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Open Access Journal of Agricultural Research
ISSN: 2474-8846

Advances in Agricultural High-Quality Development

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Research Article
Volume 10 Issue 3
Received Date: August 04, 2025
Published Date: September 29, 2025
DOI: 10.23880/oajar-16000386

Abstract

Agricultural development has gone through a long time. According to the efficiency plant use nature resources, the whole process of agricultural development can be divided into three stages: Low level development stage or primitive agriculture, Level improvement stage and new stage of agriculture high-quality development. Theory foundations of Agriculture high-quality development are natural resources use limit by plants, Vegetation carrying capacity and the critical period of plant resources relation regulation and the method of Agriculture High-quality development is to select excellent tree species or varieties, take appropriate initial plant density and take effective measures to ensure plant grow well and get the cultivated goal, maximum yield and benefit.

Keywords: Agriculture; Development; Agriculture High-Quality Development; Natural Resources Use Limit by Plants; Vegetation Carrying Capacity; Critical Period of Plant Resources Relation Regulation

Abbreviations

VSWC: Volumetric Soil Water Content; MID: Maximum Infiltration Depth.

Introduction

Agricultural development has gone through a long process. There are different kind of agriculture concepts such as ecological agriculture [1], organic agriculture [2], smart agriculture and data agriculture and so on.

Organic agricultural practices respond to and offer alternatives to the health and environmental problems related to conventional technologies and practices of production and embrace many alternative ideals such as alternative distribution and retailing networks and the counter-cultural wholefoods movement.

Study Method

Since 2017, China put forward the concept of high-quality development. In order to solve the question of soil and vegetation degradation and crop failure in modern agriculture development and promote agricultural high-quality development, Author reviews a lot of relative papers and find the new stage of Agriculture high-quality development according to the efficiency of resource utilization by plants based on the innovation study [3-13], Because the soil water content changes with soil water suction at different soil depth, and the variation of soil water content with soil water suction accords with the Garden equation, so we can use Garden equation to fit soil water content and soil water suction data and establish the soil water characteristics curve and then estimate the wilting coefficient at different soil depth [14]. Before estimated soil water suction at different soil depth, we must take undisturbed soil sample and determine the soil moisture suction of undisturbed soil when plant wilting. In general, the sampling pits (soil profile) was dug in the experimental site for investigating soil profile and sampling purposes, whose dimensions were 1m× 2 m × 4 m depth. The undisturbed soil samples were collected for 3 times at different soil depth with cutting rings (a 5 cm in high and 5 cm in inner diameter). Soil moisture suction at different soil layers were measured by centrifuge method, a HITACHI centrifuge, made by Instrument Co., Jappan, or Pressure Chamber method made in USA. The theory of soil water resources use limit by plant is improved.

Plant root vertical distribution in soil is an important index to estimate soil moisture deficit criteria because plant absorbs soil moisture in the root zone. Soil moisture resources are a good indicator to express the effect of soil moisture on plant growth because plant roots are distributed in soil and suck water in certain soil body. Sometime the root distribution depth is more than tree height and maximum infiltration depth, and suck water from considerable soil depth. The plant growth and vertically distribution of Robinia (*Robinia pseudoacacia L.*) forest in the semiarid loss hilly region (Guyuan, China) see (Figure 1).

Figure 1: The plant growth and vertically distribution of roots and the maximum infiltration depth (Hm) in Robinia (*Robinia pseudoacacia L.*) forest in the semiarid loss hilly region (Guyuan, China).

But from the perspective of sustainable development, when soil water resources drop to a certain extent in the deeper soil more than maximum Infiltration depth, the soil water is difficult to restore in the deep soil, which is the soil layer more than maximum Infiltration depth, see Figure 1 it is necessary to control the utilization of soil water resources by plants for sustainable use of soil water resources[8].

The whole process of agricultural development can be divided into three stages: Low level development stage or primitive agriculture, Level improvement stage and high-quality development new stage. The new stage of Agriculture development is Agriculture High-quality development. Only in this way, land can produce more better and health food and service to meet the people's needs for a better life and crop type, yield and quality.

Results

Agricultural development has gone through a long time. According to the efficiency plant use nature resources, the whole process of agricultural development can be divided into three stages: Low level development stage or primitive agriculture, Level improvement stage and high-quality development new stage. That is the Low-level development stage or primitive agriculture, the Level improvement stage and Agriculture High-quality development.

Low Level Agriculture Development Stage

At Low level development stage or primitive agriculture, people pick up wild fruits and rely on nature for a living because science and technology are underdevelopment and people labour productivity are low. People must live on nature. Today in some African primitive tribe, you can see this kind of Low-level agriculture development. However, with the economic and society development, this kind of Low-level agriculture development will disappear.

Level Improvement Stage

At the Level improvement stage, people start to select or cultivate better plant species, weeding, producing and applicating fertilizer and irrigating, if there are water resources, to increase food kinds, improving quality and amount of food. The turning point from the low level of development to the Level improvement is plant domestication and animal introduction domestication, the development of gathering economy to planting economy. There are some events such as overuse chemical fertilizer and the over dose application of pesticides and so on, which cause crops failure and resources waste happens, which is not good for Agriculture High-quality development but easily cause environment and healthy problem. In most of farmland, you can see this kind of agriculture development. Level improvement stage is a transition stage from Low level agriculture development stage to agriculture high-quality development. With the economic and society development, this kind of agriculture development will be developing into Agriculture high-quality development.

Agriculture High-Quality Development

Now, Agriculture development has entered high-quality development. At the new stage of high-quality development, people must take effective measures or method to get the maximum yield and benefit and produce more better and health food and service to meet the people's increasing needs for a better life and crop types, yields and quality. To carrying out high-quality development, we must overcome the overuse chemical fertilizer and the over dose application of pesticides and so on in the production process to ensure sustainable use of nature resources and agriculture high yield and benefit.

Theory Foundations of Agriculture High-Quality Development

Theory foundations of Agriculture high-quality development are natural resources use limit by plants, Vegetation carrying capacity and the critical period of plant resources relation regulation.

- **Natural Resources Use Limit by Plants:** Natural resources is limit. In order to carry out sustainable development, we have to carry out sustainable use of natural resources and Agriculture high quality development, so, we must use the natural resources in sustainable way.

The natural resources use limit by plants is the controlling limit plants use natural resources, expressed by indicator plant in a plant community. The natural resources use limit by plants can be divided into space natural resources use limit by plants in water and nutrient rich regions, soil water resources use limit by plants in water-limit regions and soil nutrient resources use limit by plants in nutrient -limit regions. For example, the natural resources use limit by plants in semiarid loess hilly region is soil water resources use limit by plants. The natural resources use limit by plants changes with plant species and location [13,15,16]. For example, natural resources use limit by plants in water-limited region is the limit of soil water resources use limit by plants, which is the soil water resources in the maximum infiltration when soil water content is equal to wilting coefficient.

Infiltration is the process of water entering the soil in a certain time. After the rain event happens, raindrops received on the land surface, infiltration process, there are two vertical soil water characteristics cures left on the soil profile.

There are two vertical distribution curve of soil water with soil depth before and after a period, such as one rain event because soil evaporation plant transpiration and soil water movement. The two vertical distribution curves can be used to determine infiltration depth and soil water supply for the rain event if we take suitable time to investigate the vertical distribution curve of soil water with soil depth. The infiltration depth for one rain event or a given time was equal to the distance from the land surface to the crossover point between the two soil water distribution curves with soil depth, and the MID could be estimated by a series of two-curve methods.

We can use the two vertical soil water characteristics cures to estimate infiltration depth. Before estimating infiltration depth, a neutron probe was used to monitor the changes of field volumetric soil water content (VSWC) with soil depth before a rain and after the rain event because of its high precision. If we establish the relation between soil water content and soil depth at starting time and ending time of infiltration process in the soil profile, there is a starting vertical distribution curve of soil water before an infiltration process and an ending vertical distribution curve of soil water after the infiltration process. Two curves method was found by Guo in 2004 [17], and used to estimate the depth of infiltration of Caragana shrubland by Guo and Shao in 2009 [6] and Guo in 2014 [9], and named by Guo in 2020 [10].

The indicator plant for original vegetation is dominate species, especially constructive species, the uppermost dominant species, which is native to the local region because for a long time they have developed a good relationship with the local condition. The indicator plant for non-Native vegetation is goal or cultivated plant species.

Soil water resources is the water storage in given soil depth. Plant root cannot suck soil water unlimitedly in water-limited regions. There is a limit plant use soil water. There are some soil water deficit indices, such as crop water index, soil water deficit index, evapotranspiration deficit index, plant moisture deficit index. Because most of the drought indices are based on meteorological variables or on a moisture balance equation, they do not indicates water deficit accumulation or soil water storage (soil water resource) in root zone, they cannot act as a suitable index for distinguishing severe drying of soil in the water-limited regions because soil drought is a nature phenomenon, a water deficit accumulation or a decrease in soil water storage in the root zone soil plant root distribute.

The amount of soil water resources changes with weather condition, plant growth and soil water movement in the soil. To achieve sustainable use of soil water resources, there should be a sustainable use indicator of soil water resources, which is the SWRULP [8]. So, the SWRULP can be defined as the soil water resources in the maximum infiltration depth (MID) when the soil water content within the MID equals the wilting coefficient, expressed by wilting coefficient of an indicator plant in a plant community. The indicator plant is construction species for old vegetation and goal plant species for non-native vegetation [16,18].

After having analyzed the data of the relationship between soil water content w and soil water suction S in the soil under caragana in 2004 and found the relationship between soil water content w and soil water suction S in the soil under caragana (Caragana korshenskii) shrubland of semiarid loess hilly region can be expressed by the equation:

$$W=a \cdot S^{-b} \quad ...(1)$$

the wilting coefficient can be estimated by the above formula:

$$W=a \cdot 15^{-b} \quad ...(2)$$

Here, the symbol, W, is volumetric soil water content in %. S is soil water suction in MPa, a and b are coefficient [5,6].

Generally, the wilting coefficient is assumed to be the soil water content when the soil water suction is 1.5 MPa because soil water potential at wilting ranged from -1.0×10^6 to -2.0×10^6 MPa, with an average of approximately -1.5×10^6 MPa (15 bar).

- **Change of Wilting Coefficient with Soil Depth:** The loess profile develop from is generally considered to be uniform, However, after the process of soil water Infiltration and maximum Infiltration depth having analyzed the data of soil water content w and soil water suction S at different soil depth and found that there are some changes of soil physical characters such as silt particle content, with soil depth in soil profile, see (Table 1), which cause the changes of wilting coefficient with soil depth.

Soil depth (cm)	Bulk density ($g \cdot cm^{-3}$)	Organic matter content ($g \cdot kg^{-1}$)	Clay Particle content (%)	Silt Particle content (%)	Sand Particle content (%)	Physica 1 clay content (%)	Total Porosity (%)	Capillary Porosity (%)	Non-capillary Porosity (%)
5	1.19	6.86	13.76	65.68	20.56	24.92	55.06	35.01	20.05
20	1.21	3.69	13.19	68.67	18.14	23.17	54.19	33.89	20.3
40	1.22	3.1	10.99	71.63	17.38	21.55	53.77	34.21	19.56
80	1.23	3	11.94	70.39	17.67	20.99	53.43	34.07	19.36
120	1.25	2.62	11.42	68	20.58	21.58	52.98	33.43	19.55
160	1.24	2.56	10.75	67.73	21.52	20.05	53.06	33.92	19.14
200	1.25	2.52	11.6	71.2	17.2	20.28	52.75	33.89	18.86
280	1.26	2.61	11.28	72.34	16.38	22.29	52.3	34.24	18.06
320	1.27	2.5	12.47	70.93	16.6	22.73	52.23	34.22	18.01
400	1.26	2.58	12.57	71.51	15.92	22.5	52.34	35.04	17.3

Table 1: Changes of main soil physical and chemical indicators of huangmian soil with soil depth.

Vegetation Carrying Capacity: The vegetation carrying capacity is the ability of nature or land resources to carry vegetation in given time and space, expressed by the quality or plant density of indicator plant in plant community. The vegetation carrying capacity is the function of plant species, time and location [9,11]. For example, in water-limited region, vegetation carrying capacity is soil water vegetation carrying capacity, which is the ability of soil water nature resources to carry vegetation, which changes with plant species, times and location [9,11,13,19]. For example, the vegetation carrying capacity in water-limited region is soil water vegetation carrying capacity, which is the ability of soil water resources to carry vegetation in given time and space because soil water is the most important factor to influence plant growth, fruit quality, yield and benefit. Plant resources relationship is very harmony and plant grow well and bear fruit but the goods and service cannot meet people's need in the stage of primitive agriculture, a lot of original vegetation has been changed into non-native plantation such as Saskatoon berries, red plum apricot and corn in the semiarid region, China. Some plant such as Saskatoon berries, grow and develop well, suitable for local climate, easy to develop. But another plant, such as corn and red plum apricot, they are not suited to the local climate and need to regulate plant resource relationships.

The Critical Period of Plant Resources Relation Regulation: As plant grows, plant canopy and root grow, plant use more resources, and plant resources relation changes with time. When the resources plant use in the appropriate canopy depth or root in the maximum infiltration depth [15,16] is equal to natural resources use limit by plants, plant resources relation enters the critical period of plant resources relation regulation. The ending time of the critical period of plant resources relation regulation is the ineffective time of plant resources relation regulation such as the ending time of fruit expanding. The critical period of plant resources relation regulation is the most important period in the whole process of plant growth and yield and benefit cultivation, which can be expressed by the amount of available natural resources in canopy or root zone. The vegetation carrying capacity in the critical period of plant resources relation regulation decides the quality, maximum yield and benefit of plant in a plant population and community [20-25].

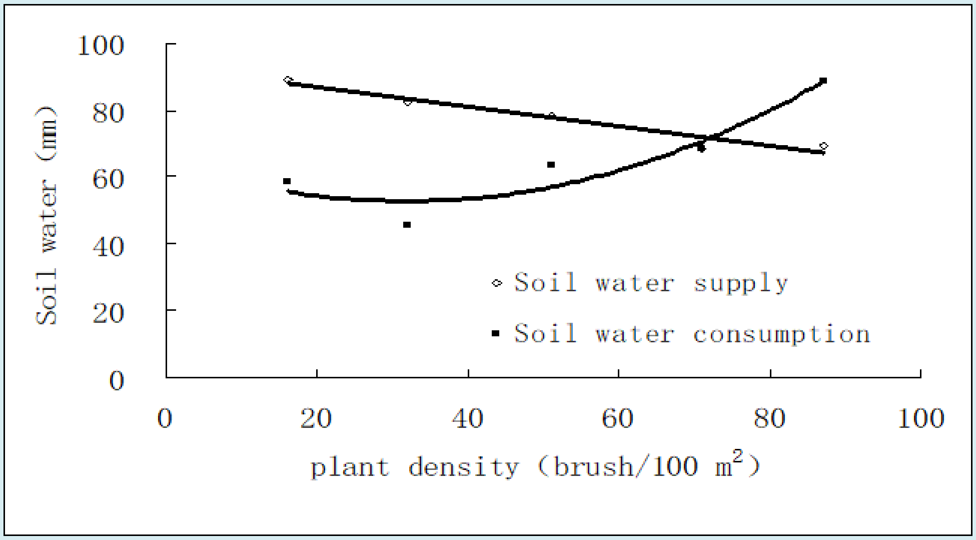

Figure 2: The relationships between soil water supply or consumption and plant density and soil water vegetation carrying capacity in critical period of plant resources relation regulation in caragana shrubland of water-limited region (Guyuan, China).

Methods of Agricultural High-Quality Development

Because the carrying capacity in the critical period of plant resources relation regulation decides the maximum yield and benefit, we must take the theories of resources use limit by plants, vegetation carrying capacity and the critical period of plant resources relation regulation as a guild, select excellent tree species or varieties, take appropriate initial plant density and take effective measures to regulate the plant resources relation regulation and ensure plant grow well and get the cultivated goal. If the plant density exceeds the vegetation capacity, the plant resources relation should be regulated based on vegetation carrying capacity, especially the vegetation carrying capacity in the critical period of plant resources relation regulation, otherwise the further increase plant use natural resources will lead overuse of natural resources because available natural resources is more than natural resources used by plant, which will lead to the decline of vegetation and the decline of grain yield and quality [26-39].

Conclusion

Agricultural development has gone through a long process, and now, Agricultural development enters high-quality development stage. Theory foundations of Agriculture high-quality development is Natural resources use limit by plants, vegetation carrying capacity and critical period of plant resources relation regulation. Methods of Agricultural high-quality development is to select excellent tree species or varieties, take appropriate initial plant density and take effective measures to ensure plant grow well and get the cultivated goal.

Because the large agricultural area is huge and the increasing population, population of the world has exceeded 8.2 billion at present in the world, different regions have different climate and crops suitable for growth, so we have to strengthen the agricultural high-quality development research in different regions to determining of excellent tree species or varieties, appropriate initial plant density, resources use limit by plants, vegetation carrying capacity, the critical period of plant resources relation regulation to regulate the plant resources relation, especially The appropriate amount of water and fertilizer application required by plants in the critical period of plant resources relation regulation to make plant grow well and get maximum yield and benefit to realize sustainable use of nature resource and agricultural high-quality development to meet people's needs for a better life and crop types, yields and quality in different regions.

Acknowledgements

This project was supported by the National Science Foundation of China (Project No: 42077079,41271539 41071193) and Study on high quality sustainable development of soil and water conservation (A2180021002). We thank two anonymous reviewers for their helpful suggestions.

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