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GIES Case Dataset on Panshi Qiantang (Thousands Reservoirs) Rice in Permanent Farmland, Jilin Province of China

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Abstract: Panshi Qiantang (Thousands Reservoirs) rice is planted in the low-lying areas downstream of reservoirs and flood dam in Panshi city, Jilin province, with an area of 17,787 ha. The case area is located in the transition zone from Changbai Mountain to Songhuajing-Nenjiang Plain, a mostly hilly area. Snow-melt water and precipitation are naturally collected into reservoirs and flood dam. The soil in the rice field is mainly black soil rich in organic matter. The soil quality is better than the standard of soil environmental quality risk control value for soil contamination of

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agricultural land, and the quality of irrigation water is better than that of urban drinking water. At present, there are mainly six rice varieties planted in Panshi city, and the qualities of the rice are equal to or better than standards of Wuchang rice and Panjin rice. The case proposes a new model of black soil protection and sustainable development of permanent basic farmland. The case dataset consists of five data files: location and scope of case study area; physical geographical data; rice variety characteristics data; management data; and historical data. The data is archived in .shp, .docx, .jpg, .tif. and .xlsx formats, and 22.4 MB in size.

Keywords: Panshi city; Qiantang (Thousands Reservoirs) rice; permanent basic farmland; black soil; sustainable development; Geographical Indications for Environment & Sustainability (GIES) ; case 12

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1 Introduction

To meet increasing demand for quality agricultural products, the protection of origin of agricultural products has become more important. Agricultural modernization and intelligent agriculture of "quality geographical products" (geographical indications, geographical product with unique features, and geographical product with special traditional) came into being[1]. Panshi city is located in the central and southern part of Jilin province, in the transitional zone between the Songnen Plain and the Changbai Mountains, with unique ecological and atmospheric conditions. Panshi city has a vast area of black soil[2,3]. The paddy fields lie in the downstream of the reservoirs and ponds. The use of reservoirs and ponds for irrigation yields "Jilin Panshi Qiantang (Thousands Reservoirs) rice", a quality rice product with regional geographical characteristics.

2 Metadata of the Dataset

Table 1 shows the metadata of Panshi Qiantang (Thousands Reservoirs) rice case dataset on permanent farmland of ecosystem protection and sustainable development[4].

Table 1 Metadata summary of the Panshi Qiantang (Thousands Reservoirs) rice case dataset on permanent farmland of ecosystem protection and sustainable development[4]

Items	Description
Dataset full name	Panshi Qiantang (Thousands Reservoirs) rice case dataset on permanent farmland of ecosystem protection and sustainable development
Dataset short name	PanshiRiceCase12
Authors	Song, X. F. 0000-0001-5244-1113, Institute of Geographic Sciences and Natural Resources Research, CAS (IGSNRR/CAS), songxf@igsnrr.ac.cn Yu, J. Q., Panshi Municipality, 1539549166@qq.com Qi, W., Panshi Municipality, 931300049@qq.com Wang, Z. X., Panshi Agriculture and Rural Affairs Bureau, pssnyj@163.cm Qiao, Y. B., Panshi Agriculture and Rural Affairs Bureau, 1104335154@qq.com Yang, L. H. 0000-0002-4580-4972, IGSNRR/CAS, yanglihu@igsnrr.ac.cn Yao, D. X. 0000-0003-2274-0918, IGSNRR/CAS, yaodongxu@igsnrr.ac.cn Fu, J. Y., IGSNRR/CAS, fujy@igsnrr.ac.cn Du, X. L., Jilin University, duxinglin2004@163.com Wu, F., Panshi Supply and Marketing Investment (Group) Co., Ltd., 1271138685@qq.com Liu, H. B., Institute of Agricultural Resources and Regional Planning, CAAS, liuhongbin@caas.cn Zhu, X. G., BeijingTianhangHuachuang Technology Co., Ltd., 18510867688@163.com Chen, C. H., Panshi Agriculture and Rural Affairs Bureau, 294576808@qq.com Ren, J. X., Panshi Agriculture and Rural Affairs Bureau, 1104335154@qq.com Wu, Y. M., Futai Town, 771525172@qq.com Li, L., Niuxin Town, 438840716@qq.com

(*To be continued on the next page*)

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Geographical region	Panshi city, Jilin province.
Year	2000–2021
Data Format	.shp, .tif, .xlsx, .docx, .jpg
Data Size	22.4 MB (compressed to 7.22 MB)
Data files	Five documents (study area, physical geography, variety characteristics, management data, natural characteristics and historical and cultural traditions)
Data publisher	Global Change Research Data Publishing & Repository, http://www.geodoi.ac.cn
Address	11A, Datun Road, Chaoyang District, Beijing, 100101, China
Data sharing policy	***Data*** from the Global Change Research Data Publishing & Repository includes metadata, datasets (in the *Digital Journal of Global Change Data Repository*), and publications (in the *Journal of Global Change Data & Discovery*). ***Data*** sharing policy includes: (1) ***Data*** are openly available and can be free downloaded via the Internet; (2) End users are encouraged to use ***Data*** subject to citation; (3) Users, who are by definition also value-added service providers, are welcome to redistribute ***Data*** subject to written permission from the GCdataPR Editorial Office and the issuance of a ***Data*** redistribution license; and (4) If ***Data*** are used to compile new datasets, the 'ten per cent principal' should be followed such that ***Data*** records utilized should not surpass 10% of the new dataset contents, while sources should be clearly noted in suitable places in the new dataset[5]
Communication and searchable system	DOI, CSTR, Crossref, DCI, CSCD, CNKI, SciEngine, WDS/ISC, GEOSS

3 Dataset Development

3.1 Physical Geographic Data

3.1.1 Case Area

The case area is the paddy fields from 34 sub-watersheds in Panshi city (county-level), Jilin city (prefecture-level) of Jilin province, with an area of 17,787 ha. The Panshi city is located in the central and southern parts of Jilin province, between 42°39′N–43°27′N and 125°39′E–126°41′E. Panshi city covers an area of 3,861 km^2. It has jurisdiction over 14 towns, 3 sub-districts and 2 provincial economic development zones (Figure 1).

3.1.2 Meteorological Characteristics

Panshi city has a temperate continental monsoon climate with four distinct seasons: a dry and windy spring, a hot and rainy summer, a cool and sunny autumn, and a long and cold winter. The temperature difference between day and night is large[6,7]. Ten observation stations were established over the case area to automatically record the rice growth conditions. The indicators from the stations include water quality, soil, meteorology, vegetation, pests and diseases (Table 2).

The annual average temperature in Panshi city is 4.6 ºC, and the annual accumulated temperature above 10 ºC is between 2,578 and 3,093 ºC. The annual average precipitation is 699.6 mm, mainly in June to August. The annual sunshine hours are 2,491.2 h with

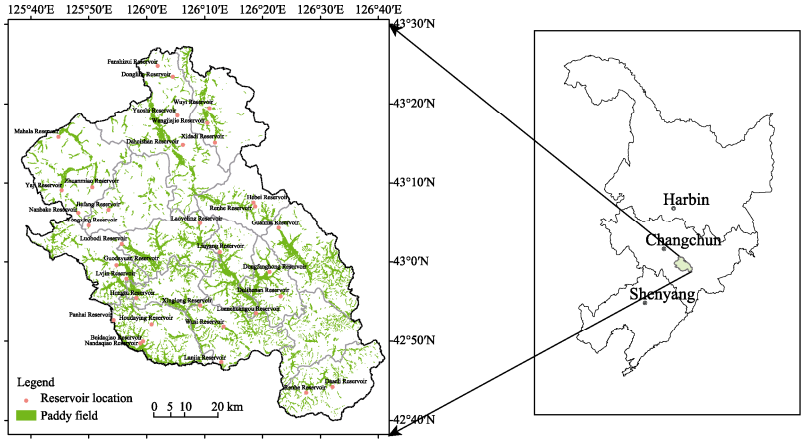

Figure 1 Geographical location and scope of the case area

Table 2 Ten observation stations in the case area

Number	Station Code	Station Name	Longitude (ºE)	Latitude (ºN)
1	402	Lanjia Monitoring Station	126.218,002,3	42.786,998,7
2	429	Baoshan Monitoring Station	126.043,998,7	42.845,901,5
3	750	Huanghe Monitoring Station	126.095,001,2	43.219,898,2
4	751	Yaji Monitoring Station	125.759,002,7	43.160,301,2
5	752	Panhai Monitoring Station	125.904,998,8	42.873,699,2
6	753	Wusi Monitoring Station	126.222,999,6	42.863,899,2
7	754	Guanma Monitoring Station	126.397,003,2	43.050,201,4
8	755	Renhe Monitoring Station	126.459,999,1	42.728,500,4
9	756	Dongfanghong Monitoring Station	126.328,002,9	42.969,398,5
10	757	Liuyang Monitoring Station	126.231,002,8	42.991,001,1

125 frost-free days by average. The annual extreme temperatures are –42.6 and 36.1 ºC, respectively.

The major part of black soil in China lies in the central plain of Jilin province (Figure 2). Of which the cultivated black soil is 12.93 million ha (Figure 4). In terms of surface slope, 68% of the cultivated black soil is in slope region (not flat). The gently sloping farmland of 2°–6°and above 6° account for half of each[2,3] (Figure 3 and Figure 4). The sub-types of the black soil are meadow soil and dark brown soil.

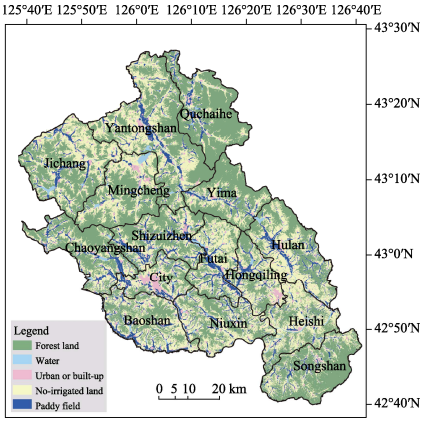

Figure 2 Land use of the case area

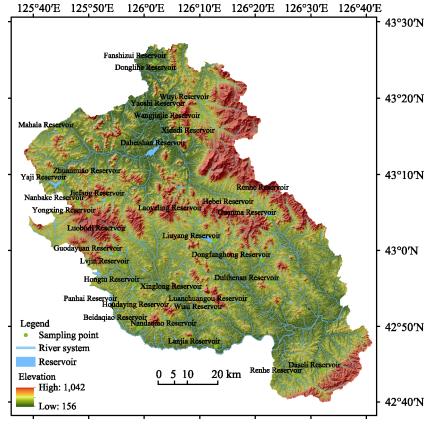

Figure 3 DEM of the case area

3.1.3 Soil Properties

A total of 39 soil samples from the case area were collected, and nitrogen content (N%), carbon content (C%), carbon-nitrogen ratio (C/N), and soil metal elements were tested by the Physical and Chemical Analysis Center of the Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences (IGSNRR/CAS). The nitrogen (N) content was about 0.12% to 0.48%, the carbon (C) content was about 1.16% to 7.11%, the C/N was 9.63 to 14.81, and the organic matter content was between 1.89% and 12.49% (Table 3).

The soil metal contents in the case area are far lower than the soil pollution risk screening value of the corresponding paddy field in the soil environmental quality standard (GB 15618—2018). Therefore, the soil in the area is rich in organic matter, high in nitrogen and carbon, and low in harmful heavy metals (Table 4).

Table 3 Soil carbon, nitrogen and organic matter in the case area

Statistics	N/%	C/%	C/N	Organic matter/%
Max	0.48	7.11	14.81	12.49
Min	0.12	1.16	9.63	1.89
Mean	0.21	2.20	10.72	3.68

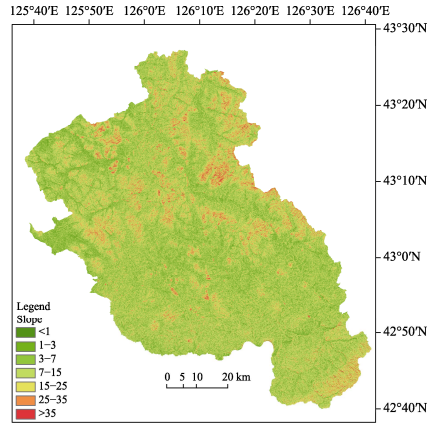

Figure 4 Slope of the case area

3.1.4 Water Resources and Quality

There are abundant water resources in Panshi city. The average annual water resource is 893 million m^3, with 781 million m^3 from surface water, and 112 million m^3 from groundwater. The two major rivers in the case area are the Huifa river in the south and the Yinma river in the north, divided by the Hadaling Mountains. There are 65 sub-rivers in the case area, with a total drainage area of 3,867.31 km^2 (Figure 5). The average annual rainfall is 719 mm, decrease gradually from southeast (803 mm) to northwest (624 mm).

Table 4 Soil element contents in the case area and comparison against national standard

Elements	Max	Min	Mean	Soil environmental quality standard (Screen value) GB 15618
Al (mg/kg)	113,035.83	18,529.53	46,802.13	–
Ba (mg/kg)	1,594.86	250.74	642.75	–
Ca (mg/kg)	11,246.70	1,409.85	6,117.49	–
Co (mg/kg)	30.14	6.83	16.03	–
Cu (mg/kg)	33.28	8.41	21.09	100
Fe (mg/kg)	24,298.13	7,280.82	14,995.63	–
K (mg/kg)	32,943.00	12,347.73	20,665.66	–
La (mg/kg)	78.00	1.56	28.37	–
Li (mg/kg)	74.45	21.76	39.99	–
Mg (mg/kg)	40,074.33	4,257.30	13,064.31	–
Mn (mg/kg)	1,892.31	280.46	838.73	–
Na (mg/kg)	25,248.96	8,857.01	14,550.36	–
Ni (mg/kg)	52.24	14.08	31.01	100
P (mg/kg)	1,895.49	498.72	951.52	–
Sc (mg/kg)	24.75	6.36	11.66	–
Sr (mg/kg)	286.73	53.12	144.70	–
Ti (mg/kg)	8,173.87	2,570.93	5,292.86	–
V (mg/kg)	133.58	48.41	95.04	–
Zn (mg/kg)	133.07	40.37	82.13	250
Hg (mg/kg)	0.06	0.02	0.03	0.6
As (mg/kg)	14.98	4.46	8.50	25
Pb (mg/kg)	79.92	16.55	35.89	140
Cr (mg/kg)	138.37	32.00	72.00	300

There are 794 water storage projects in Panshi city: 4 medium reservoirs, 23 small-I reservoirs, 133 small-II reservoirs, and 634 ponds and dams, with a total water storage capacity of 130 million m^3[6,7]. Reservoirs and ponds are used as the main irrigation water sources in the rice planting area, and there are no polluting factories and enterprises in the case area. We tested the water qualities from three water sources: reservoir, groundwater and snow in Panshi city. The indicators included 25 elements and ions such as aluminum, arsenic, and boron. It can be found that all indicators of water quality are better than the urban drinking water supply standards (Table 5).

3.2 Rice Characteristic Data

3.2.1 Rice Varieties

Based on the local planting habits and rice quality performance[8–12], six rice varieties were selected, including: Daohuaxiang-2, Changle-520, Jinongda-667, Jida-518, Tongyu-269, and Jihong-6. Rice seeds are purchased by Panshi Agricultural Materials Station to ensure the quality. Rice cultivar characteristics are briefed below (Figure 6).

(1) Daohuaxiang-2

Plant height is 90–100 cm with strong and concentrated tillers, neat, erect leaves, dark green leaves, no awn, seed coat light brown. Ear length is 21.6 cm, an ear mature grain is 130 and average seed setting rate is 90%–92%. It belongs to a kind of japonica rice with oval grains, and the thousand-grain weight is 26.8 grams. The rice has the characteristics of good quality, good palatability, stickiness, non-regeneration, and clear fragrance. It is disease resistance and lodging resistance. The growth period is between 138 and 140 days, and the active accumulated temperature is 2,700–2,800 ºC. The yield is about 7,500 kg/ha.

(2) Changle-520

Plant height is 111.6 cm, with compact plant type, strong tillering ability, raised flag leaves, and green stems and leaves. Panicle length is 22.4 cm, the average panicle grain is 122.3, and the seed setting rate is 90.9%. With long grain shape, golden glume and no awn or short awn, the 1,000 grain weight is 25.8 g. The taste value is 89.76. From 2018 to 2019, artificial inoculation of bacterial strains at seedling stage and multi-point natural induction at adult stage were adopted for two consecutive years. The identification results showed that it was moderately susceptible at seedling stage, moderately resistant to leaf blast and susceptible to ear blast. Among the 16 effective identification points of natural induction of sheath blight in the field from 2018 to 2019, the highest disease level was 7, showing moderate susceptibility. Growth period is 136 days, and the accumulated temperature is about 2,720 ºC (above 10 ºC). The yield is about 8,000 kg/ha.

(3) Jinongda-667

Plant height is 113.6 cm, with compact plant type, strong tillering ability, upright flag leaves, and green stems and leaves. Ear length is 19.6 cm with semi erect ear type. The average ear grain is 143.1 and seed setting rate is 87.3%. With oval grain, yellow glume and no awn, 1,000 grain weight is 23.6 g. From 2016 to 2018, artificial inoculation of bacterial strains at the seedling stage and natural induction identification at multiple places in the disease area at the adult stage were used for three consecutive years. The results of disease resistance identification showed

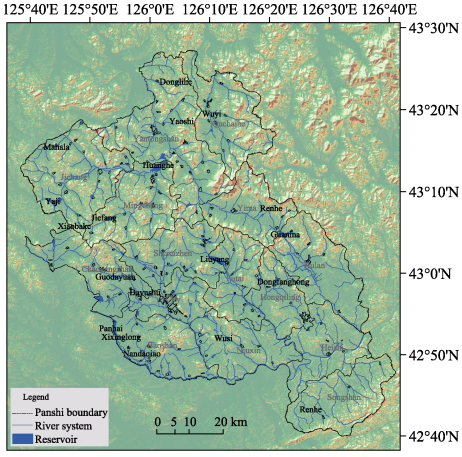

Figure 5 Hydrological system of the case area

that the seedling blast was moderately susceptible, the leaf blast was moderately resistant and the ear blast was susceptible. Among the 19 effective identification sites naturally induced by sheath blight in the field from 2016 to 2018, the highest disease grade was grade 5 and showed moderate resistance. The growth period is 137 days, and the accumulated temperature is about 2,740 ºC (above 10 ºC). The yield is about 9,500–10,000 kg / ha.

(4) Jida-518

Plant height is 109.8 cm with compact plant type, strong tillering ability, raised flag leaves, and green stems and leaves. Ear length is 18.7 cm with half-curved ear type. The average number of grains per ear is 123.7, and seed setting rate is 82.1%. With oval grain, glume and glume tip yellow, occasionally sparse short awn, 1000-grain weight is 26.0 g. From 2012 to 2014, artificial inoculation of mycobacteria at the seedling stage, and natural induction and identification of multiple points in the ward at the adult stage were used. The results showed that it showed moderate resistance to seedling blast, moderate resistance to leaf blast, and moderate sensitivity to ear blast. Among the 20 effective identification points for natural induction of sheath blight resistance in the field from 2012 to 2014, the highest disease grade was grade 5, showing moderate resistance. The growth period is 143 days, and the accumulated temperature is about 2,850 °C (above 10 °C). The yield is about 8,500 kg/ha.

(5) Tongyu-269

The plant height is 102.8 cm with moderate plant type, strong tillering power, erect and raised flag leaves, and green stems and leaves. Ear length is 19.2 cm, with partial semi-curved ear type. The average ear grains are 154.5, and seed setting rate is 89.8%. With oval grain, glume yellow and no awn, 1000-grain weight is 23.3 g. From 2015 to 2017, artificial inoculation of seedling stage mycobacteria was used, and multi-point off-site natural induction identification in adult-plant stage wards. The results showed that the seedling blast showed moderate resistance, leaf blast showed moderate resistance, and panicle blast showed moderate resistance. Among the 19 effective identification points of natural induction of sheath blight in the field from 2015 to 2017, the highest disease grade

Table 5 Irrigation water quality from three sources in Panshi city and comparison against national standard

Index	Groundwater	Reservoir	Snow	Urban drinking water supply standard
Al (mg/L)	0	0	0.02	0.2
As (mg/L)	0	0	0	0.01
B (mg/L)	0.01	0.01	0	0.5
Ba (mg/L)	0.03	0.03	0.01	0.7
Ca (mg/L)	70.08	27.70	5.46	–
Cd (mg/L)	0	0	0	0.003
Co (mg/L)	0	0	0	–
Cr (mg/L)	0	0	0	0.05
Cu (mg/L)	0	0	0	1
Fe (mg/L)	0	0.01	0	0.3
K (mg/L)	3.37	2.93	0.91	–
Li (mg/L)	0.00	0	0.00	–
Mg (mg/L)	10.19	5.35	0.78	–
Mn (mg/L)	0	0.01	0	0.1
Mo (mg/L)	0	0	0	0.07
Na (mg/L)	19.33	7.26	1.60	200
Ni (mg/L)	0	0	0.00	0.02
P (mg/L)	0.06	0.04	0.04	–
Pb (mg/L)	0	0	0	0.01
Se (mg/L)	0	0	0	0.01
SiO_2 (mg/L)	23.77	4.68	1.42	–
SO_4^{2-} (mg/L)	26.18	18.22	2.85	250
Sr (mg/L)	0.30	0.14	0.03	–
V (mg/L)	0	0	0	–
Zn (mg/L)	0.02	0	0.01	1

was 5, showing moderate resistance. The growth period is 140 days, and the accumulated temperature is about 2,800 ºC (above 10 ºC). The yield is about 8,000–8,500 kg/ha.

(6) Jihong-6

Plant height is about 103.7 cm, with compact plant type, strong tillering ability, raised sword leaves, and green stems and leaves. Ear length is about 17.3 cm, with loose ear type, neat main tillers and ears. The average ear grain is 100.5, and the seed setting rate is 88.8%. With oval grain, yellow glume and glume tip and sparse top awn, 1000-grain weight is 25.4 g. From 2011 to 2013, the strains were artificially inoculated at the seedling stage and naturally induced in different places in the disease area at the adult stage. The results showed that they were moderately resistant to seedling blast, moderately resistant to leaf blast and sensitive to ear blast. Among the 20 effective identification sites for natural induction of resistance to sheath blight in the field from 2011 to 2013, the highest disease grade was grade 7, showing moderate susceptibility. The growth period is 138 days, the accumulated temperature is about 2,800 ºC (above 10 ºC). The yield is about 7,300 kg/ha.

Figure 6 Sensory characteristics of six rice varieties in case area

3.2.2 Nutritional Quality of Panshi Qiantang (Thousands Reservoirs) Rice

Nutritional qualities of Panshi Qiantang rice were tested by two units: the Grain and Product Quality Supervision, Inspection and Testing Center (Harbin) of the Ministry of Agriculture and Rural Affairs; and Jiangsu Shipu Testing Service Co., Ltd. (Table 6). According to Table 6, the chalkiness of the six rice samples are between 1.4% and 4% and adhesive strength reaches to 81–98 mm. Referring to the national quality rice standard (GB 17891—2017), the chalkiness of the first-class rice is lower than 2% and that of the second-class is 2% to 5%. All the Panshi Qiantang rice samples except for the Daohuaxiang-2, meet the national standard for first-class rice.

Comparing against the national standard for rice in Wuchang (GBT 19266—2008) and for rice in Panjin (GBT 18824—2008), the quality of Panshi Qiantang rice is far better than the specified value of Wuchang rice and Panjin rice in the three indicators of chalkiness degree, percentage of grains with chalkiness, and adhesive strength. In terms of amylose index, four of the six varieties of Qiantang rice have the equivalent quality as Wuchang rice and Panjin rice, with Tongyu-269 and Daohuaxiang-2 having slightly lower amylose index.

3.3 Management Data

“Qiantang (Thousands Reservoirs) rice” was registered as a trade mark in 2020 (Figure 7).

3.3.1 Rice Planting Management

Panshi city has established a "Qiantang rice" production leading group, with the party committee secretaries of all towns as the group leaders and village secretaries and staffs as the team members, to ensure the standardization of rice cultivation.

Table 6 Nutrition of six Panshi rice samples and comparison against two national standards

Indicators	Jida 518	Jihong 6	Jinongda 667	Tongyu 269	Daohuaxiang 2	Changle 520	Wuchang rice GBT 19266—2008	Panjin rice GBT 18824—2008
% of grains with chalkiness	6	8	5.5	3.5	7.5	7	≤15	≤30
Chalkiness degree	1.5	1.9	1.9	1.4	4	1.7	≤5	≤5
Adhesive strength (mm)	81	82	89	98	95	94	≥70	≥60
Alkali spreading value	7	7	4.6	4.7	5.3	5.1	–	–
Amylose content	15.42	15.26	15.6	13.2	14	17.1	15–20	15–20
Thousand seed weight	23.2	22.9	18.7	18	22.8	22.9	–	–

Professionals are assigned to be responsible for rice production, and rice cultivation technicians are invited to the field to guide and demonstrate rice planting. The main process of rice planting is recorded and archived for traceability. Some specifications for rice production have been established, including: planting, irrigation, fertilization, acquisition, storage, pest management, and natural disaster response.

The main measures of Qiantang rice cultivation in Panshi city are as follows:

(1) Rice field selection. The air quality should meet the ambient air quality standard (GB 3095). The soil quality should conform to the land environmental quality—agricultural soil pollution risk management and control standards (GB 15618). Irrigation water must meet the water quality standard for farmland irrigation (GB 5084). The environment of rice production areas must meet the environmental quality standards of green food production areas (NY/T 391—2021).

(2) Rice variety selection. After multiple screening, 6 rice varieties were selected for planting, namely: Daohuaxiang-2, Changle-520, Jinongda-667, Jida-518, Tongyu-269, Jihong-6.

(3) Rice seed treatment and seedling technique. The quality of seeds should meet the national first-class standard set by GB 4404.1—1996, Seed needs to be sun-dried outdoors in late March, laid 8–10 cm thick under the sun, sun-dried for 2–3 days, and turned 3–4 times each day. Seeds should be selected with salt water or yellow mud water with a density of (1.08–1.13) $\times 10^{-6}$ kg/L. In the early and middle of April, the rice seeds were soaked and disinfected, and the germination was accelerated under appropriate temperature and moisture. This process is carried out according to the production, processing, identification and management standard of organic products (GB/T 19630—2019).

(4) Field technique. (a) Fertilization: carry out deep ploughing in autumn, and transplant rice in late May. The paddy fields that produce A-grade green food rice should apply organic fertilizers only. (b) Irrigation: reasonable irrigation of high-quality rice should be shallow water transplanting, deep water seedling protection, shallow water tillering promotion, deep sun drying and tiller control, deep water protection of tires, and intermittent grain increase, so as to save water while maintaining yield and quality. (c) Pest and disease control: follow the national standard GB/T 19630—2019 comprehensive management of pests and diseases and NY/T 393—2020 guidelines for the use of pesticides in green food. Place a frequency-vibration insecticidal lamp every 4 ha in the field to trap and kill rice borers.

(d)Weed control: manually, and stock ducks in paddy fields.

3.3.2 Rice Harvesting and Processing

(1) Harvest and storage management. The rice should be harvested in time after maturity, and the threshing should only be conducted when the moisture content of the rice drops to 15%, so that the moisture content can be kept at a lower level. The packaging of Grade A green quality rice shall comply with the national standard GB/T 17109. Different varieties should be treated separately, and their transportation, storage, and processing must comply with the NY/T 5190 standard.
(2) Rice processing enterprise selection. Only qualified rice enterprises can conduct rice processing and they should follow the national standards of GB1354—2009, GB 5490—1985, and GB/T 5539—1985.

Figure 7 The trademark of Panshi Qiantang rice

3.3.3 Qiantang Rice Traceability System

(1) Scope of traceability: geographical location, time, and quality.
(2) Traceability data: In the origin of Qiantang rice, the traceability data mainly includes three categories: planting, processing and storage.

Planting: farmer name of rice fields, soil, water, rice varieties, fertilizer and pesticide use.

Processing: qualification of the rice enterprises, site environment, and standards adopted.

Storage: warehouse environment, finished grain batch, check-in time, check-out time, operator, and quality inspection information of finished grain.

3.3.4 Product Business Promotion

(1) Product positioning: green, eco-friendly, organic, and healthy rice.

(2) Production model: double layer structure, i.e., rural comprehensive service cooperatives (village level), and supply and marketing groups (county level).

(3) Sales model: village comprehensive service cooperatives (village collective economic organizations), cooperatives and order sales, aided by traceability system.

(4) Brand management: based on the product positioning of "Qiantang rice", strictly manage the rice cultivation environment.

3.4 Social Economy and Rice Cultivation History

3.4.1 Population and Economy Development of Panshi City

According to the census data of China in 2010 and 2020, the population of Panshi city has decreased from 405,779 in 2010 to 370,238 in 2020, a drop of 135,541 or 26.80% over 10 years. The shrink of rural population is as serious as that of urban population (Table 7).

Table 7 Population changes in Panshi city from 2010 to 2020

	Total population	Urban population	Urban %	Rural population	Rural %
2010	405,779	231,004	45.67	277,775	54.92
2020	370,238	163,592	44.19	206,646	55.81
Difference	–135,541	–67,412	–1.48	–71,129	0.89
Change (%)	–26.8	–29.81	–3.24	–25.6	1.62

Meanwhile, the GDP of Panshi city has also dropped, yet the primary industry is relatively stable. The grain area (102,670–11,2571 ha, +9.6%) and yield increased slightly, and the rice area (20,785–17,787 ha, –14.42%) and yield decreased slightly (Table 8).

3.4.2 Rice planting history in Northeast China

Rice has been planted in Northeast China for a long time. According to the New Book of Tang—Bohai Biography, there was rice from Lucheng during the Tang dynasty over 1,300

years ago[13]. In 1910, Korean peasants moved to Panshi. In 1917, a Korean farmer at Da-an-tun, Chaoyangshan (now Chaoyangshan Town), opened a 12-mu (12×667 m^2) paddy field. Since 1949, Panshi county has been encouraging rice cultivation. In late 1980s, rice replaced corn as the staple food of local people.

Table 8 Agricultural economy in Panshi city from 2010 to 2020

	GDP ($\times10^4$ yuan)	The primary industry ($\times10^4$ yuan)	Grain area (ha)	Grain yield ($\times10^4$ tons)	Rice area (ha)	Rice yield ($\times10^4$ tons)
2010	242.9	37.8	102,670	63.02	20,785	13.2
2020	129.3	37.7	112,571	75.6	17,787	12.7
Difference	–113.6	–0.1	9,901	–12.58	–2,998	–0.5
Change(%)	–46.77	–0.26	9.6	–19.96	–14.42	–3.78

Rice seedling raising and cutting technique also experienced a series of innovations. (1) in 1949, rice planting was mainly scattered, and seedling raising and transplanting accounted for only 10%. In 1952, seedling raising and transplanting reached 50%. By 1958, all old paddy fields were using seedling raising and transplanting. (2) Seedling raising method: before 1949, it was waterbed seedling raising. In 1958, wet seedling raising was promoted. By 1965, wet seedling raising had been normally used. (3) Plant spacing and row spacing: There was no plant spacing and row spacing before 1952. The 20 cm×20 cm spacing came into being since 1952 and became popular in 1965. Meanwhile the 30 cm×10 cm spacing was also accepted by some places. (4) Seedling technique: In 1965, plastic film seedling was used; in 1975, greenhouse seedling was used. In 1985, greenhouse plate seedling was used. Since 2000, rice varieties in Panshi city gradually tended to be of high quality[14].

4 Discussion and Conclusion

The habitat of the case product (Qiantang rice) is located in the black soil region in northeast China. The unique geographical environment has given birth to quality rices with regional characteristics in Panshi city, Jilin province. But there are still some issues that need further research.

4.1 The Standardized Management of Qiantang Rice

While the current national standards are relatively comprehensive for rice planting management, the industry standards and local standards tailored to Qiantang rice are still lacking, including: irrigation water quality standards for Qiantang rice, planting standards for different varieties of rice, standards for water-soil-farmland ecosystems in different planting areas, standards for cultivation and screening of Qiantang rice seed resources, integrated standards for production, processing, and transportation traceability of Qiantang rice.

4.2 Black Soil Protection and Sustainable Use

Panshi Qiantang rice is planted in the permanent farmland of black soil. To prevent soil fertility from decline and conserve the growth environment, the following issues need to be further studied: return rice straw to field after treatment, implement rotation by different varieties, conduct land fallow and conservative tillage, uplift soil organic matter, balance soil nutrients.

4.3 Outflow and Return of Rural Population

The main cause of population outflow in Panshi is lack of employment opportunities. This case study offers a novel way to solve this problem. The planting, processing, transportation, management and other links of Qiantang rice management can provide jobs, enable farmers

to work in their hometown to obtain appropriate income, attract migrant workers to come back, promote local economic development, and gradually alleviate the problem of population loss.

Author Contributions

Song, X. F., Yu, J. Q., Qi, W., Wang Z. W. and Fu, J. Y. designed and coordinated the case study. Yang, L. H. and Yao, D. X. analyzed the dataset and wrote the manuscript. Qiao, Y. B., Chen, C. H. and Ren, J. X. compiled the dataset. Chen, C. H., Wu, Y. M., Li, L., Zhang, L. J., Yao, L. P., Zheng, F., Yan, G. D., Zhang, C. M., Piao, R., Li, E. G., Guo, C. H., Sun, Z. G., Gu, Q., Zhou, L. G., Sun, H. F., Hu, H. Y. and Li, H. S. sampled the rice and ecological elements, maintained the monitoring stations, and offered case management information. Du, X. L. provided data of rice varieties and quality. Liu, H. B. reviewed the basic farmland data. Zhu, X. G. provided real-time monitoring data. Yang, L. H., Yao, D. X. and Fu, J. Y. provided rice quality and soil elements data. Wu, F. provided information on management and marketing of Qiantang rice.

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Conflicts of Interest

The authors declare no conflict of interest.

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