This document is an extract from:

Liu Yonggong, Wang Xiaoli, Li Jian, Wang Li, Xiao Chuan, Baas, Stephan (2009): *Final Technical Report "Strengthening Disaster Preparedness of Agricultural Sector in China TCP/CPR 3105"*, Beijing.

(4) Improve drought and water-logging resistance of cotton cultivations in Shandong Province, China

Hazard	Drought/Water logging/Flood
Hazard Impact	Reduction of yield or crop loss
Strategy	New varieties of cotton with enhanced characteristics against drought and water logging
Agrovoc Terms	cotton; flooding; drought; double-cropping
Categories	Climate Change Adaptation and Disaster Risk Reduction
Global Farming System	Wetland Rice Based

Synopsis

The losses caused by seasonal floods in the agricultural sector in the county of Juye, in the southwest of the Shandong Province have increased during the last decade. Juye is the lowest lying area of a topographical depression zone. Rain water from the 6 nearby counties flows into Juye during heavy rainfall. Juye, while having an average of 500 mm of annual rainfall only, is exposed to high annual and seasonal rainfall variability. It is very important to increase agricultural resilience to natural disasters and floods, in particular by introducing practical and advanced agricultural technologies.

This practice introduces new, more water-logging resistant cotton varieties and includes a new transplanting technique. In contrast to traditional transplanting, this technique is not only labour-saving, but significantly improves root development, rendering cotton plants more resistant to water-logging and drought.

Detailed description of the Technology

Introduction

In the context of current climate change and natural hazards such as water-logging and drought spells, the introduction of new cotton varieties, namely *Lumianyan* No.28 and No.29 constitutes an efficient way to enhance the resilience of local farming systems, which rely on cotton as a key cash crop.

Luminayan 28 is an insect pest-resistant and drought-tolerant Bt transgenic cotton variety. Its characteristics include strong roots, tough stems, middle-size leaves and large bolls. This cotton variety matures early but not with a premature senescence, it is an incompact plant type with good aeration, appropriate fruiting site, strong boll-setting ability, high resistance to insect pests and to *Fusarium* wilt and good tolerance to *Verticillium* wilt. Overall, this cultivar has a high field potential, wide adaptability and yield stability. This variety was examined and approved in China in 2006.

Lumianyan 29 is insect/pest-resistant transgenic and water-logging-resistant cotton. Its main characteristics are short growth and development periods (around 125 days), early maturity, high fruiting site, high resistance to insect pests and to *Fusarium* and *Verticillium* wilts. Overall, this cultivar has high field potential and good yield stability, easily adapting to the region. The variety was examined and approved in China in 2006.

Lumianyan 30 is an insect pest-resistant transgenic and water-logging resistant hybrid cotton variety of SAAS[11]. Its main features include short growth and development period (about 121-130 days), this

[11] Sichuan Academy for Agricultural Sciences

cultivar can reach a 101-110 cm height, and has early maturation and high level fruiting. In general, Luminayan 30 has good aeration, a strong boll-setting ability, a large boll size, high yield and resistance to Fusarium wilt and a high tolerance to Verticillium wilt. The variety was examined and approved in China in November 2007.

In order to introduce the new varieties, training of farmers on high yield efficiency cultivation, with a focus on techniques for planting, fertilization, plant density and harvesting, as well as cultivation technologies is necessary.

Objective

To mitigate the impacts of water-logging and drought spells on cotton crops through the introduction of more hazard resilient varieties and innovative cultivation technologies.

Implementation of the Technology

For the implementation of the cultivation system, dry ridge water cultivation techniques were applied. This system includes water-saving agricultural production technologies, the use of new varieties with anti-flood and insect-resistant features, and soil improvement through the application and extension of 3-D cultivation technologies.

1. Cultivation technologies

Cropping pattern

1.1 Wheat-cotton double cropping:

Three lines of wheat were planted in a 1.5m width area in early October with an in-row spacing of 20 cm. The following year, two other lines of cotton were planted in late April or transplanted in mid-May alongside the wheat with an in-row spacing of 50 cm. The row spacing between the wheat and cotton was 30 cm.

Before planting, a 10cm high ridge was built up. Wheat was planted at the bottom of the ridge, and cotton on the ridge. Wheat could therefore easily be watered and make full use of rainwater. It could improve the germination of cotton and alleviate the controversy between wheat and cotton. During the rainy season in the summer, the rainwater can be drained out in time. This method can increase the movement of air in the cotton field and prevent boll rotting, as well as considerably reducing the damage caused by water-logging.

1.2 Garlic-cotton double cropping:

Six lines of garlic were planted in a 1.5m width area in mid-October, with an in-row spacing of 16 cm. The following year, two lines of cotton were planted in late April or transplanted in mid-May alongside the wheat with an in-row spacing of 50 cm. The row spacing between wheat and cotton was 10 cm.

Seeds

It is important to select seeds that have been through acid-delinted treatment, a chemical process that removes all linters from cotton seeds, increasing nutrient density and flowability of the product. Imidacloprid seed treatment is a pest control treatment that improves resistance to insect and seedling diseases.

Risk reduction measures

- ***Drainage:*** The water level of the ditches of cotton fields was lowered by digging out and clearing the ditches. Water should be pumped out of the field if it is lying below the surrounding rivers.
- ***Loosen the soil early***: Soil ventilation is bad after floods. Loosening the soil is very important to

improve soil aeration and increase soil temperature, speeding the restoration and growth of cotton.

- ***Fertilization:*** Cotton should be fertilized in time; otherwise nutrients drain away during the floods. 5 to 8 kg per mu[12] of pure nitrogen, such as urea, and some organic and potassic fertilizer are necessary to fertilize after wilting disappears. Fertilizer should be used during irrigation at flowering stage, preventing pests and diseases in time.
- ***Delay topping***: The topping stage of cotton should be delayed by 7 days to increase fruiting branches and bolls because cotton grows very slowly after suffering from water-logging.
- ***Proper pruning***: Many shoots come out and consume nutrients after water-logging. Therefore, shoots should be cut off immediately to improve the output of cotton.

2. Technical training

Technical training for farmers is a pre-requisite for introducing new varieties. The series of technical trainings conducted in this project included an in-door workshop, technical guidance in farmers' fields and field demonstrations.

2.1 *In-door workshop*: Before planting, farmers and field-level technicians were invited to an indoor technical training workshop on practical knowledge and skills for disaster prevention and reduction, given by experts on cotton from universities and research institutes. Detailed knowledge and techniques were discussed during an informal discussion, and the field-level technicians and farmers learned the characteristics and management skills of the main cotton cultivars. They were also taught about a number of practical techniques for disaster prevention and reduction.

2.2 *On-spot technical guidance:* Cotton experts were invited to Juye to provide technical guidance on site during the critical growing stages of cotton, such as the planting, germination, seeding, squaring, and boll-setting stage. Detailed techniques about cotton transplanting, and management skills on how to prevent drought and water-logging in double cropping during the planting, germination and transplanting stage were explained and demonstrated. During the seeding, squaring and boll-setting stages of cotton, experts demonstrated some details about management techniques, fertilization, pruning and topping etc., putting emphasis on practical techniques for disaster prevention and reduction after water-logging.

2.3 *Field demonstrations:* High-standard demonstration fields were created using disaster prevention and reduction cultivation technologies in the project area. Farmers attended these field demonstrations to learn about the technologies.

Results and Impacts

The training sessions provided farmers with understanding of the characteristics of the new cotton varieties, and cultivation technologies.. Their ability to adopt these new technologies was greatly improved through the technical trainings, by means of in-door workshops, on-spot technical guidance and field demonstrations. Compared to the previous year, the yield of cotton increased by 15%.

Pre-tests showed that the lint yield of Lumianyan 28 averaged 96.2 kg per mu (15.6% greater than the control) in regional trials during 2002-2003. In 2004, this cultivar averaged 95.7 kg per mu (20.1% greater than the control) and averaged 95.91 kg per mu in the Shandong Province (23.03% greater). The following year, the lint yield of Lumianyan 28 averaged 103.4 kg per mu (17.9% greater) in the same province. The average yield of Lumianyan 28 in the area is 252.6 kg per mu.

[12] The mu is a traditional unit of land area in China equivalent to 667m^2. It is often reckoned to be 1/15 hectare

In the case of Luminayan 29, the lint yield in 2003-4 averaged 94.32 kg per mu (23.15% more than 33B). In the Huanghe growth area, the lint yield of Lumianyan 29 averaged 91.5 kg per mu (9.6% more than Zhongmiansuo 41) in 2004. The following year, the yield averaged 93 kg per mu (10.7% more) than Zhongmiansuo 41 in the same area. Average yield of Lumianyan 29 in the project area is 251.3 kg per mu.

For the Luminayan 30 lint yield, the average was 97.17 kg per mu (12.4% more than Zhongmiansuo 29) in the Shandong regional trials during 2003-2004. In the Huanghe the following year, the lint yield averaged 96 kg per mu (14.7% more than Zhongmiansuo 41). In the Huanghe growth area in 2006, Lumianyan 30 averaged 99.2 kg per mu (7.7% more than Lumianyan 15). Overall, the average yield of Lumianyan 29 in the project area is 254.2 kg per mu. Seeds of Lumianyan 30 were the most expensive among the three induced cotton varieties because it is hybrid cotton; however, the yield of Lumianyan 30 was the highest.

In 2009 the cotton crops, which are planted in Juye in late April or transplanted in mid-May were not affected by the early spring droughts. But cotton was affected by water-logging, due to the high rainfall season in the summer, especially in the months of July and August.

Table 1: Cotton yield in 2008 and 2009

Yield（kg/mu）in 2008	Yield（kg/mu）in 2009			
	Lumianyan 28	**Lumianyan 29**	**Lumianyan 30**	**control**
223.2	252.6	251.3	254.2	219.2

The induced cotton varieties distinctly increased the local farmers' income (about 140 RMB/mu) when compared to the previous cotton varieties.

A cost-benefit analysis demonstrates that although more investment is needed for these new cultivars, yields are greater. About 140 RMB/mu more were obtained with the Luminayan varieties, and Lumianyan 30 was the variety with the highest yield.

Table 2. Cost and benefit analysis of cotton planting in 2009. Cotton price was 6.8 RMB/kg[13].

Variety	Input（RMB/mu）				Outcome（RMB/mu）	Net income（RMB/mu）（Outcome - Input）
	Seed	**Water**	**Fertilizer**	**Labour**		
Lumianyan 28	40	20	160	590	1717.7	907.7
Lumianyan 29	40	20	160	590	1708.3	898.3.
Lumianyan 30	60	20	160	580	1728.6	918.6
Control	32	20	140	530	1490.1	768.1

Monitoring of the Demonstration

Based on the results above, optimum management procedures were established for sowing time, seeding rate, irrigation, fertilization, and pest and disease control. The optimum planting time was mid to late April for Luminayan 28 and 29. Regarding seeding rate: Luminayan 28's optimum seeding rate

[13] China's curreny, Yuan Renminbi (1 CNY = 0,146 USD)

was 2500 for low fertility areas, 3000 for middle areas and 3500 for high fertility areas; Luminayan 29's optimum seeding rate was 3000 plant per mu.

The highest yielding Luminayan 30 had an optimum planting time of about mid-April and transplanting time of about mid-May. The seeding rate was 2200-2800 plant per mu in the Shandong province and 1600-2000 plant per mu in the lower reaches of the Changjiang River.

The cultivars continue to be monitored to further analyze their response to droughts and water-logging and further compare their yields to control variety.

Source of testing adaptation option

This adaptation practice has been successfully tested in the county of Juye, in southwest of Shandong province in China, from October 2008 to November 2009 in the context of the Strengthening Disaster Preparedness in the Agricultural Sector (TCP/CPR/3105). Farmers who attended technical training skilfully apply the techniques in production practices.

Reference

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Further Reading

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Photo: 5-1 Boll of Luminayan cotton 	*Photo 5-2 Intercropping of cotton with Chinese Onion*