

Application s of Soil Series in Sustainable Land Use of Oasis Farm lands

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**Abstract** The issue of agricultural land sustainability is important to every part of the world, especially in the developing countries. Based on the data collected by field investigation and laboratory analysis as well as soil classification theory, the authors discuss the applications of soil series in the arid northwestern China. On the one hand, the application in the layout of rational agricultural of oasis farm lands: (1) two soil series namely, Lanjiabao (main) and Nijiaxiaying belong to the moderate and extremely arid region in the study area, accordingly, the layout of crops is the spring wheat and maize (main) and winter wheat; (2) Nijiaxiaying (main) and Lanjiabao, however, fall into the warm-cold and extremely arid region, where the winter wheat (main) and spring wheat grow; and (3) the Shangfusi is part of the warm-chilly-arid region, which is used as seasonal pastureland. On the other hand, the application on the soil quality of oasis farm lands, the results indicating that among all soil series, the content of N is very low, however, the content of K is abundant, and the content of P is greatly scarce.

**Key words** soil series; sustainable land use; soil quality; Linze sampling area in arid northwestern China

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1 Introduction

Sustainability of land use is defined as the sustainable increasing and stability of land productivity, with the good benefits in the society, economy and environment. Because the production of sufficient food to feed an ever-increasing population is one of the main challenges today, the agricultural sustainability is obviously important<sup>[1]</sup>, especially in the arid regions of northwest China<sup>[2-4]</sup>. On the other hand, the Chinese Soil Taxonomy (CST) plays important roles in soil survey, soil mapping and agricultural technology transfer in the light of local conditions, which is worked out based on diagnostic horizons and diagnostic characteristics of soils<sup>[5]</sup> being the advanced experiences of foreign soil classification, especially the US soil taxonomy<sup>[6]</sup>. Soil series are the basic units in CST<sup>[7-9]</sup>.

This paper takes Linze sampling area (LSA), a typical oasis agriculture area in the Hexi Corridor, northwestern China as a case study to discuss the applications of soil

series in sustainable land use of oasis farm lands through using the collected data and the soil classification theory. The applications of soil series mainly include two aspects: (1) the application in the layout of rational agricultural of oasis farm lands and (2) the application on the soil quality of oasis farm lands.

2 Materials and Methods

2.1 Study area

The study site is located in the south of Linze County, Zhangye City, Gansu Province, the arid regions of northwest China whose area is 399 775 km<sup>2</sup>, and situated at east longitude 100°00'~ 100°15' and north latitude 39°00'~ 39°10'. The mean annual temperature is 7. 6℃, with a maximum of 21. 9℃ (July) and a minimum of - 9. 2℃ (January), and the mean annual precipitation is 113. 4 mm<sup>[7,8]</sup>. Since we are dealing with arid regions there are considerable variations in mean annual precipitation. Rainfalls are abundant in the summer season mainly. Mean

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**Biography** Q I Shan-zhong (1972-), Male, Han Nationality, from Zhangqiu County of Shandong Province, PhD. of Science major in soil geography and land resources, land desertification, published 20 research papers, among which 14 was published by myself and 1 was embodied by SCI  
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potential evaporation is 2 341 0 mm /a The soil types are various, mainly alluvial deposits and Gobi soils A cording to the CST<sup>[5]</sup>, the soils of the study area are divided into 4 soil orders, namely, Anthrosols, Aridisols, Gley soils and Cambisols, 4 soil suborders, 5 soil groups, 8 soil subgroups and 12 soil series.<sup>[8]</sup>

2 2 Data resources

There have been seven soil series relating to oasis farmlands, that is, Lanjiabao, Nijiaxiaying, Dongsancun, Huayin, Wusancun, Caojiazhuang and Panshiying. Their characteristics are prescribed in the table 1<sup>[7]</sup>.

Table 1 Types and characteristics of soil series in the study area

Soil series types	Soil characteristics
Lanjiabao	A thickness of siltic epipedon more than 80 cm; the contents of organic carbon (OC) and total nitrogen (TN) are 11.6 (7.7~20.8) g/kg and 0.9 (0.6~1.5) g/kg respectively; the ratio of carbon and nitrogen (C/N) is 12.5; the cation exchange capacity (CEC) is 11.7 Cmol(+ ) g/kg; lumpy structure.
Nijiaxiaying	A thickness of siltic epipedon 50~80 cm; OC 9.0 (7.0~10.4) g/kg; TN 0.9 (0.7~1.0) g/kg; C/N 0.5; OEC 8.7 Cmol(+ ) g/kg; lumpy structure.
Dongsancun	The color of soil is very light; OC 9.2 (7.3~11.1) g/kg; TN 0.8 g/kg; C/N 1.5; CEC 7.0 Cmol(+ ) g/kg; the below solum of bamy texture soil has the oxidation-reduction characteristic.
Huayin	The surface of soil has salt efflorescence; OC 9.0 (7.4~10.4) g/kg; TN 0.9 g/kg; C/N 9.9; CEC 10.5 Cmol(+ ) g/kg; the below epipedon of bamy texture soil has the oxidation-reduction characteristic.
Wusancun	The siltic epipedon is very thin; OC 5.8 (3.3~7.4) g/kg; TN 0.6 g/kg; C/N 9.3; CEC 9.3 Cmol(+ ) g/kg; having a leaking sand epipedon with oxidation-reduction characteristic.
Caojiazhuang	A thickness of siltic epipedon 20~50 cm; OC of surface epipedon 7.6 (7.1~8.4) g/kg; TN 0.7 g/kg; C/N 10.5; OEC 9.6 Cmol(+ ) g/kg.
Panshiying	A thickness of siltic epipedon 20~50 cm; OC of surface epipedon 8.7 (6.6~10.8) g/kg; TN 0.8 g/kg; C/N 10.6; OEC 7.2 Cmol(+ ) g/kg; having sandy or sandy gravel epipedon.

3 Results and Conclusions

The results show that there have been two applications of soil series in the study area, namely, the application in the layout of rational agriculture and the application in the soil quality of oasis farmlands.

3.1 Application in the layout of rational agriculture

Soil mantle and agricultural regional characteristic are reflected by the distribution map of soil series in the study area which are divided into three soil regions according to the

elevation 1 500 m and 1 700 m as 1 (Table 2): (1) the moderate and extremely arid region includes two soil series of Lanjiabao (main) and Nijiaxiaying and growing the crops of spring wheat and maize (main) and winter wheat; (2) the warm-cold and extremely arid region includes two soil series of Nijiaxiaying (main) and Lanjiabao and growing the crops of winter wheat (main) and spring wheat; and (3) the warm-chilly arid region included the soil series of Shangfusui mainly used as seasonal pastureland.

Table 2 Relations between combinations and diagnostic characteristics of soil series and the layout of agriculture in the study area

The divided regions of agriculture	Moderate and extremely arid region	Warm-cold and extremely arid region	Warm-chilly arid region
Elevation /m	1440~1500	1500~1700	1700~2100
A cumulated temperature for the assured ratio of 80% $\geq 0^{\circ}\text{C}$	3292~3360	3020~3292	2475~3020
$\geq 10^{\circ}\text{C}$	2757~2838	2428~2757	1774~2428
Mean annual temperature / $^{\circ}\text{C}$	6.9~7.2	5.9~6.9	3.8~5.9
Mean annual rainfall/mm	113.4~132	132~162	162~222
Annual aridity	4.58~5~4.90	3.77~4.57	2.14~3.76
Days of no frost in a year	152	145	130
Soil characteristics			
Soil temperature in the depth of 50 cm / $^{\circ}\text{C}$	9.5~10.5	8.0~9.5	<8.0
Soil moisture regions	Dry and moist (Irrigation)	Dry and moist (Irrigation)	Arid
Characteristics of soil series combinations	Lanjiabao (main) + Nijiaxiaying	(main) + Lanjiabao	Shangfusui
Characteristics of layout of crops	Spring wheat and maize (main) + winter wheat	Winter wheat (main) + spring wheat	Seasonal pastureland

3.2 Application in the valuation fror soil quality

Soil quality is defined as the capacity of a soil to function both within its ecosystem boundaries and with the environment external to that ecosystem<sup>[9]</sup>. By this definition, soil quality can be specifically related to its ability to function as a medium for plant growth, in the partitioning and regulation of the flow of water in the environment and finally as an envirommental buffer. Soils exhibit variation in levels of quality. Such variation could be inherent (due to the factors of soil fomation) or they could be induced through the management<sup>[[11]</sup> and use of the soil series. The

overall quality of soils in the study area is determined by the individual qualities of various attributes of soil series (Tables 1 and 3) <sup>[7]</sup>

From Table 3, we conclude that in the study area the content of N in soil series is very low, however, the content of K in soil series is abundant and moreover, the content of P in soil series is greatly scarce. These results are suitable to the local oasis farmlands. It is a better insight into the sustainable land use to analyze the soil characteristics of cultivated land using soil series as research units.

Table 3 The nutrient of soil series in the study area

Soil series	Samples of soil	OC / (g° kg <sup>-1</sup> )	Total N / (g° kg <sup>-1</sup> )	Total P / (g° kg <sup>-1</sup> )	Total K / (g° kg <sup>-1</sup> )	Avaikble N / (mg° kg <sup>-1</sup> )	Avaikble P / (mg° kg <sup>-1</sup> )	Avaikble K / (mg° kg <sup>-1</sup> )	CEC Com l / (+ ) (g° kg <sup>-1</sup> )
Lanjiaobao	5	11.64	0.93	1.25	22.40	105	10	132	11.68
Nijiaxiaying	4	9.00	0.86	1.65	22.70	86	17	125	8.74
Dongsancun	6	9.20	0.80	0.50			6	122	7.02
Huayin	5	8.91	0.90	0.70				106	10.54
Wusancun	4	5.84	0.63	0.59				132	9.31
Caojiashuang	3	7.56	0.72	1.06	23.70	65	7	118	9.56
Panshiying	11	9.0	0.82	1.63	22.70	86	10	136	7.21

Soil classification plays important roles in soil survey, soil mapping and agricultural technology transfer in the light of local conditions. It is a quatitive process to value the agricultural sustainability through soil series. As one of the important research fields in soil science, soil classification

marks the advance of soil science, and may serve as the basis of soil survey and popularization of site-specific agricultural technology, as well as media of worldwide information exchange in soil science.

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