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CONSERVATION AND SUSTAINABLE MANAGEMENT OF BLACK SOIL IN JILIN PROVINCE

JULY 2024

SDGs:

Country:	The People's Republic of China
Project Code:	TCP/CPR/3806
FAO Contribution:	USD 200 000
Duration:	1 July 2021–31 December 2023
Contact Info:	FAO Representation in China FAO-CN@fao.org

Implementing Partner

Ministry of Agriculture and Rural Affairs.

Beneficiaries

Farmers, cooperative representatives and extension officers.

Country Programming Framework (CPF) Outputs

CPF 2021 – 2025

Priority 1: Supporting people and prosperity and better production and better nutrition through rural revitalization.

Priority 2: Protecting planet and better environment through a sustainable and resilient agrifood systems.

Priority Areas

Better Environment (BE) 3: Biodiversity and ecosystems services for food and agriculture.

Background

Black soils cover around 1.03 million square metres in Northeast China and produce between 22.5 and 25 million tonnes of commercial grains annually. However, unlimited exploitation and unsustainable farming practices on these fragile soils through intensive tillage, which has led to depriving the land of soil organic carbon (SOC), as well as excessive removal of organic matter and unregulated use of chemical fertilizers over the past few decades have produced significant land degradation, nutrient imbalance and an annual average loss of 0.3-1.0 cm of the black soil layer. Due to its inherent fertility, recovering black soils is essential to ensure food security in China, and maintaining SOC is crucial to enhance black soils resilience against droughts and extreme temperatures caused by climate change. Jilin Province in Northeast China is one of the most affected, given that great part of the area is rich in black soils. Although the government implemented several regulations, the province is facing several technical challenges to increase SOC and return crop residues to the land.

In order to address this situation, this project aimed to develop sustainable and appropriate technical guidelines and policy recommendations to improve black soils management in Northeast China, which would contribute to food security and sustainable production systems.

The project also aimed to provide potential technical and management options from the International Network of Black Soils (INBS) in order to test them in the field.

Impact

The project contributed to sustainable and safer food production systems, resource conservation and improved livelihoods of local farmers through the introduction of sustainable agricultural practices, the reduction of chemical fertilizers and the inclusion of appropriate technologies. Provincial institutional capacities were increased in black soil conservation techniques and advanced land management, which helped increase arable land quality and protect agrifood systems and the environment. Furthermore, using fewer chemicals and new technologies enhanced yields and increased farmers' incomes, while establishing sustainable development models in the target province.

Achievement of results

All the project outputs were successfully completed and provided positive results. Several suitable techniques to manage and use crop residues as natural fertilizers were identified and tested through surveys, exchanges with experts and pilot activities. As a result, and after proving positive results in decreasing greenhouse gas emissions and chemical fertilizers, enhancing water use efficiency and improving the land properties, three techniques were selected to return maize straw to the land. The type of technique (mulching, rotary-pulverizing or deep ploughing) was implemented depending on land properties and regional climate conditions.

In addition, a domestic exchange and a capacity-building trip were conducted, in which the exchange team performed some on-site inspections of black soil protection work in the three provinces and autonomous regions of Heilongjiang, Liaoning, and Inner Mongolia. During this activity, extension officers gained a deeper understanding and experience on local advanced land management and black soil protection technology. Furthermore, the experts also provided detailed suggestions on black soil conservation to be considered by the provincial government.

Regarding the elaboration of a database for monitoring purposes, a total of 374 soil samples was collected in Lishu County and 174 soil samples in Yongji County. All samples were analysed to identify the soil quality from different dimensions such as soil pH, bulk density, organic matter content or total nitrogen content, and the surveys' findings were used to feed the monitoring and information management system and to provide support for nutrient management decisions.

As part of Output 3, a four-session technical training course was conducted on black soil protection techniques and its required technologies, adapted to the Province of Jilin. A total of 467 farmers, cooperative representatives and institutional stakeholders participated in this training, of whom 167 were women.

By the end of the project, a meeting for stakeholders and government counterparts was carried out to summarize the project's achievements and provide recommendations for a research report on all relevant topics, such as technical training, planting residues (maize straw), database elaboration, and the evaluation of the regional arable land quality.

Implementation of work plan and budget

All activities were completed within the initial budget, which was sufficient and appropriate to carry out all the outputs. However, due to some delays caused by the COVID-19 pandemic situation, it was required to request and approve a no-cost extension until December 2023, in order to complete all the field activities and the four-session training course. The project did not pose any social or environmental risks and all stakeholders and government counterparts worked in close collaboration with the project's management office to evaluate any possible risks to the project, such as the constraints of the COVID-19 pandemic. Mitigation plans and measures were implemented as needed.

Follow-up for government attention

The activities produced positive results; however, it was highly recommended to continue monitoring a range of soil quality values in the region to protect the fields, as follows: i) the soil pH in the plough layer was gradually decreasing, so it was advised to conduct further research on soil pH changes and its causes; ii) it was suggested to study how changing the application of nitrogen fertilizers and the use of organic fertilizers will benefit the land in the longer term; iii) the plough layer of black soil in Yongji County was relatively thin and low quality, and seemed to be decreasing, so it was highly recommended to conduct technical research and start conversations on how to break through barriers and deepen plough layers in the shallow and thin barrier layer, to improve production and yield potential when using technologies.

The technical guidelines developed during this project will be further distributed to other black soil conservation entities in the project counties. It is recommended that responsible authorities use the guidelines available for future capacity-building trainings and that all partnerships continue to operate and spread the project's results.

Sustainability

1. Capacity development

Both the national government and Jilin provincial governments enhanced their capacities to protect black soils through the project. The Province of Jilin created a leading group formed by 31 departments to manage and promote food security and black soil protection under the lead of the provincial party secretary and the provincial governor. Several trainings were conducted for farmers and agricultural extension officers to increase their knowledge and skills in sustainable agricultural practices that will protect black soils and rural livelihoods. The training materials and technical manuals developed under the project will be available for all beneficiaries for future reference, and for further trainings and capacity-building activities at the Provincial Soil and Fertilizer Station and the Provincial Academy of Agricultural Sciences.

Now that participating institutions have increased their capacities and several partnerships have been established at national and local levels, the existing legal framework to protect black soils will ensure the results sustainability and the achievement of further national goals.

2. Gender equality

The project was designed to promote and mainstream gender equality at all stages, especially during the workshops, which were expected to receive at least a 20 percent participation rate of women. During the four training sessions conducted in Yongji County, Gongzhuling, and Lishu County for a total of 467 participants, 167 were women, representing 35.76 percent of participants and reaching the highest participation rate during the second session, where almost half of the participants were women. At the other training sessions, women participation rates reached: 34.72 percent at the first session, 35 percent at the third session and 20.59 percent at the fourth session. Furthermore, women trainees received the same opportunities and platforms as men and acquired the same capacities on black soil protection and its related technologies. Some women even took the initiative to participate in demonstrations.

3. Environmental sustainability

This project focused on protecting black soils through the elaboration of a database and a survey to assess the typical regional arable land quality. Several changing trends of black soil quality were found and sent to the county agricultural technology extension departments, which studied the data to provide scientific support and protection during the use of black soils. In addition, the project implemented a sustainable resource management system based on reusing local agricultural waste as natural fertilizer, which decreased the use of chemicals and promoted healthier food systems, while increasing yields and crop quality. Thus, the project helped protect the environment in the short and long-term and set the groundwork for other counties and regions to transform their agricultural systems.

4. Human Rights-based Approach (HRBA) – in particular Right to Food and Decent Work

Since the project helped implement sustainable and safer food production systems through the introduction of appropriate technologies and the reduction of chemical fertilizers in the Province of Jilin, it provided a direct access to safer and healthier foods, while increasing yields by seven percent and improving working conditions and income for farmers.

5. Technological sustainability

The project provided black soil protection techniques and appropriate technology to plough, mulch and rotary-pulverize maize straw and return it to the fields, which is an ecological technique based on many years of experience and field observations in other parts of the world.

Together with sustainable management measures to use cleaner local fertilizers, the technology provided was highly suitable, flexible and implementable for different types of land and climate within the same province. Various questionnaires and tests proved that beneficiaries and stakeholders from the targeted province acquired the required knowledge and skills to continue performing the project's activities without further technical assistance.

6. Economic sustainability

The Ministry of Agriculture and Rural Affairs was fully involved in the project from the beginning and supported the activities through a financial investment. Both the Provincial Government of Jilin and the municipal and county governments agreed to include the project in their financial plans in order to continue allocating resources and expanding the technology to other interested regions. This project largely strengthened the sustainable cooperative relationship between provincial agricultural institutions and rural administrative departments, agricultural technology extension departments, agricultural research institutes, county governments, county-level agricultural technology extension departments, and agricultural operators, including farmers networks. Since the additional funds will be provided by several national institutions and local governments, the cost of the technology will be shared in an affordable manner, so all beneficiaries and future stakeholders will be able to benefit from it.

ACHIEVEMENT OF RESULTS - LOGICAL FRAMEWORK

Expected Impact	**Sustainable food production, resource conservation and improved livelihood of local farmers**		
Outcome	Sustainable management of black soils in the northeast China		
	Indicator	Identification of black soil sustainable management technologies.	
	Baseline	0	
	End Target	Four–five.	
	Comments and follow-up action to be taken	Based on farmer surveys, expert discussions and pilot demonstrations, the project promoted three sustainable management models to fully incorporate maize straws in black soil: i) mulching, ii) rotary-pulverizing, and iii) deep ploughing. The project organized several technical trainings for 467 extension officers from agricultural and technology sectors, representatives of cooperatives and large-scale growers. These sessions increased their capacities on sustainable options to conserve and use black soil. In addition, the project carried out a detailed survey on the quality of arable land in typical black soil areas, and its results and findings were considered to support the Black Soil Nutrient Management Decision Support System (http://saas.zjtpyun.com/login/6iGH48/7c5Mfk).	
Output 1	Suitable crop-residue management practices identified to improve the soil health and sustain productivity of black soils		
	Indicators	Target	Achieved
	Identification of sustainable crop residue management models.	Four–five.	Partially
Baseline	0		
Comments	Based on farmer surveys, expert discussions and pilot demonstrations, the project gathered and promoted the three most suitable sustainable management models for black soil in the region: maize straw fully incorporated by mulching, maize straw fully incorporated by rotary-pulverizing, and maize straw fully incorporated by deep ploughing. Due to climatic variations and environmental features across different ecological zones in Jilin Province, the three methods had different results and effectiveness rates depending on the region. Maize straw fully incorporated by rotary-pulverizing is most effective in the humid eastern area of Jilin Province; maize straw fully incorporated by deep ploughing is most effective in the central semi-humid area; and maize straw fully incorporated by mulching is most effective in the semi-arid western area.		
Activity 1.1	Assessment		
	Achieved	Yes	
	Comments	Several assessments were conducted in three towns of Lishu County (Caijia, Lishu and Wanfa), as well as in two towns of Yongji County (Wanchang and Yilaxi). Among the topics, surveys included arable land area, crop planting situation, large-scale operation modalities, farm management, straw removal, and management methods of corn residues such as soiling.	
Activity 1.2	Learning		
	Achieved	Yes	
	Comments	Through a literature review and several seminars with experts, three appropriate methodologies were chosen to return straw to the fields in Northeast China: i) full-coverage corn straw; ii) full corn straw rake return, and iii) full corn straw deep-ploughing return. A professor from Purdue University in the United States was invited to perform online lectures on land protection systems in countries where agriculture is largely developed. Approved by the Jilin Provincial Department of Agriculture and Rural Affairs, experts and agricultural technology extension officers from five project units, including the Provincial Soil and Fertilizer Station, the Jilin Chinese Academy of Agricultural Sciences, Gongzhuling Primary Agricultural Technology Extension Station, Lishu County Agricultural Technology Extension Station, and Yongji County Agricultural Technology Extension Station formed a team and performed six field visits to counties in Heilongjiang Province, Liaoning Province, and Inner Mongolia Autonomous Region. Over the course of these visits, the team conducted several exchanges on black soil protection and utilization with local experts. Furthermore, six new agricultural entities, five agricultural limited companies, and three black soil protection and utilization achievement sites were visited, covering a total area of nearly 5 000 km.	

Activity 1.3	Experiment and demonstration	
	Achieved	Yes
	Comments	The project performed several experiments to return corn straw to fields in Gongzhuling City (Jilin Province). After applying the three fully return techniques, corn yield increased by 0.32 percent–6.43 percent, while the use of fertilizers improved between 15.1 percent and 29.2 percent, and water use efficiency improved between 0.3 percent and 5.2 percent. In addition, net income increased by 900 CNY/ha2, and greenhouse gas emissions decreased by 8.5–10.9 percent. Following the application of maize straw full incorporation by deep ploughing, the actual ploughing depth increased to 35 cm, while soil bulk density in layers from 0 to 20 cm and 20 to 40 cm layers decreased by 11 percent and 6.6 percent. Organic matter content increased by 9.5 percent and 20.1 percent on each layer, and readily available nitrogen increased by 16.1 percent and 12.2 percent respectively. After applying maize straw fully incorporated by rotary-pulverizing, the application rate of nitrogen fertilizer could be reduced to 100 kg/ha2, the use of phosphorus fertilizer would be reduced to 50 kg/ha2, and potassium fertilizers to 50 kg/ha2, saving 300 CNY/ha2 in fertilizer costs and increasing yields by seven percent.
Activity 1.4	Formulation of technical guidelines and policy recommendation	
	Achieved	Yes
	Comments	During this activity, several technical manuals were elaborated on maize straw full incorporation though mulching, rotary-pulverizing, and deep ploughing.
Output 2	Black soil properties monitoring, and information management system established for black soil nutrient management decision support system	
	Indicators	Target / Achieved
	Black soil properties monitoring and information system.	One / Yes
Baseline	0	
Comments	A detailed survey was carried out on the quality of arable land in typical black soil areas in Lishu County and Yongji County. All findings and data from the survey provided useful information to feed the black soil nutrient management decision support system.	
Activity 2.1	Database	
	Achieved	Yes
	Comments	The towns of Caijia, Lishu and Wanfa in Lishu County and the towns of Kouqian, Xiyang, Beidahu, Shuanghe, Huangbai, Laxi, Chalukou, Wanchang and Jinjia in Yongji County participated in the survey of arable land quality in typical black soil areas. In Lishu county, a total of 374 soil samples was collected from 81 sampling sites. In Yongji county, 174 soil samples were collected from 41 sampling sites. All these samples were analysed and provided valuable information regarding the cultivated land area, the soil type, terrain characteristics, the thickness of soil layers in cultivated fields, soil bulk density, soil pH, soil organic matter content, soil total nitrogen content, soil available phosphorus content, soil available potassium content, soil slow-acting potassium content, and data related to the soil quality index (SQI).

Activity 2.2	Meta-analysis	
	Achieved	Yes
	Comments	The information, data and analysis results collected by the survey provided a solid base for the black soil nutrient management decision support system. Among the results, in Lishu County it was found that: - The arable land area was relatively stable, remaining between 3.8 million mu (253 333 ha) and 3.9 million mu (260 000 ha) for many years, which ensured grain production. - In the main towns of Lishu County, the thickness of the plough layer and bulk density of soils were well distributed and showed a fair quality regarding nutrients. Although in recent years the plough layer had become thinner, the soil bulk density had decreased, implementing the project helped improve and maintain a better distribution of the soil organic matter, the total nitrogen concentration rate and available phosphorus in the plough layer of the main towns. Along with some changes in regional yield levels and soil quality index, the implementation of black soil protection and management policies and technologies proved to be effective. However, during the introduction of technologies, it was recommended to build deep tillage layers to improve production and yield potential. - The soil pH in the plough layer in the region was gradually decreasing, so it was recommended to conduct further research on soil pH changes and its causes, and to study how the new approach introduced by the project, such as changing the application of nitrogen fertilizers, the new techniques to return corn straw to the field and the use of organic fertilizer will benefit the land. - Lishu County has black soil, meadow soil and chernozem as the main soil types. During the project, black soil protection policies were implemented and targeted application of restoration techniques were applied to degraded black soil. Furthermore, these protection and management policies and technology will prevent degradation in healthy black soils from other regions. Regarding Yongji County, the assessment found that: - The plough layer of black soil in Yongji County was relatively thin and low quality and seemed to be decreasing. Therefore, it was suggested to conduct a technical research and start conversations on how to break through barriers and deepen plough layers in the shallow and thin barrier layer. - Soil indicators like bulk density, pH, organic matter, total nitrogen, available phosphorus, and available potassium in Yongji County were mostly distributed in quality levels 1 to 3, indicating a strong nutrient supply capacity. The thickness of the plough layer was one of the main constraints that restricted the improvement of the quality of regional arable land. - The total nitrogen content in the soil of Yongji County showed a downward trend, so it was essential to monitor the nitrogen balance after returning straw to the fields. With albic soil, meadow soil, and paddy soil as the main soil types, there should be further emphasis on implementing black soil protection measures to diffuse the application of targeted soil barrier reduction techniques and promote the use of sustainable technologies for healthy black soils.
Output 3	Black Soil conservation and sustainable management technologies promoted and disseminated	
	Indicators	Target / Achieved
	Number of farmers and technicians that will receive trainings.	200 / Yes
Baseline	0	
Comments	Starting in August 2022, four training sessions were conducted in Yongji County, Gongzhuling, and Lishu County. A total of 467 participants attended these sessions, of whom 167 were women, representing 35.76 percent of participants.	
Activity 3.1	Technical trainings	
	Achieved	Yes
	Comments	In August 2022, the Jilin Soil and Fertilizer Station started a series of four training sessions in Yongji County, Gongzhuling City, and Lishu County, where the 467 participants who attended increased their capacities on black soil management and protection.
Activity 3.2	Dissemination workshop	
	Achieved	Yes
	Comments	On 12 December 2023, the project carried out a summary meeting to review and mainstream the technical models proposed by the project.

Partnerships and Outreach
For more information, please contact: Reporting@fao.org

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