundwater overdraft control in Hebei. China Water Resources (06), 15-16.

trees can form a self-contained ecosystem, which is conducive to maintaining the balance of water and fertilizer in plants, reducing the amount and frequency of chemical fertilizer, improving the utilization rate of fertilizer, reducing the risk of water pollution in the orchard, and is conducive to sustainable development.

It has obvious economic benefits to implement the dry farming and rain-fed fruit trees. According to the research of the Fruit Tree Institute of Shanxi Academy of Agricultural Sciences, the dry farming and rain-fed fruit trees can control the consumptive growth of fruit trees, making the growth rate of fruit trees smaller, the tree vigor smaller, and the workload of branch shaping and pruning reduced; Moderate drought-induced flower bud differentiation and fruit growth in advance. Moderate drought stress can also improve fruit quality, improve product competitiveness, thus increasing the sales and price of fruit products, and increasing farmers' income. Also, dry farming and rain-fed can save irrigation costs by reducing the waste of water.

It has obvious social benefits to carry out dry and rain cultivation of fruit trees. The development of dry farming and rain-fed is beneficial to rational dense planting and water-saving agriculture, which is in line with the requirements of current national policies. Article 28 of Chapter III of the Regulations of Hebei Province on Groundwater stipulates that people's governments at or above the county level should formulate comprehensive agricultural water-saving plans, reasonably control the effective irrigation area of farmland, adjust and optimize the agricultural planting structure according to the water resources situation, and vigorously promote comprehensive agricultural water-saving technologies. As a fruit tree planting industry with large water demand for underground irrigation, the implementation of dry farming and rain-fed can promote the orderly implementation of the national water-saving plan.

2. Feasibility and Restriction Research of Fruit Tree Cultivation Dry Farming and Rain-Fed Research in Hebei Province

(1) Natural Aspects

At present, the area of fruit trees in Hebei Province has reached more than 30 million mu, including 20 million in mountainous and hilly areas and 10 million in plain areas, ranking second in the country.[3]Compared with crops such as winter wheat and corn, which have been included in the dry farming and rain-fed pilot projects, fruit trees have deep roots and luxuriant leaves, and have a stronger ability to resist and adapt to drought, making the implementation of dry farming and rain-fed crops more sustainable.

[3] Li, X.-H. (2005). Current status of fruit tree production and development suggestions in Hebei Province. Hebei Fruit Tree (06). doi:10.19440/j.cnki.1006-9402.2005.06.007.

Hebei province is located in the temperate monsoon climate zone, spring drought is common. Due to Hebei's location, from March to May, Hebei province suffers from scarce precipitation and rapid temperature rise. In addition, due to strong wind, the evaporation of surface water is large, and the shortage of water resources has a great limit on agricultural development. The annual precipitation of 500 mm in Hebei Province can only meet the water demand of fruit trees for stable production, but the peak water demand of fruit trees is generally from March to May in spring and October to November at the turn of autumn and winter. The distribution of natural precipitation in Hebei Province is concentrated during the year. More than 70% of the annual rainfall is concentrated in the flood season (June to September), and the rainfall in the flood season is mainly concentrated in July and August, or even a shorter period. In years with more precipitation, the rainfall is concentrated in a few heavy drops of rain.[4] This period is not the peak water demand period for fruit trees. As a result, there is a saying that goes "When water is needed, there is no precipitation. When there is precipitation, water will no longer be needed", which means the rainfall distribution is not synchronized with the water demand period. Moreover, because the single-use of groundwater irrigation consumes a great amount of water, it is not enough to ensure the sprouting and growth of fruit trees only by irrigation water.

Dry farming and rain-fed techniques still do not provide enough water for the initial growth of fruit trees. In the early stage of growth, the roots are not deep, the saplings are unstable, and the leaves are insufficient. Therefore, appropriate irrigation water is necessary for the early stage of fruit trees' growth, otherwise, the survival rate of fruit trees may be reduced. Therefore, in the seedling stage of fruit tree growth, it is more difficult to implement, and the dry farming and rain-fed method should be used every year after the branches and leaves grow. When it comes to the tree formation period as well as the full fruiting period, the water-seeking ability and water-fixing ability of fruit trees have matured, so it is more suitable for dry farming and rain-fed during this period.

(2) Social and Economic Aspects

The annual precipitation in Hebei Province is generally 500 mm, which is greater than 300-400 mm in the northwest region. Long-term irrigation and cultivation and intensive cultivation, lead to the fact that the soil quality such as organic matter in orchards in Hebei Province is also better than that in the western region. Therefore, after the fruit trees are changed from irrigated to dry farming and rain-fed, the yield of fruit trees will decrease by less than 20-30%.

The Five-year Implementation Plan for the Comprehensive Control of Groundwater Over-exploitation in Hebei Province (2018-2022)[5] proposed a pilot program for dry farming and rain-fed crops in fields,

[4] Fan, Jun-Hong & Guo, Shu-Jun. 2011 A new genus of the genus Phyllostachys (Coleoptera, Staphylinidae, Staphylininae) from China. (2003). Climatic characteristics and trends of precipitation in Hebei Province. Climatology Committee of the Chinese Meteorological Society. (eds.) Meteorological Science and Technology Innovation and Atmospheric Science Development in the New Century - Proceedings of the 2003 Annual Meeting of the Chinese Meteorological Society "Climate System and Climate Change" (pp. 460). Meteorological Press.

[5] https://www.sjz.gov.cn/col/1516346198323/2018/08/30/1535620619975.html

with a subsidy of 800 yuan per mu. If the cultivation of fruit trees is also Fund-supported, it will be conducive to the faster promotion of the implementation of dry farming and rain-fed technology of fruit trees. If the implementation is effective and the national green development policy is fully used, compared with the mode of a large amount of water and fertilizer, the fruit trees are grown in dry farming and rain farming have higher sugar content, better quality, and are more popular in the market, resulting in a brand effect. Consequently, it can realize without subsidy, realize the market-oriented operation of dry farming and rain feeding, and achieve the coordination of economic benefits, ecological benefits, and social benefits.

The benefits of fruit trees are relatively high, which is mainly determined by the yield. As a result, fruit farmers blindly pursue yield and are used to the management model of large water and fertilizer. The proportion of irrigation costs is low, and the production-to-investment ratio is economical. At the same time, the tree yield will be relatively reduced as a result of changing from irrigation to dry farming and rain-fed, which increases the difficulty of implementing the cultivating model.

(3) Technical Aspects

There exists relatively mature dry farming and rain-fed technology in Northwest China. The main technologies of dry farming and rain-fed include biological water-saving technology, agricultural water-saving technology and engineering water-saving technology. The first one involves a selection of tree species and rootstocks that are drought-tolerant, drought-resistant, and water-saving. Generally speaking, the more drought-tolerant fruit trees are dates, apricots, peaches, grapes, etc., the moderately drought-tolerant fruit trees are hawthorn, walnuts, pears, apples, persimmons, plums, etc. The second adopts straw and other ground or inter-row mulching, using water-retaining agent, drought resistance agent, steam reducing agent, and other steam reducing agents to reduce consumption; Naturally growing grass or planting green manure for water conservation and storage; Soil storage and capacity expansion technologies such as increasing and deep application of compost and organic fertilizer, application technology of drought-resistant and water retaining slow-release fertilizer, conservation tillage technology, etc. The third one includes orchard planning, farmland capital construction, water storage cellars, etc.

For a long time, irrigated cultivation has been the traditional habit of fruit tree cultivation in the plains of Hebei Province. The selection of fruit tree varieties, planting density, shaping methods, fertilization methods, pest control, fruit harvesting, storage and processing, and machinery and equipment are all based on irrigation. Insufficient technical reserves for the cultivation of fruit trees, dry and rain-fed technologies for fruit trees need to be integrated, rain collection and water-saving facilities are incomplete, and there is a lack of fruit tree agricultural technicians at all levels, technical training systems and training materials for fruit farmers. Consequently, further study remains to be completed.

3. Possible Implementations of Dry Farming and Rain-Fed for Fruit Tree Cultivation in Hebei Province

(1)A Pilot Program for Dry Farming and Rain-Fed Fruit Trees need to be implemented

Handan, Xingtai, Hengshui, and Cangzhou were selected as pilot demonstration areas, where the administrative department of agricultural production organized the compilation of pilot programs. It is essential to focus on monitoring the germination, flowering, pollination, yield, and quality indicators of fruit trees under dry and rain-fed conditions, regularly investigate the status of diseases and pests, soil fertility, soil microorganisms, etc., as well as carry out meteorological observation of precipitation, temperature, wind, disasters, etc. in the orchard field.[6] It is also of great necessity to define the objectives and key areas of water-saving pressure production, take appropriate technical measures, formulate inspection and acceptance standards, and explore replicable and generalizable pilot experience. Increasing financial support, including the established fruit tree dry farming and rain-fed pilot projects in the special support fund plan and providing financial subsidies to fruit tree growers who adopt the fruit tree dry farming and rain-fed technology should be considered.

(2) Innovative Researches on Tree Species and Field Management are supposed to be carried out

Given the problems existing in the application of dry farming and rain-fed technology for fruit trees, here are relevant researches that are expected to be carried out: the selection and cultivation of drought-tolerant and drought-resistant tree species such as apples, pears, peaches, grapes, and jujubes, research on stable yield, high-quality and high-efficiency cultivation models of saplings under different densities and different tree types under rain-fed, high-efficiency fertilization technology of rain-fed rain-fed fruit trees, research on integrated utilization technology of pesticides and fertilizers combined with foliar fertilizer, research on the integrated utilization technology of orchard green manure varieties, research on screening, breeding, and cultivation technology, and research on integrated technology of biological, agronomic and engineering water resources under dry farming and rain-fed. The dry farming and rain-fed cultivation of fruit trees could be penciled in the scientific research plan by relevant departments, which have the duty to organize professional technicians such as forest and fruit, soil fertilizer, and water conservancy to carry out collaborative researches and to make integrated innovations on the dry farming and rain-fed cultivation technology of fruit trees.

(3) Scientific and Technological Extension for Dry Farming and Rain-Fed Fruit Trees should be provided

[6] Zhang, Z.-W., Kang, Z.-Y., Han, P. & Guo, M.-X. (2022). Demonstration and promotion of dry farming and rainfed technology in an over-extracted groundwater area in Hebei Province. China Agricultural Extension (02), 49-50.

The dry farming and rain-fed technology consulting service expert group should be formed by scientific research units, colleges, and agricultural technology extension departments to compile popular science materials, and carry out various forms of technical training with fruit tree technicians and fruit tree growers at all levels as carriers. Experts are supposed to guide fruit tree growers to adopt new technologies, new products, new varieties, and new planting techniques for dry and rain-fed planting of fruit trees, and provide follow-up technical service guidance for pilot work. In addition to the production process, the government are expected to offer corresponding management and services in the sales process to promote brand building. Due to the fact that fruit trees in the seedling stage or when the precipitation is too scarce which means they still need appropriate irrigation as an auxiliary, the practice of dry farming and rain-fed can only be fully carried out in the mature and full fruiting period. Therefore, relevant implementation personnel should also do a good job of docking with scientific researchers, to clarify the stage of dry farming and rain farming fruit trees, so as to promote the accurate implementation of dry farming and rain-fed.

(4)Water price reform should be implemented to provide financial support for dry farming and rain-fed technologies

According to a survey conducted by the Urban Department of the National Bureau of Statistics on a sample of more than 50,000 urban households nationwide, 38.3% of households consume an average of 5-9.99 tons of water per month, and 31.3% of households consume 10-19.99 tons.[7] This means that household water consumption is as great as agricultural water consumption. Therefore, the authors argue that it is necessary for ordinary citizens to promote the promotion of dry farming and rainfed technologies by paying the relevant water fees. Therefore, the government can not only issue policies to encourage researchers to conduct research and implement pilot programs, but also set a reasonable water pricing system for residents to contribute to the water shortage.

(5) A Fruit Tree Farming System Suitable for Optimum Water Planting is essential to be established

As mentioned above, compared with the fruit tree irrigation planting method, the yield of dry farming and rain-fed cultivation generally decreases by 20-30%. Therefore, while pursuing water-saving planting methods, it is also necessary to pay attention to planting density to improve yield. Based on the sustainable and efficient utilization of limited agricultural water resources faced by dry farming, the designated personnel of the farming system should start from the fundamentals of ensuring future food security, water security, and ecological security, taking into account various factors, gradually building and optimizing the water-friendly planting structure model, and allocating limited water resources to crops with higher relative advantages. For instance, in 2017, Hebei province launched a pilot program of dry and rain-fed planting on 10,000 mu of farmland in Hengshui, which reduced

[7] Xu, Guirong & Gao, Wei. (2013). Analysis of domestic water use structure and water saving potential in Hebei Province. Hebei Enterprise (07), 60.

groundwater extraction by 220 cubic meters per mu. In 2018, Hengshui, Xingtai, Handan, and Cangzhou cities, which are in deep groundwater funnel areas, organized and implemented a pilot project of dry farming and rain-fed cultivation of 100,000 mu.[8] Therefore, the pilot project of dry farming and rain-fed cultivation of fruit trees in this region has the potential to be further carried out, which is recommended to connect with the cultivation of dry farming and rain-fed cultivation of farmland for easy management, gradually form a dry farming and rain-fed cultivation system suitable for water cultivation in this region, and promote the fruit industry in Heilonggang basin in the groundwater over-exploitation area from the blind pursuit of output to high-quality development.

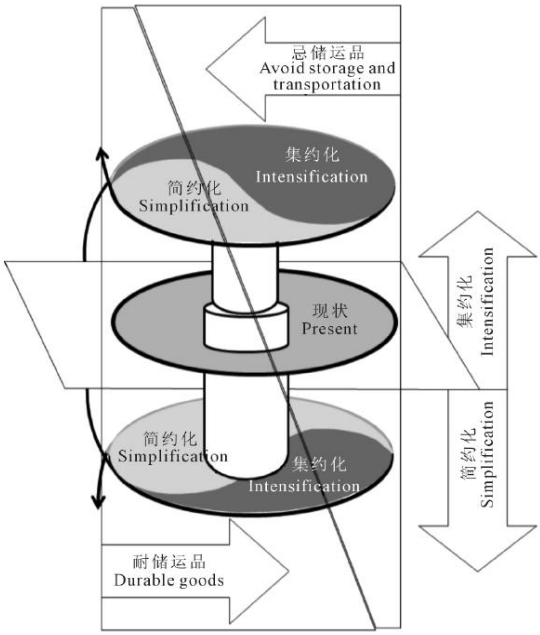

图 1　农业生产的集约化-简约化进步图示

Image 1 The intensification of agricultural production-contracted change progress

4. Research Conclusions

After analyzing the natural, economic, and social conditions and the growth conditions of fruit trees in the groundwater over-exploitation areas in Hebei Province, the author believes that it is feasible to implement dry farming and rain-fed fruit trees in the groundwater over-exploitation areas in Hebei Province, but there are obvious stages in time. It is more feasible in the mature and full fruiting period of the fruit tree growth period. Moreover, the dry farming and rain-fed project for fruit tree cultivation in Hebei Province are still in the research and initial stage, and many difficulties will be faced in the implementation process. Different people can have different views on further research,

[8] Zhang, Z.-W., Kang, Z.-Y., Han, P. & Guo, M.-X. (2022). Demonstration and promotion of dry farming and rainfed technology in an over-extracted groundwater area in Hebei Province. China Agricultural Extension (02), 49-50.

implementation, and promotion of the feasibility of dry farming and rain-fed fruit tree cultivation in this area.

5. Further Thought

Because of the wide disparities in geography and economic conditions in different regions of China, technologies that fit local natural and human characteristics and have economic, social, and ecological significance are generally more likely to be accepted and applied by Chinese communities.There are some technologies that are clearly inappropriate in China, and they often have characteristics including blindly destroying nature to obtain economic growth, causing large amounts of pollution, and going against the concept of green, sustainable development.

As a member of the helping society, ordinary people should build on their identity as communicators and actively participate in the social promotion of new technologies. For example, individuals can participate in voluntary awareness activities in their communities by preaching and helping with posters in their neighborhoods. In addition, individuals can also access the websites of relevant research projects or foundations through social media channels and contact the relevant staff for individual financial support.

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[7] Fan, Jun-Hong & Guo, Shu-Jun. 2011 A new genus of the genus Phyllostachys (Coleoptera, Staphylinidae, Staphylininae) from China. (2003). Climatic characteristics and trends of precipitation in Hebei Province. Climatology Committee of the Chinese Meteorological Society. (eds.) Meteorological Science and Technology Innovation and Atmospheric Science Development in the New Century - Proceedings of the 2003 Annual Meeting of the Chinese Meteorological Society "Climate System and Climate Change" (pp. 460). Meteorological Press.

Appendix

1 Related Data

Name	Grain	Cotton	Oil	Melons	Fruit	Vegetable	Meat	Egg	Milk	Aquatic Products
Total	3979	22.7	119.5	513.9	1004	5093	429.6	385.9	356.8	93.4
Percentage of the country	5.61	5.65	4.31	6	7.54	10.27	5.36	12.55	12.33	1.98
Ranking	6	2	8	5	6	4	5	3	3	15
Area	9703	309	546.8	82.43	759.0	869.0				
Ranking	5	2	8	9	9	11				

Form 1 The Total Amount and Ranking of Agricultural Products in Hebei Province in 2019 (unit: 10,000 tons, 10,000 mu)

Name	Total	Percentage of the country	Ranking	Per Capita	Ranking	National Average
Arable Land	6520.45	4.83	7	0.09	17	0.10
Water Resources	208.3	0.64	25	279.69	26	6846.12
Water Consumption	182.6	3.02	15	245.18	9	986.68
Agricultural Water Consumption	128	3.4	13			
The Percentage of agricultural water use Accounting for the Total Water Consumption	70.1		9			60.57

Form 2 Cultivated land, Water Resources and Utilization in Hebei Province (unit: thousand hectares, billion cubic meters, hectares/person, cubic meters/person)

2 Interview Outline

Interview Outline

Interview Date	May 22,2022	**Interview Staff**	Liu Mengchao, Wang Liying, Shi Jianshuo, Guo Li

Interview Subject	Thoughts on Dry Farming and Rain-Fed Fruit Tree Cultivation in Groundwater Over-Exploitation Areas in Hebei Province
Purpose of the Interview	Through an exclusive interview with related technical personnel of dry farming and rain-fed, we can further understand the current situation and significance of dry farming and rain-fed for fruit trees.

Interview Questions:

1. What is dry farming and rain-fed?

Dry farming and rain-fed agriculture refers to a kind of rain-fed agriculture that relies on natural precipitation for agricultural production in arid or semi-arid areas, or in areas with over-exploitation of groundwater.

For the survival of future generations, the sustainable development of regional agriculture, the research and application of dry farming and rain-fed agricultural technology has important practical significance and social development significance.

2. What is the effect of dry farming and rain-fed on the growth of crops?

As we all know, water is the lifeblood of agriculture, and the objective requirements of social development must be based on the carrying capacity of regional water resources to properly exploit groundwater. At present, groundwater in Hebei (whether shallow or deep) is severely overexploited. The important producing areas of grain, fruit and vegetables in China need water to stabilize their production capacity. Rain feeding is very important to ensure the growth and development of crops and high yields.

3. What are the main measures to deal with water shortage in agricultural planting in North China? What needs to be improved?

1) Increased investment in water-saving infrastructure construction. Increase investment in water conservancy construction, water conservation and dry farming, combine the strengthening of water conservancy infrastructure construction with the development of water-saving irrigation, dry farming, water pollution control, and protection of the ecological environment, and build a number of water blocking, water storage, and Water pivot projects, water-saving irrigation and ecological water harvesting projects, and renovation and renovation of a number of aging and disrepairing irrigation and water supply projects.

2) Strengthen the research, demonstration and popularization of dry and rain-fed agricultural technology. Implement scientific water-saving and actively promote advanced water-saving irrigation and dry farming techniques. To meet the development needs of water-saving and dry farming, agricultural scientific research departments should speed up the cultivation of new varieties of drought-resistant and water-saving crops, and study water-saving irrigation modes for different crops, utilization of brackish water, artificial rainfall and other technologies. Six kinds of dry farming water-saving modes, such as dry farming and rain feeding, plastic film mulching, and water and fertilizer integration, have been promoted.

3) Adhere to water management and water use in accordance with the law, and promote the construction of the legal system of water-saving and dry farming. Attach great importance to the work of water control according to the law, and conscientiously implement laws and regulations such as the Agricultural Law, the Water Law, the Law on Soil and Water Conservation, and the Law on the Prevention and Control of Water Pollution.

4) The policy subsidy intensity of dry farming and water-saving agriculture has been

increased, and projects such as "high-efficiency engineering irrigation", "wheat reduction irrigation", "seasonal fallow planting", "dry farming and rain-fed planting" have been implemented successively.

What needs to be improved: Major aspects: water conservation, water resource regulation, water diversion, water storage, water resource management, water replenishment

In terms of dry farming: rainwater harvesting engineering measures, agronomic water-saving measures, and high-efficiency technologies of "water storage, concentrated water resources, water conservation, water saving, and water use" are integrated and matched to form a comprehensive drought-resistance and water-saving technology system.

4. The role of dry farming and rain-fed on local water shortage?

There is no doubt that it's a big deal of great importance. The effective use of ineffective "rainwater" and the improvement of the utilization efficiency of precipitation are the main ways to alleviate agricultural water resources, which not only ensure the growth and development of dry farming crops, increase production and harvest, but also make groundwater resources "recycle", reducing the amount of over-exploitation of groundwater resources.

5. The Existing Research Results of the Institute of Resources and Environment of the Hebei Academy of Agriculture and Forestry Sciences in dry farming and rain-fed?

- Fertilize the soil and improve the water storage capacity of the soil;
- Formulated fertilization, realizes the coupling of water and fertilizer, determines production by water, and promotes production by fertilizer;
- Screen and introduce drought-resistant crop varieties to give full play to the potential of biological drought resistance and water saving;
- Develop water-adaptive planting to adapt to the temporal and spatial variation of precipitation through the diversification of planting crops and planting situations.

6. What do you think is the prospect of dry farming and rain-fed using in North China?

Very promising. The shortage of water resources is unquestionable in North China. Groundwater is severely overexploited and annual rainfall is declining year by year. For the sustainable development of mankind and agriculture, dry farming and rain-fed agriculture has become an important water-saving technology in agricultural production in North China. The annual rainfall is calculated as 450mm. If the total rainfall is about 300m2 per mu of land, which is enough to meet the planting pattern of the second harvest of wheat and corn in one year, the annual water requirement of one mu of fruit trees is 100 m2, which is only 1/3 of the annual rainfall.

7. Can all the fruit tree planting in North China be used in dry farming and rain-fed?

Of course, the annual rainfall calculated according to the above can fully meet the annual water demand of fruit trees. If the rain-collecting and water-saving technical facilities are complete, all fruit trees in North China can apply rain-fed technology. The reality is that the construction of rainwater harvesting and water-saving technical facilities is difficult to meet the demand, and the application area of rain-fed projects will gradually expand with the implementation of dry farming.

3 Inspection Pictures

Acknowledgement

In the process of completing this paper, I encountered many difficulties. Fortunately, under the guidance of my teachers family and friends, I went through many obstacles, and eventually finished the paper.

This topic in the selection and research process is in Zhang Yutong, my tutor's cordial care and careful guidance to complete. Her serious scientific attitude, rigorous spirit of scholarship, excellence of the work style, deeply influenced and inspired me. In addition, Helen Wang and Charlie Kang offered great help in translating the essay. At the same time, from the topic selection to the final completion of the project, Lv Jianheng, my academic tutor has always given me guidance and unremitting support. I would like to extend my sincere thanks and high respect to Zhang ,Wang, Kang and Lv.

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