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### (3) Soils Rehabilitation in areas exposed to recurrent floods and water-logging, Shandong Province, China

<i>Hazard</i>	Floods
<i>Hazard Impact</i>	Salinization/Alkalization of Soil
<i>Strategy</i>	Integrated measures for Soil Improvement Including Tailor-made Fertilization
<i>Agrovoc Terms</i>	Flooding; water-logging; alkaline soils; saline soils; fertilizer formulations; soil ph; wheat; cotton; soil sampling
<i>Categories</i>	Climate Change Adaptation and Disaster Risk Reduction
<i>Global Farming System</i>	Wetland Rice Based

#### Synopsis

One severe impact of recurrent flooding in Juye County in the Shandong Province is the salinization and alkalization of soils. The soil in Juye is rich in Calcium, Magnesium, ions of Chloride, sulphate and carbonate. Salt compounds, created by positive or negative ions, enhance water salinity in the soil, reducing the roots' absorptive capacity of soil nutrients. The average annual rainfall in Juye is 500 mm, which is concentrated (more 60% of the annual precipitation) in the months of July and August.

The good practice strategy for soil rehabilitation consists of a series of interrelated measures including: drainage improvements; land levelling; deep ploughing; and most importantly, based on detailed soil testing, the application of formulated fertilization which is key to the rehabilitation of local soil conditions. Soil testing focused on nutrition values and salinity. Suitable fertilizer compositions were developed in response to the specific soil conditions and predominant local cropping patterns. Local fertilizer production enterprises were hired to produce the formulated fertilization with the dual objectives of rehabilitating the soils while providing sound fertilization for the main crops used the region, mainly wheat, cotton and maize.

#### Detailed description of the Technology

##### Introduction

The cropping areas in Juye are low lying and uneven in general. The higher lying parts of land are prone to salinization, and the lower lying segments are prone to water-logging. The uneven surface structure has adverse impacts on both irrigation and drainage. By levelling the land the irrigation efficiency can be improved and the irrigation costs can be reduced.

Deep ploughing is another important way to improve the soil in the area. For a long period of time farmers have practiced shallow ploughing and this has caused the lower soil layers to harden, thus constraining the growth of crop roots. In addition it has caused the pH of the surface layer to increase above 7.5, as alkaline soil components remain in the upper layers, and this thus further affects the growth of the root systems. Therefore, deep ploughing is applied to smash the plough pan, increasing the active soil layer and reversing the alkalinisation process.

In addition the degraded soils should be regularly sluiced. During the dry season, in order to reduce soil evaporation and thus salt encroachment towards the surface, the amount of irrigation water should be increased and the application of mulching and other agronomic measures should occur. During rainy season, water with low salt content or rainwater should be used to flush the soil salinity, generally 1-2 times per season.

The above measures are a precondition for further soil improvement, which must then be based on the results of soil testing. The ultimate goal is to increase soil quality and fertility through the application of tailor made, formulated fertilization which should be applied according to the local plant patterns and targeted yields. The capacities and skills of available fertilizer factories need to be taken into account. Technical training and field days are needed for demonstration and to promote replication.

### Implementation details of the tested Technology

The practice was tested in the Nancao, Liuxi, Qian Fengqiao and Caolou villages in Qilin Township of Juye County from 2007 to 2009..

#### 1. Soil Analysis

- a) *Sampling quantity and method:* 1500 soil samples were taken from different degraded soils, using the S shape method. Every soil sample takes 15 spots and each spot is a 0-20 centimetre depth of topsoil. The sample quartering is kept after the intensive mixing.
- b) *Soil sample pre-treatment:* natural withering, smashing and bottling pre-treatment was carried out on all gathered soil samples, establishing soil sample files.
- c) *Soil sample testing:* The soil sample testing was performed in accord with common technical standards. The testing included: soil organic matter content; soil pH value; soil available nitrogen, phosphorus, potassium, zinc, boron, iron; soil salinity; as well as other tests.
- d) *Data processing and analyses:* Data processing and analyses was delivered by the laboratory, as well as the fertilization plan, including a scientific, environmentally sound and economically affordable fertilizer formula for soil rehabilitation and fertilization of the main crops on the demonstration plots.

#### 2. Application of the Formulated Fertilizer

- a) *Production of soil formulated fertilizer:* A local fertilizer production enterprise was selected and contracted to produce soil formulated fertilizer according to formulas provided by the laboratory and checked by the soil experts of the agricultural bureau.

**Table 1:** Formulated Fertilizers identified for Juye

Fertilizer Types	Crop system	Soil type	Growing period
Type I: 48% 16-N-16P-16K	wheat-cotton	Water-logged soil	Base fertilizer
Type II: 40% 30 N-5 P-5K	wheat cotton maize	Water-logged soil	Early Growing Period
Type III: 36% 31N-5Ka	maize	Water-logged soil	Corn milking period
Type IV: 57% 19N-19P-19K	wheat cotton	Water-logged soil	Base fertilizer
Type V: 48% 22 N-8P-18K	maize	Water-logged soil	Corn milking period
Type VI: Organic fertilizer	All crops	Saline and water-logged soil	Base fertilizer

- b) *Field demonstration*: Field demonstrations on demonstration plots, with a control plot, were set up and were accompanied by technical training and on-the-spot meetings. An organic-based fertilizer with a reasonable collocation of nitrogen, phosphorus, and potassium, was used as the starting point for the fertilization strategy and was then complemented with extended fertilization plans in the demonstration area.

Examples of specific fertilization applications tailored to the study areas:

- a) *Fertilization for wheat production in the area with salty water-logged soil*: for each mu wheat, 2-3 cube meter organic fertilizer (Type VI) together with 30 kg/mu of Type I as base fertilizer. At early growing period, use 20-25 kg/mu of high-nitrogen compound fertilizer (Type II). At late period, foliage top dressing, spray urea and potassium dehydrogenate phosphate (KDP).
- b) *Fertilization for cotton production in salty water-logged soil*: Adhere to the principle of "adequate base fertilizer, little sprout fertilizer, stable cotton ball fertilizer, much flower fertilizer, fill the top cover fertilizer", in accordance with the rule of cotton fertilization, increasing the organic fertilizer and potash, balance the proportion of organic fertilizer, NPK fertilizer, microelement fertilizer. Let the fertilizer play a full role for increasing yield effectively. Through the growth period, a total amount of 50-60 kg/mu formula fertilizer will be used.
- c) *Fertilization for maize production in salty water-logged soil*: The "three-period fertilization approach" is applied:
  - i. "Early growing period fertilizer" (Type II) when corn leaf age index is 30% (6-leaf seedling stage), with a total fertilizer amount about 30% of the total fertilization amount;
  - ii. "core ear bearing period fertilizer"(Type V) when the corn leaf index is 60%, (12-leaf seedling stage), fertilizer in total amount of 50% of total fertilization;
  - iii. "corn milking fertilizer" (Type III) in the corn tasseling stage after the topdressing, in amount of 20% of total fertilization.

During the entire growth period, a total amount of 40-60 kg of nitrogen formulation fertilizer is used.

### **3. Supportive Measures**

- a) *Workshops* at city and county level to discuss soil characteristics and the suitable soil fertilizer formula based on the data processing results of soil nutrient testing.
- b) *Technical training*: Two-term technical training specifically for the association personnel in the project area, so as to enhance the understanding of soil testing and formulated fertilization. Training are should be ideally held during the spring and the autumn periods.
- c) *Technical information*: After data processing and expert workshops, publication and distribution of the soil formulated fertilizer suggestion materials, to make sure that every household gets a soil formulated fertilizer suggestion card and a leaflet.

### **Impacts and performance of formulated fertilization**

According to the County Agricultural Bureau, in average, the average yields of wheat, maize and cotton have increased by 8-12% through applying formulated fertilization techniques. While the input costs for formulated fertilization remained the same as conventional fertilization pattern.

### Source of testing adaptation option

This adaptation practice has been successfully tested during 2007 -2009 in the context of Strengthening Disaster Preparedness of Agricultural Sector in China. In this project FAO and the Institute of Agricultural Technique in the county of Juye were working in promoting and conducting the soil improvement activities at the county and community level. This was done in collaboration with the county/township line agencies and local farmers. The county agricultural bureau and Shandong Agricultural Academy of Science proceeded with specific technical processing and the demonstration of formulated fertilization. Pilot testing was closely monitored and results were included into a wider option menu of potentially viable adaptation practices to drought/flood conditions, which may become more frequent and severe in the context of future climate change.

### Further Reading

Reference person responsible for the content of the GP sheet and available as contact person for the content of the GP

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### Source where practice was tested

- Project “Strengthening Disaster Preparedness of Agricultural Sector in China” TCP/PRC/3501, Report of Soil Improvement by Research Institute of Agricultural Technique in Juye County.

Photo: Air-dried soil sample pre-treatment	Photo: Soil Sampling preparation (bottling)	
		