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Agricultural Disaster Reduction Technology Products

Technologies and Equipment Solutions for Waterlogging Disaster Mitigation in China's Major Grain Producing Areas

Prof. LEI Tianjie

Institute of Environment and Sustainable Development in Agriculture

Chinese Academy of Agricultural Sciences

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Cloud School

Sharing for Learning

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Background

1.1 Definition of Waterlogging

Waterlogging disasters refer to agricultural meteorological disasters caused by heavy or prolonged rainfall that leads to surface water accumulation on farmland (surface waterlogging) or excessive soil moisture (subsurface waterlogging).

- **Surface waterlogging**: It occurs when post-rain farmland water accumulation exceeds the flood tolerance of crops. The farmland surface is submerged by accumulated water, forming a certain water layer that soaks the root systems or entire plants of crops, causing significant damage.

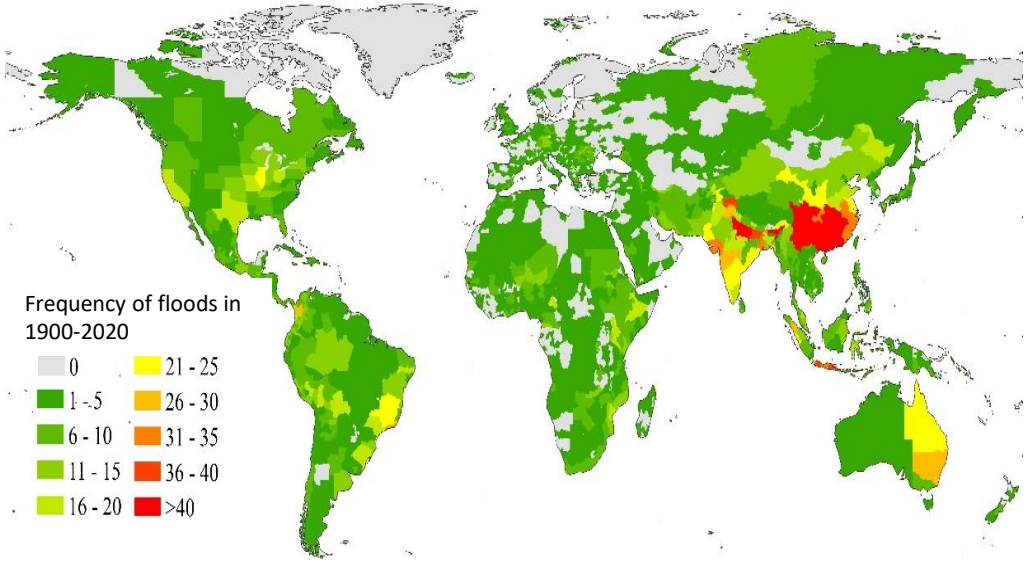
- **Subsurface waterlogging**: It is primarily caused by excessively high groundwater tables, leading to a long-term saturated state of soil moisture. Excessive water in the crop root activity zone affects root respiration and growth. Although there is no obvious surface water accumulation, the soil moisture is clearly supersaturated.

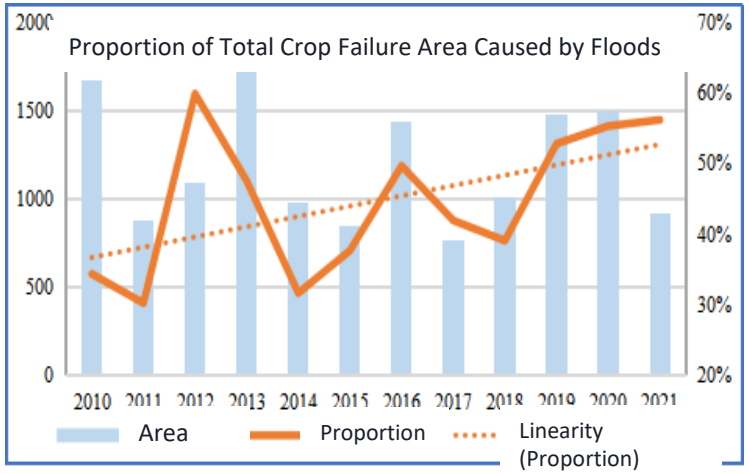
Surface waterlogging

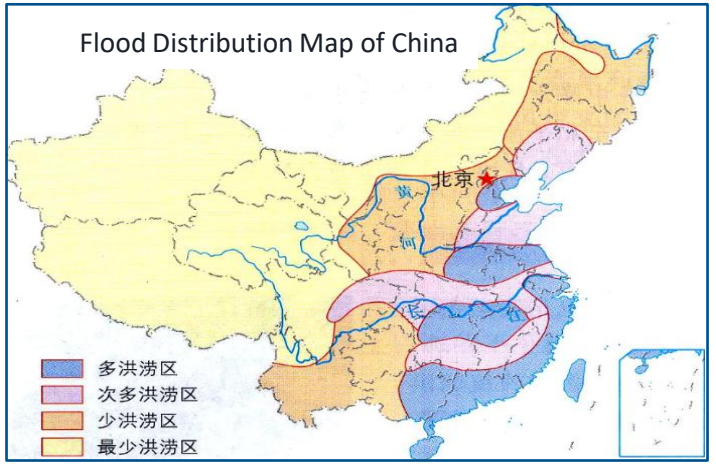
Subsurface waterlogging

1.2 Extreme Rainfall Worsens Waterlogging Risk in Major Grain Production Areas in China

- Over the past decade, global annual crop yield losses caused by flood disasters have accounted for over half of the total losses induced by natural disasters.
- Global warming exacerbates water cycle anomalies and significantly increases the frequency of extreme rainfall, driving a concurrent rise in both the exposure and vulnerability of traditional agricultural regions.
- Floods occur frequently across the globe, with Asia emerging as a major hotspot for such disasters.
- It is highly expected to establish a smart platform integrating forecasting, early warning, simulation, contingency planning and regulation, enhancing the prevention and mitigation capabilities against agricultural waterlogging disasters.







Intelligent Platforms and Core Equipment

2. Intelligent Platforms and Core Equipment

✓ **A series of agricultural disaster reduction equipment platforms and products covering the full chain of engineering, agronomic, and ecological regulation**

Intelligent Irrigation and Drainage Device

Achieving tiered drainage for mild, moderate, and severe waterlogging disasters

Soil Moisture and Water Level Monitoring Equipment

Monitoring of soil moisture content and farmland water level

Eco-technology Product

Promoting crop recovery and renewed growth after waterlogging

Agronomic Waterlogging-resistance Conditioner and Foliar Fertilizer

Increasing the root and lateral root ratio and the crop stress tolerance

Integrated Surface and Subsurface Trenching Equipment

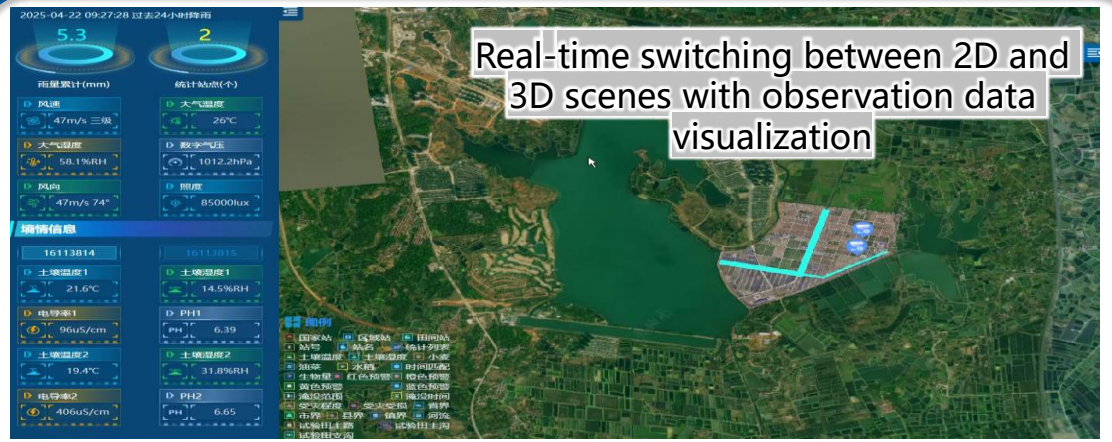
Combining surface and subsurface drainage engineering

Physical Frequency-Based Yield Enhancement Equipment

Enhancing stress tolerance in crop root systems

2.1 Digital Twin Platform for Waterlogging Disaster Prevention and Control

An integrated intelligent prevention and control platform, coupled with dynamic rendering, a multi-source knowledge base, and a model base, enables dynamic cyber-physical visualization of the entire waterlogging process, and accurately maps critical information including drainage flow fields and waterlogging extents, achieving precise disaster mitigation across the regional, field, and crop levels.



2.2 Regional Multi-level Intelligent Drainage Control Equipment: A Systematic Solution

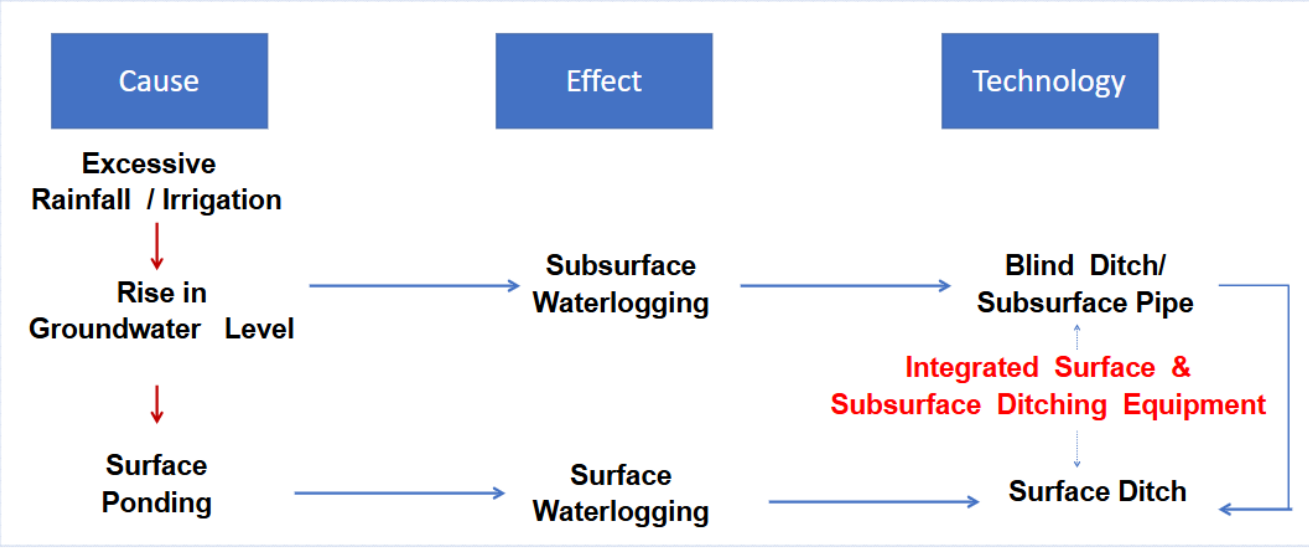
Building an engineering technology system integrating “monitoring, simulation, and regulation” that covers the entire evolution process of waterlogging disasters by

- utilizing high-precision 3D models to optimize drainage engineering layouts
- leveraging hydrodynamic models for regional joint dispatch
- coupling agricultural meteorological observation stations to develop core equipment such as smart drainage gates and dispatch system platforms

2.3 Field-Scale Waterlogging Drainage Technologies and Surface-Subsurface Trenching Equipment for Rice, Wheat, and Rapeseed

The integrated surface-subsurface trenching equipment is utilized to establish a field drainage engineering model featuring a “three-ditch” supporting system (border ditches, cross ditches, and boundary ditches) combined with surface-subsurface drainage, for the rice, wheat, and rapeseed cropping system.

This forms a highly efficient disaster mitigation engineering technology mode integrating multiple combinations of surface ditches, blind ditches, field bunds, and trenching operations.



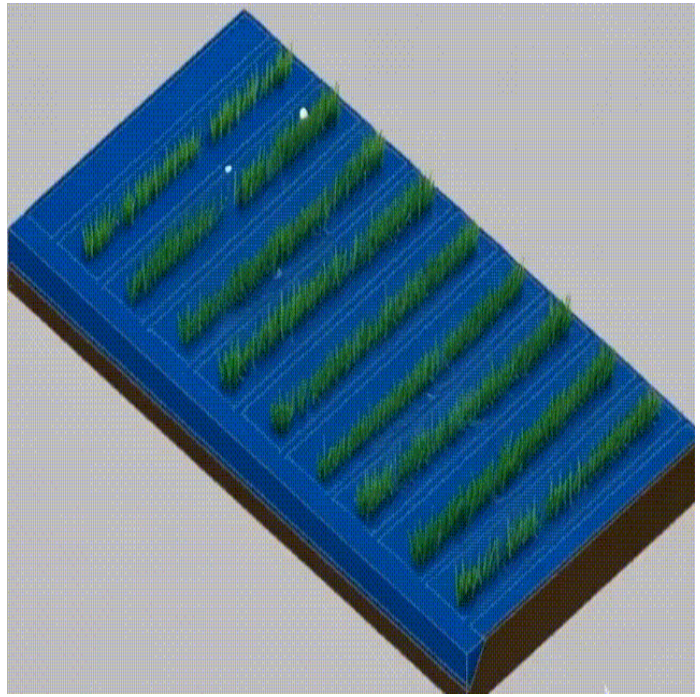
Three-ditch Supporting System

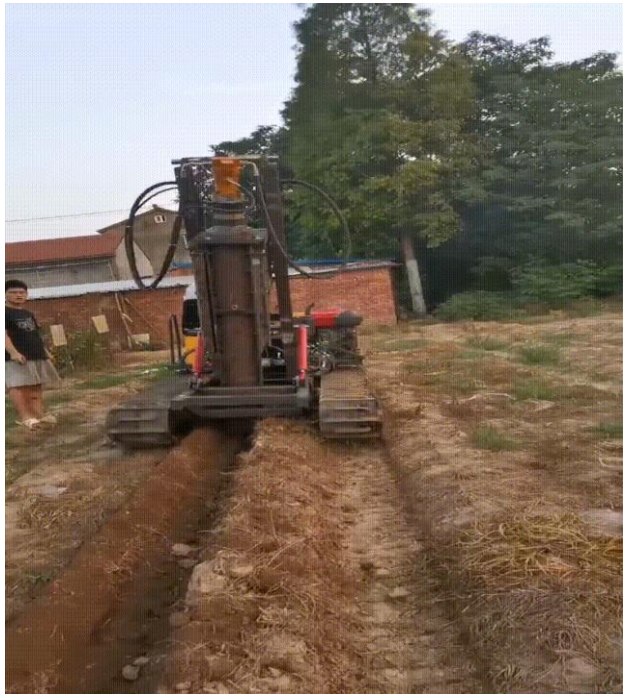
Surface-Subsurface drainage

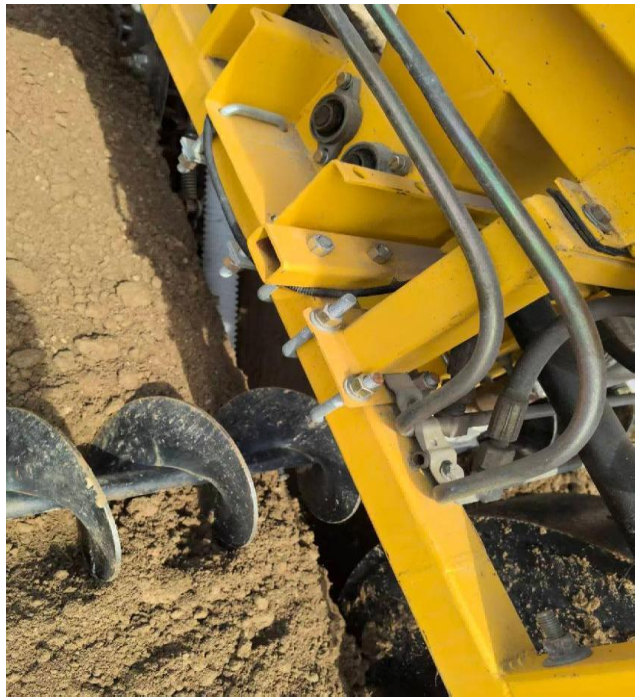
2.3 Field-Scale Waterlogging Drainage Technologies and Surface-Subsurface Trenching Equipment for Rice, Wheat, and Rapeseed

Mild Waterlogging	Moderate Waterlogging	Severe Waterlogging
• Border ditches: Depth 25-30 cm, Spacing 3 m • Cross ditches: Spacing 70 m, Depth 30-35 cm	• Blind ditches: Burial depth 60 cm, Spacing 3 m • Surface ditches • Cross ditches: Depth 40 cm	• Blind ditches: Burial depth 60 cm, Spacing 3 m • Boundary ditches: Depth 40 cm

2.3 Field-Scale Waterlogging Drainage Technologies and Surface-Subsurface Trenching Equipment for Rice, Wheat, and Rapeseed







An "auger trenching and biomass subsurface pipe laying" integrated surface-subsurface trenching equipment to enable the integrated operation of trenching and straw filling

2.4 Agronomic Technologies and Prevention & Products for Waterlogging Mitigation in Rice, Wheat, and Rapeseed

- **Foliar waterlogging-resistance conditioners** primarily composed of functional oligosaccharides, monopotassium phosphate, and silicon amino acid fertilizer
- **Seed coating agents** mainly composed of oligosaccharides and plant growth-promoting bacteria
- **Specific-frequency electromagnetic wave equipment** resonating with plant biological waves was developed to accelerate cellular metabolism and stimulate root division

Seed coating agents

Foliar waterlogging-resistance conditioners

Specific-frequency electromagnetic wave equipment

2.4 Agronomic Technologies and Prevention & Products for Waterlogging Mitigation in Rice, Wheat, and Rapeseed

Disaster Occurrence Characteristics

Wheat/Rapeseed Sowing Season
- High soil viscosity
- Rainfall prone to trigger disaster

Mid-March to Mid-April
- Continuous rain
- Lack of sunshine

Late Jun to Early July
- Plum rain season
- Extreme Weather

Agronomic Process

Microbial Seed Coating
- Rhizosphere Microenvironment
- Soil Structure

Ultrasonic Treatment
- Seed Vigor

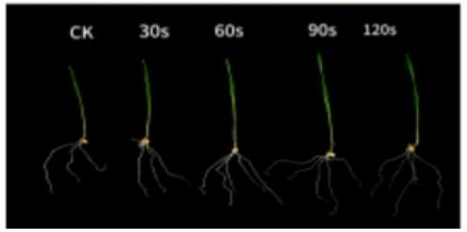
Foliar Regulators
- Oligosaccharides
- Potassium Dihydrogen Phosphate (20ppm)

Enhance

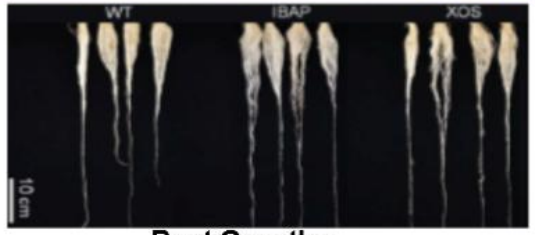
Enhance

Improvement Effects


Seedling Emergence Rate



Seedling Growth Status



Root Growth


Chlorophyll

Mitigate Adverse Effects of Waterlogging Disaster

Combined multi-measure approaches boost the root absorption area by over 30%, effectively mitigating the impacts of waterlogging disasters.

2.4 Agronomic Technologies and Prevention & Products for Waterlogging Mitigation in Rice, Wheat, and Rapeseed

Mild Waterlogging

- Seed coating treatment
- Foliar application of oligosaccharides 1-2 times

Moderate Waterlogging

- Seed coating treatment
- Foliar application of monopotassium phosphate once + foliar application of oligosaccharides 2-3 times

Severe Waterlogging

- Seed coating treatment
- Foliar application of 28-homobrassinolide + foliar application of oligosaccharides 1-2 times

2.5 Eco-technologies and Prevention & Control Products for Waterlogging Mitigation in Rice, Wheat, and Rapeseed

An optimized waterlogging-regulating, growth-promoting, and restoration formula fertilizer (F3)

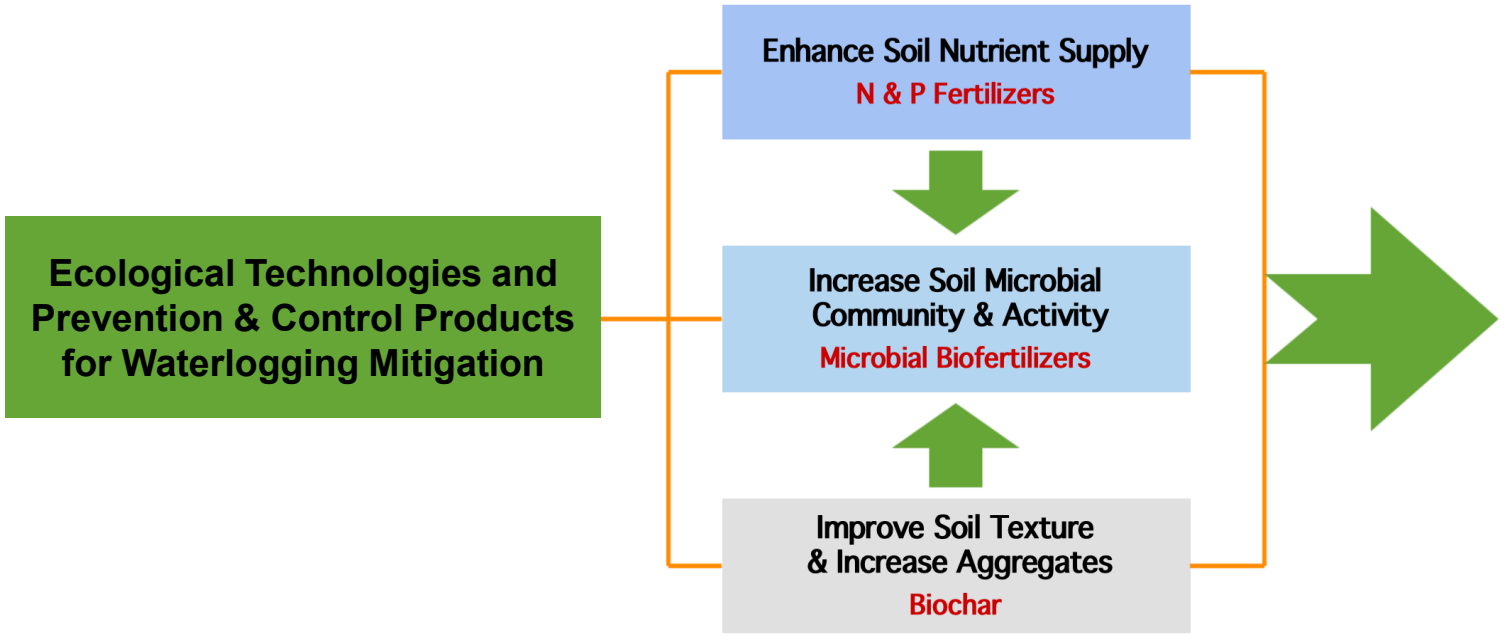
- Soil aggregate disruption
- Soil compaction
- Nutrient loss
- Decline in soil microbial community and activity

Reducing root absorption capacity and nutrient uptake and utilization

Waterlogging in rice, wheat, and rapeseed systems

F3 (N: P: Biochar: Microbial Fertilizer = 45%: 25%: 15%: 15%) is the optimal formula for a fertilizer designed for waterlogging control, growth promotion, and system restoration.

2.5 Eco-technologies and Prevention & Control Products for Waterlogging Mitigation in Rice, Wheat, and Rapeseed



Rice: Apply as topdressing after waterlogging during the seedling stage at a rate of 150 kg/ha (formula fertilizer).

Wheat: Incorporate with basal fertilizer into the soil before sowing at a rate of 474 kg/ha (organic fertilizer).

Rapeseed: Incorporate with basal fertilizer into the soil before sowing at a rate of 60 kg/ha (biochar)

The F3 formula fertilizer demonstrated the optimal effect on yield improvement after waterlogging, increasing yield by 33.5% compared to the control.

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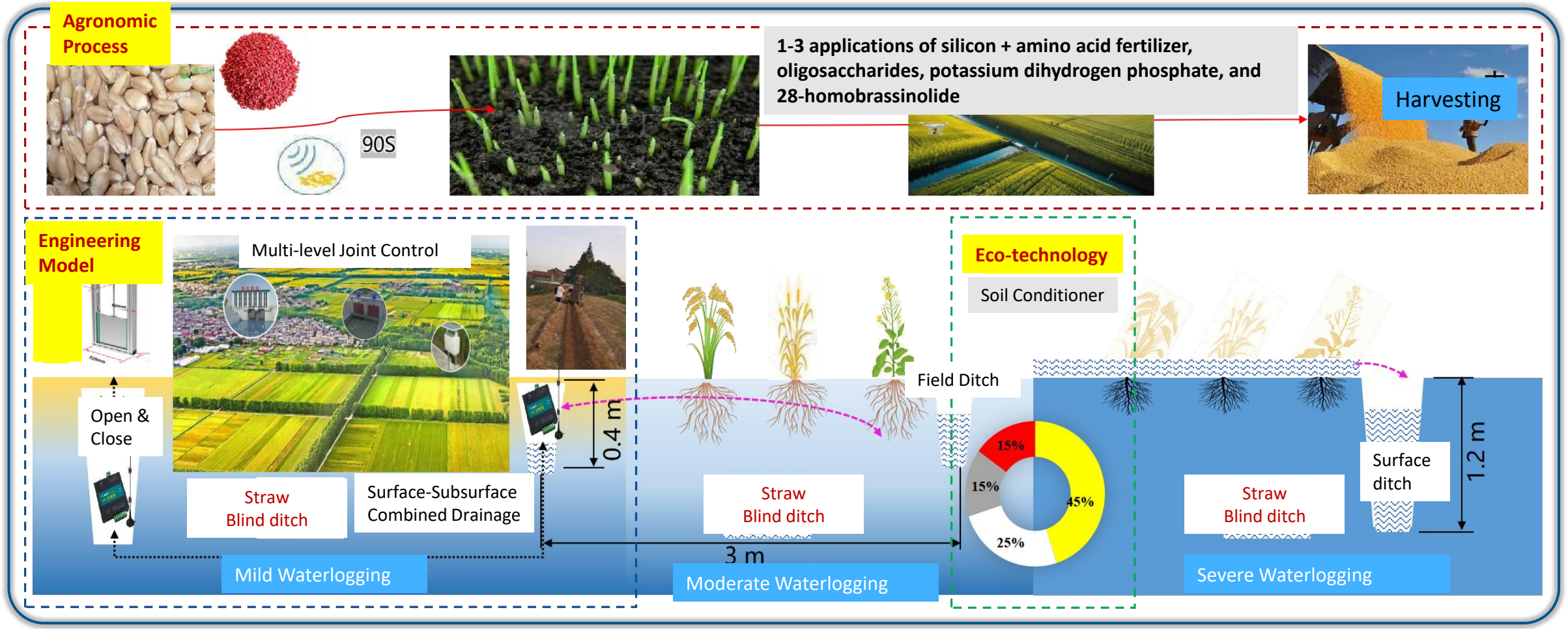
Building a Full-Chain Prevention and Control System

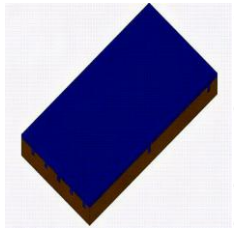
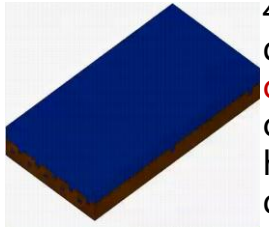
3.1 Integrated Technologies and Standardized Model for Multi-technology Synergy



The replicable and scalable standardized model for waterlogging control: deep integration of intelligent equipment with agronomic-ecological technologies

3.2 Integrated Waterlogging Mitigation Technology System and Solutions

The Engineering-Agronomy-Ecotechnology system and solutions achieve over 5% reduction in disaster and increase in efficiency

Integrated Waterlogging Mitigation Technology System (Preliminarily Formed)						
		Mild Waterlogging		Moderate Waterlogging		Severe Waterlogging
Engineering Model	Three-ditch system and open-Subsurface drainage system		Furrow spacing: 3 m, depth: 25-30 cm; lateral ditch spacing: 70 m, depth: 30-35 cm. Surface water is drained within 3.2 hours, followed by 4.7 days to lower the groundwater table to a depth of 40 cm.		Subsurface drain spacing: 3 m, depth: 60 cm; lateral ditch depth: 40 cm. Surface water drainage rate is 9.7 cm/hour with a completion time of 4.1 hours; waterlogging is drained within 3.8 days to reach a groundwater depth of 40 cm.		Subsurface drain spacing: 3 m, depth: 60 cm; peripheral ditch depth: 40 cm. Surface water drainage rate is 10.5 cm/hour with a completion time of 5.7 hours; waterlogging is drained within 3.1 days to reach a groundwater depth of 40 cm.
	Multi-level integrated drainage engineering		Keep the field ditches and canals unobstructed with the sluice gates fully open, allowing for gravity-driven natural drainage.		Partial pump operation (low load): Pump water to river/ditch for gravity downstream discharge (Gravity drainage + assisted pumping).		Full pump operation: Lift water to high-level rivers; or close secondary gates to divert to flood retention areas for temporary storage (main-powered pumping + temporary storage and detention)

3.2 Integrated Waterlogging Mitigation Technology System and Solutions

The Engineering-Agronomy-Ecotechnology system and solutions achieve over 5% reduction in disaster and increase in efficiency

Integrated Waterlogging Mitigation Technology System (Preliminarily Formed)				
		Mild Waterlogging	**Moderate Waterlogging**	**Severe Waterlogging**
Agronomic Process	Seed coating	Germination rate increased by **8.5-10.2%**		
	Foliar stress resistance regulation	Oligosaccharide foliar spray (1-2 times) **5-7% yield increase + amino acid silicon fertilizer**	KH_2PO_4 (1 time) + Oligosaccharide foliar spray (2-3 times) **6-10% yield increase + amino acid silicon fertilizer**	28-High Brassinolide + Oligosaccharide foliar spray (1-2 times) **3-5% yield increase + amino acid silicon fertilizer**
Eco-technology	Nitrogen: Phosphorus: Biochar: Microbial fertilizer	45%: 25%: 15%: 15% **20-35% yield increase**	45%: 25%: 15%: 15% **10-20% yield increase**	45%: 25%: 15%: 15% **5-10% yield increase**

3.3 Coordinated disaster reduction and intelligent regulation for waterlogging disasters throughout the entire process

Defining evaluation indicators for ecological farmland waterlogging control and establishing an integrated disaster mitigation model—linking variety breeding, engineering/agronomic/ecological technologies, equipment, and platforms—tailored to various waterlogging levels.

Waterlogging Mitigation Technical Models across Various Severity Levels For Rice

Waterlogging Level	Monitoring Indicators	Engineering	Agronomic	Ecological	Insecticide	Fungicide
Mild	Indicators such as Meteorology, Precipitation, Soil Moisture Content, Submergence Depth, etc.	Perimeter ditch	Urea, Potassium Dihydrogen Phosphate, Brassinolide	Biological Enzymes	Triflumezopyrim, Pymetrozine, etc.	Tricyclazole, Tebuconazole, Epoxiconazole, etc.
Moderate	Indicators such as Meteorology, Precipitation, Soil Moisture Content, Submergence Depth, etc.	Perimeter ditch	Urea, Potassium Dihydrogen Phosphate, Brassinolide, Amino Acids, Taurine	Biological Enzymes	Triflumezopyrim, Pymetrozine, etc.	Tricyclazole, Tebuconazole, Epoxiconazole, etc.
Severe	Indicators such as Meteorology, Precipitation, Soil Moisture Content, Submergence Depth, etc.	Perimeter ditch, blind ditch	Urea, Potassium Dihydrogen Phosphate, Brassinolide, Amino Acids, Taurine, Humic Acid, Silicon Fertilizer	Biological Enzymes, Microbial Fertilizer	Triflumezopyrim, Pymetrozine, etc.	Tricyclazole, Tebuconazole, Epoxiconazole, etc.

3.4 Experimental-Demonstration-Benefiting Zones for Disaster Mitigation, Yield Increase, and Efficiency Enhancement

***Demonstration - Application - Benefits - Industrialization*: Upgrading early warning to precise crop-level damage, forging a replicable modern waterlogging control model.**

Demonstration: Integrating conventional measures with project technologies/products supported by the management platform for various waterlogging scenarios.

Application: Extension across more than 40,000 hectares, crop yield loss reduced by over 15%, and waterlogging control efficiency improved by 5%. Validated technologies enabled hybrid rice yields of 13.55 tonnes per hectare under rice-wheat rotation.

Benefits: The Expert-Enterprise-Farmer-Government disaster management system was established, which enabled precise early warning and efficient disaster relief during the 2024 flood season, directly generating around 5.71 million USD in economic benefits.

Industrialization: The F3 soil conditioner with supporting equipment have been commercialized in Jiangsu Province.

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