The Type of Low-yielding Fields, Using Direction and Land Fertility Building Measures in Suiping County

Jiuyi HU*

Suiping County Bureau of Agriculture, Zhumadian 463100, China

Abstract Using the evaluation indicator system for arable land fertility in Suiping County, this paper analyzes some factors influencing agricultural production, such as physical and chemical properties of soil, site conditions, soil management, and soil nutrients concerning various types of low-yielding fields in the county. In accordance with the dominant soil constraint factors and main direction of improvement, the low-yielding fields in the county are divided into four types: irrigation improvement type, waterlogging drainage type, barren soil fertilization and barrier layer type. Finally this paper offers specific guidance on the construction of arable land.

Key words Type of low-yielding fields, Using direction, Land fertility building measures

Suiping County, located in the southeast of Henan Province, is one of the main grain producing areas in Henan Province. The area of arable land in the county is 66790.86 ha. The accumulated temperature with average daily temperature greater than or equal to 0 ℃ is 5 473.2 ℃, the annual average rainfall is 972 mm, and the average annual evaporation is 1574.1 mm. The soil in the county is divided into five types: moisture soil, lime concretion black soil, cinnamon soil, yellow brown soil and rocky soil. It is divided into seven sub-types: yellow brown soil, typical cinnamon soil, Albic yellow cinnamon soil, neutral rocky soil, typical lime concretion black soil, calcareous lime concretion black soil, and gray moisture soil.

1 Classification of fertility of county arable land

The Delphi method is used for the evaluation of arable land fertility in Suiping County. Based on the actual situation of Suiping County, this paper selects the qualitative indicators influencing the arable land fertility such as site conditions and physical characteristics. Through expert evaluation, the following 11 evaluation indicators are determined: topsoil texture, texture configuration, soil parent material, available potassium, available phosphorus, organic matter, drainage capacity, irrigation guarantee rate, surface gravel degree, obstacle level and terrain sites. According to the evaluation results of influence on arable land fertility, this paper builds the evaluation indicator system for arable land fertility in Suiping County. 1656 evaluation units are determined by making the soil distribution map overlap with land use map. The spatial interpolation method is used for evaluation. Using the cumulative curve grading method, this paper finally divides 66790.86 ha of arable land into five levels according to the fertility, and the area and proportion of each level arable land are shown in Table 1.

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* Corresponding author. E-mail: hujiuyi@126.com

Table 1 The fertility level of arable land in Suiping County and the area distribution

Fertility level	Area//ha	Area proportion//%
Class I land	9 174.15	13.74
Class II land	15 047.75	22.53
Class III land	20 974.12	31.40
Class IV land	13 336.89	19.97
Class V land	8 257.95	12.36
Total	66 790.86	100.00

2 Classification basis of the type of low-yielding fields

In the five levels of arable land in the county, Class III, IV and V lands have some constraints on agricultural production, and the yields are relatively low and unstable, so we classify them as low-yielding fields in the county, with a total area of 42568.96 ha, accounting for 63.873% of the county's total arable land. Through the analysis of physical and chemical properties of soil, site conditions, soil management and soil nutrients of low-yielding fields in the county as well as the factors affecting agricultural production, we find that drought, waterlogging, barrier level, and barren soil are the major factors restricting the production capacity. Based on *National Type Division and Improvement Technology for Medium Low Yield Field* (NY/T 310 - 1996) released by the Ministry of Agriculture, according to the dominant barriers and main direction of soil improvement, the low-yielding fields in the county are divided into four types of low-yielding fields: irrigation improvement type, waterlogging drainage type, barren soil fertilization type, and barrier layer type.

2.1 Irrigation improvement type

2.1.1 Basic situation. The county now has 31175.61 ha of this type low-yielding fields, accounting for 73.24% of total area of low-yielding fields in the county. The soil mainly includes gray damp loam, Shajiang black soil and sand cinnamon soil.

2.1.2 Distribution area. It is mainly distributed in Chutang, Shenzhai, Huaishu and Hexing, as well as the terraces of Kuiru Plain. The altitude is generally between 75 m and 100 m, and the

soil layer is thick, but the slope is steep and rugged, with poor ability to resist drought and waterlogging.

2.1.3 Limiting factors. Drought and water shortage is the major factor limiting this type low-yielding field, and the development of irrigation is the main way to transform this type low-yielding fields[2]. (i) The level of agricultural land infrastructure building is not high. The agricultural land infrastructure building is poor in this region, and the farmland protection forest system is not perfect; the supporting standard for the groundwater use is low, and there is a serious lack of irrigation and drainage project[3]. (ii) The using and keeping of land is in disorder and the soil fertility declines. Most farmers lay great emphasis on land use but neglect the keeping of land and application of organic fertilizer. And most of the soil is heavy and the soil compaction is severe, causing soil nutrient imbalance.

2.2 Waterlogging drainage type This type low-yielding field is the arable land prone to perennial or seasonal waterlogging due to local low-lying terrain and poor drainage. The leading barriers are soil waterlogging, and some factors related to it, such as terrain conditions, excess surface water, groundwater depth, soil configuration, texture, and drainage system capability.

2.2.1 Basic situation. Suiping County now has 2762.72 ha of waterlogging drainage type low-yielding fields, accounting for 6.49% of total area of low-yielding fields in the county. The main soil includes gray sand soil, sticky lime concretion black soil, blue green soil and black soil.

2.2.2 Distribution area. It is mainly distributed in the river beach and dish-shaped depressions of Kuiru Plain, as well as the depressions between hillocks.

2.2.3 Limiting factors. Seasonal waterlogging is the major factor limiting this type field, and drainage is the main way to transform these low-yielding fields. In addition to waterlogging, drought and poor farming are also the main factors limiting this type low-yielding field in this county.

2.3 Barrier layer type This type low-yielding field is the arable land with serious flaws in the soil profile, such as excessively thin soil body and barrier levels of sandglass, gravel, sticky plate and iron pellet at about 1 m profile. The degree of barrier includes material composition at the barrier layer, thickness and position.

2.3.1 Basic situation. Suiping County now has 7353.27 ha of barrier layer type low-yielding fields, accounting for 17.27% of total area of low-yielding fields in the county. The main soil is yellow cinnamon soil.

2.3.2 Distribution area. It is mainly distributed in the hillock slopes.

2.3.3 Limiting factors. The area is characterized by undulating terrain and different degrees of soil erosion. In one meter of soil body, there is barrier level (sticky plate layer). The soil is sticky and heavy, and the topsoil is shallow. The soil nutrient content is low, and the water table is high. The water is insufficient and irrigation conditions are poor.

2.4 Barren soil fertilization type This type low-yielding field is the arable land affected by climate and terrain. Due to poor soil structure and low nutrient content, it can be gradually improved only through long-term application of fertilizer.

2.4.1 Basic situation. Suiping County now has 1277.36 ha of barren soil fertilization type low-yielding fields, accounting for 3% of total area of low-yielding fields in the county. The soil types include yellow brown soil, rocky soil and sticky yellow cinnamon soil.

2.4.2 Distribution area. It is mainly distributed in the western hilly area (metamorphic hillock) at an elevation of 80 – 100 m.

2.4.3 Limiting factors. Due to the high terrain, thin soil, poor vegetation, lack of irrigation water and poor soil fertility, it is necessary to improve water conservancy to resist drought, return straws to fields, and apply organic fertilizer to improve fertility.

3 Land use direction and land fertility building measures

3.1 Irrigation improvement type and waterlogging drainage type It is necessary to focus on combating drought and draining waterlogged fields, and integrating various kinds of state project funds for low-yielding fields, in order to build the region into high-yielding farmland. In terms of crop cultivation, it is necessary to promote high-yielding and high-efficiency intensive cultivation, according to local economic conditions.

3.1.1 Strengthening the basic farmland construction. For the regions with rich groundwater, we should vigorously develop well irrigation projects, and improve irrigation facilities, to improve the irrigation guarantee rate.

3.1.2 Vigorously returning straws to fields. Returning straws to fields and applying organic fertilizer is the agronomic priority in this region, which can help to increase soil organic matter, improve soil structure, and protect agricultural ecological environment[4].

3.1.3 Implementing the combination of deep plowing and zero tillage. Due to deep topsoil in this type field, there is a need to combine deep plowing and zero tillage, combine deep plowing and subsoiling[5], strengthen field management, and conduct reasonable crop rotation according to the fertilizer demand characteristics of crops to reduce the hazards of continuous cropping.

3.2 Barren soil fertilization type and barrier layer type Due to the high terrain, shallow soil layer and thin topsoil, the soil erosion is serious. The lack of irrigation water results in poor soil fertility. In terms of land development, it is necessary to improve water conservancy to resist drought, return straws to fields, and apply organic fertilizer to improve fertility. In terms of engineering construction, it is necessary to focus on the development of drip irrigation, micro-irrigation facilities, and promotion of water-saving irrigation techniques[6]. In terms of crop planting, it is necessary to change the crop planting structure, guide farmers to transfer land, promote high-efficiency intensive cultivation, and focus on the development of high-efficiency cash crops such as fruit, medicine and flowers.

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