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Centre for Sustainable Agricultural Mechanization

Climate-smart mechanization and crop residue management

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Eleventh Regional Forum on Sustainable Agricultural Mechanization

Climate-smart Agricultural Mechanization for Sustainable Crop Residue Management and Resilient Agrifood Systems

26-28 October 2026 – Tianjin, China

Agricultural system is facing the realistic pressures of Climate Change

Agriculture faces the challenge of climate change

农业面临气候变化的挑战



Super El Niño超强厄尔尼诺



Drought干旱



Flood洪涝

Residue burning pollutes the air

秸秆焚烧污染空气







Crop residue burning秸秆焚烧

Climate-Smart Agriculture Mechanization

What is climate-smart agriculture mechanization

Mechanizing for productivity, resilience and a low-carbon farm.

以机械化，促增产、强韧性、实现低碳农业。



What it can achieve

Higher yields & income
增产增收

Raise yields, cut losses, save costs

Environmental protection
环境保护

Lower emissions, protect soil & water

Climate resilience
气候韧性

Cope with drought, flood and disasters

Resource efficiency
资源高效

Save water, fertilizer and labor

Mechanization turns crop residues into a CSA resource at scale.

Climate-smart agriculture mechanization → **Crop-residue retention & use** → **Climate-smart agriculture**

no-till seeders · choppers · balers

mulch · return-to-field · off-field use

yield ↑ · resilience ↑ · GHG ↓

Crop Residue Utilization Pathways

- **Fertiliser Return (Largest Share)**
  - **Conservation Tillage**
    - **Improved Soil Health**
    - **Cost & Efficiency Gains**
    - **Climate Adaptation**
- Feed
- Energy
- Base Mat.
- Raw Mat.





Three principles of Conservation Agriculture （FAO）

Conservation Agriculture is a farming system that promotes minimum soil disturbance (i.e. no tillage), maintenance of a permanent soil cover, and diversification of plant species. It enhances biodiversity and natural biological processes above and below the ground surface, which contribute to increased water and nutrient use efficiency and to improved and sustained crop production.



Minimum mechanical soil disturbance 最低程度的土壤机械扰动
(i.e. no tillage) through direct seed and/or fertilizer placement.



Permanent soil organic cover 永久性土壤有机物覆盖
(at least 30 percent) with crop residues and/or cover crops.



Species diversification 作物多样化
through varied crop sequences and associations involving at least three different crops species.

http://www.fao.org/conservation-agriculture/

High-efficient utilization of residue through mechanized conservation tillage aligns with the goal of climate-smart agriculture

通过机械化保护性耕作实现秸秆高效利用，符合气候智慧型农业的目标

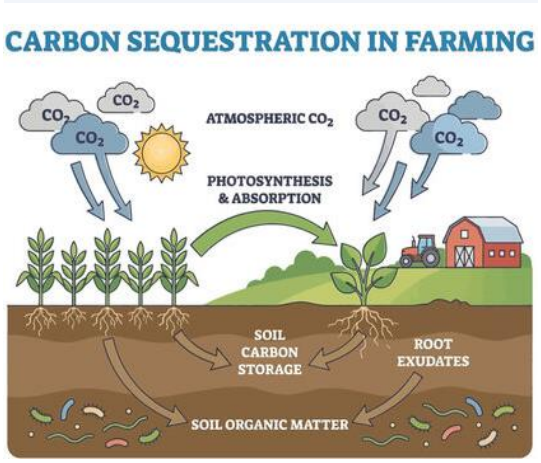
Water Retention
保水



Soil Conservation
保土



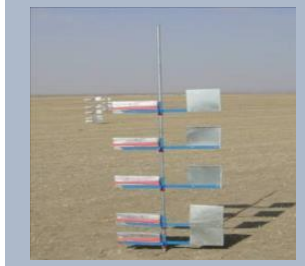
GHG Reduction
减排

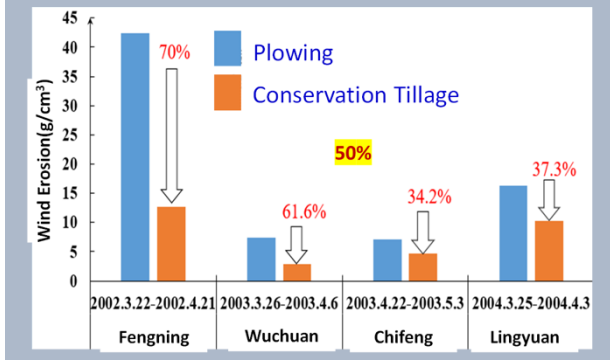


Labor Saving
省劳



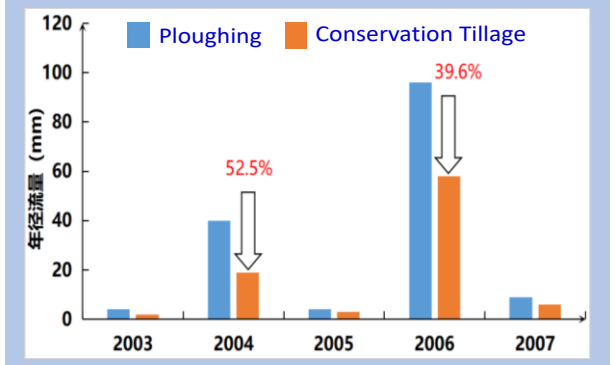
Impacts of Mechanized Conservation Tillage



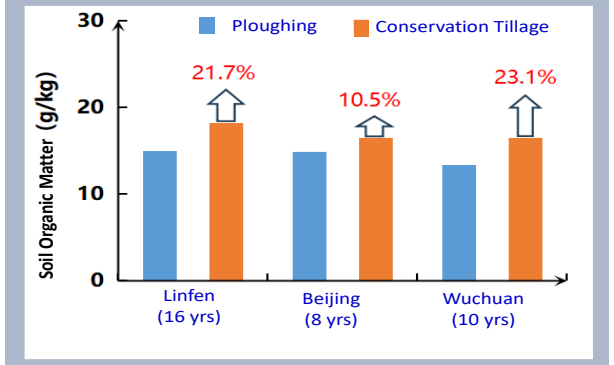
Wind Erosion
减风蚀



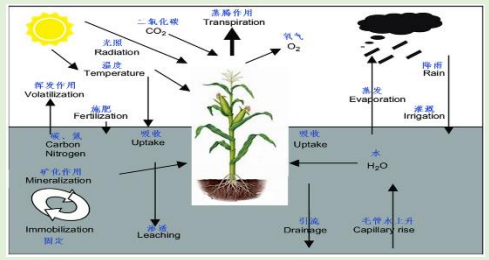



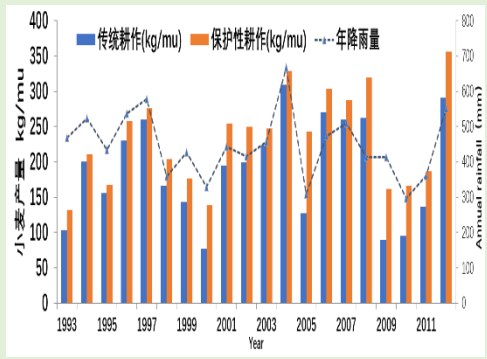
Water Erosion
减水蚀



Soil Quality
肥土壤





High Yield
高产量

保护性耕作应用效果

Start of Conservation tillage in single cropping areas
Development of small and medium CA machines (1992-)

- Geo-zones: Loess Plateau, etc.
- Drought, water erosion, wind erosion, variable yields （干旱、水蚀、风蚀、产量不稳）
- Challenges: Small land, small tractor, lower net income （小地块、小动力、低收入）










Small land, Small tractor, Small wallet **VS** **large machine, large tractor, large farm**

Early Small and simple CA machines in China





Maize no till seeder





Wheat no till drill



Subsurface tiller



Subsoiler with adjustable wings



Strip tiller



Strip tillage

早期小型保护性耕作机具

Demonstration, extension and CA in double crops area (1999-2008)

- Extending Conservation Tillage to the areas of double cropping
- Development of no-till wheat drill with fresh maize straw cover



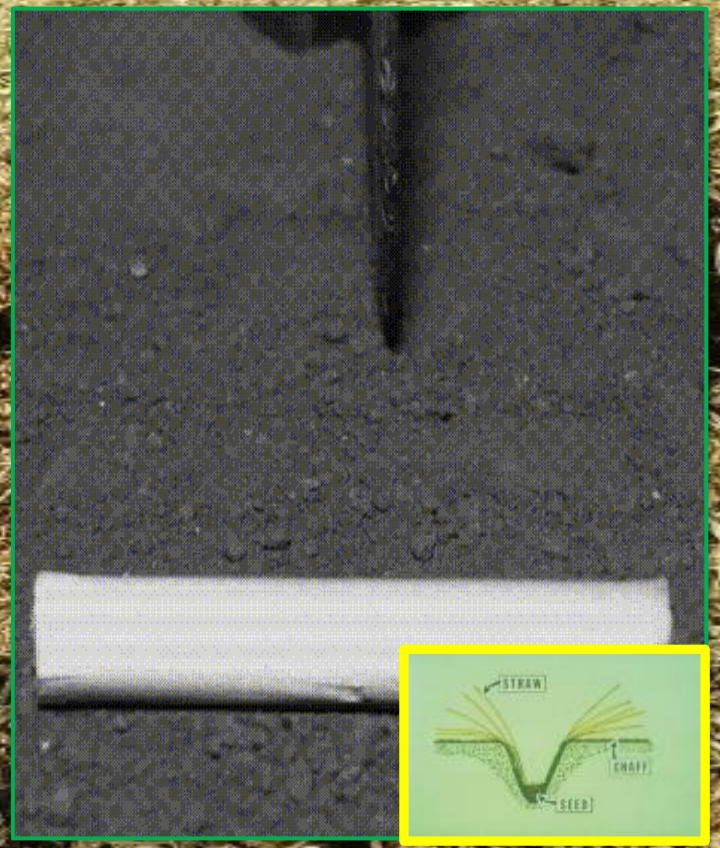


示范推广，两熟区保护性耕作

Challenges: disc coulter cannot cut through all the straw, results high rates of seed hanging 圆盘无法切断所有新鲜玉米秆









Challenges: The chisel opener is like a rake, quickly collecting straw with dense and blocked 凿形开沟器快速堵塞

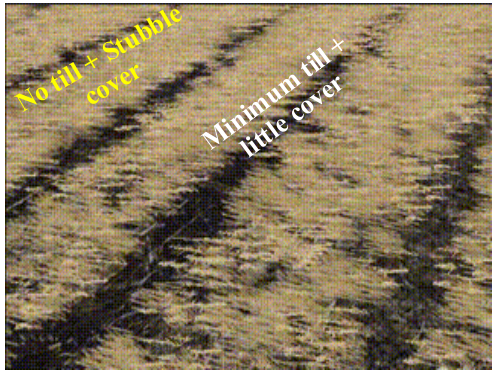


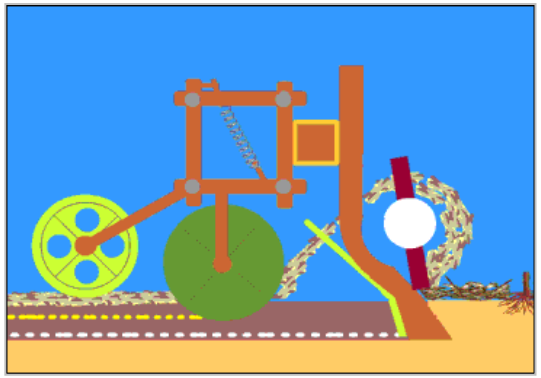


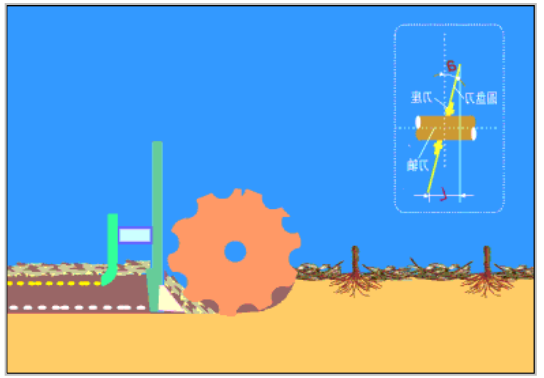


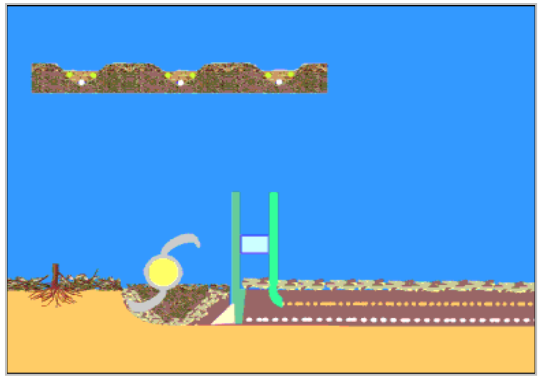


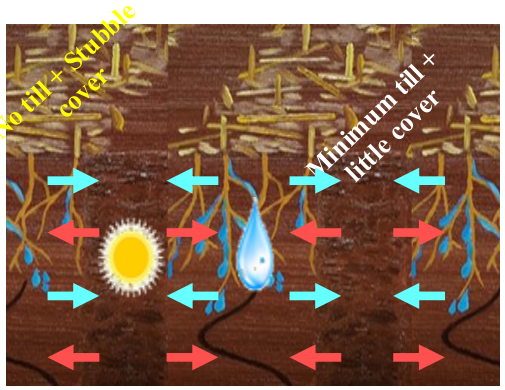
Solution: Zone no-till + stubble cover



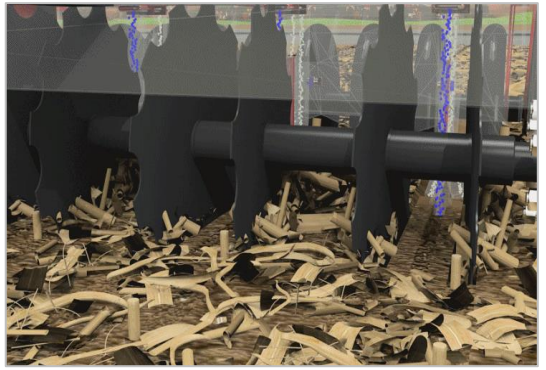














From full cover to zone cover, all stubble remains on the soil surface 带状覆盖

From no-till to zone no-till, preparing wider clean zone for seed bed only 带状免耕

You can see such machines in Hall N31, Booth B10

Wheat zone no-till drill into maize stubble covered soil









带状免耕小麦播种

Rapid development (2009-present)

- Focus on using conservation tillage to protect balck soil
- Develop high-speed precision no tillage seeder



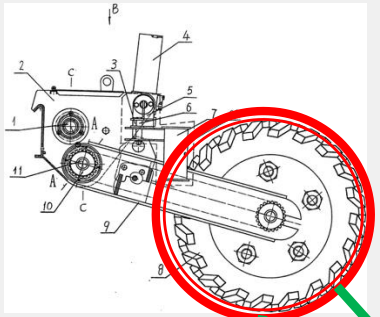




Electric-Driven Seed Metering 电驱排种

Ground-Wheel-Driven Seed Metering

- Pros: Low cost; easy installation
- Cons: Slippage, bouncing, soil buildup, chain tooth skipping, vibration



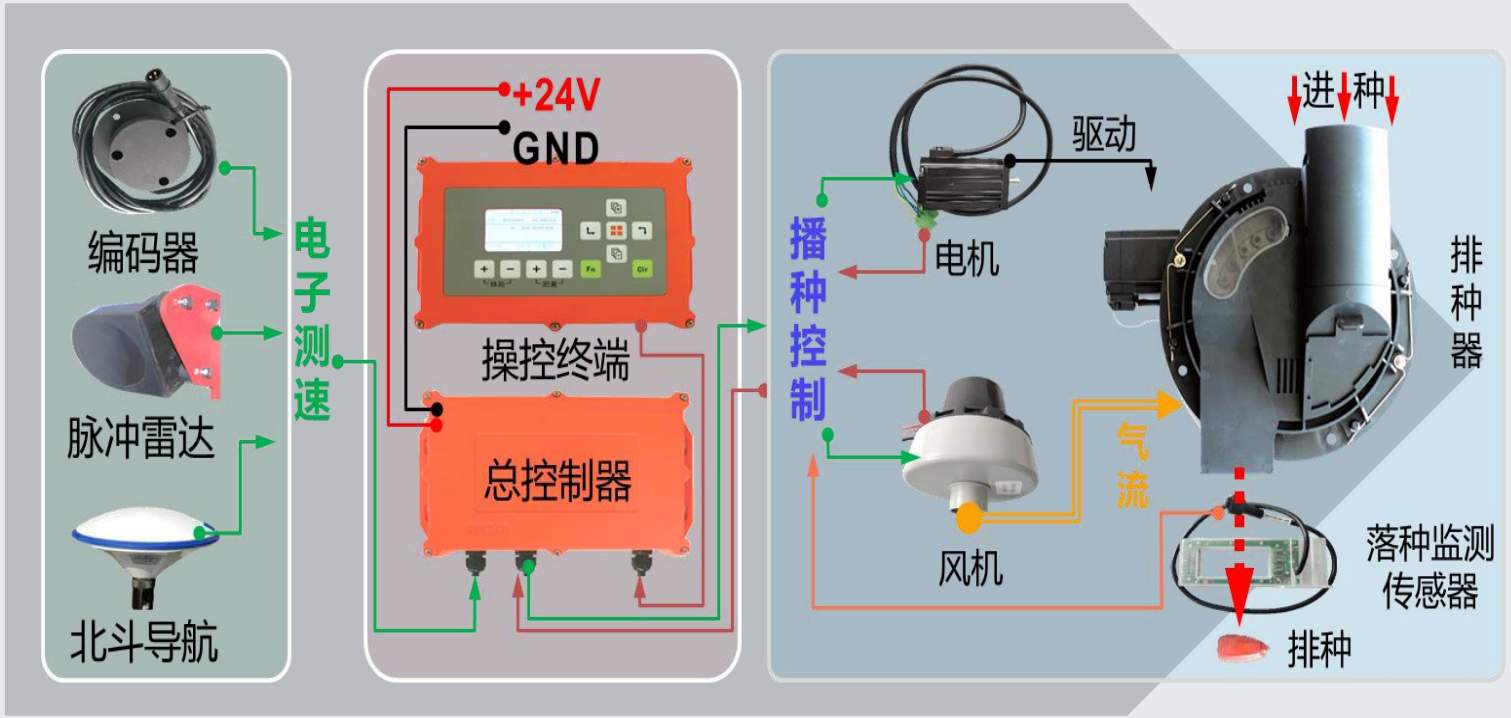




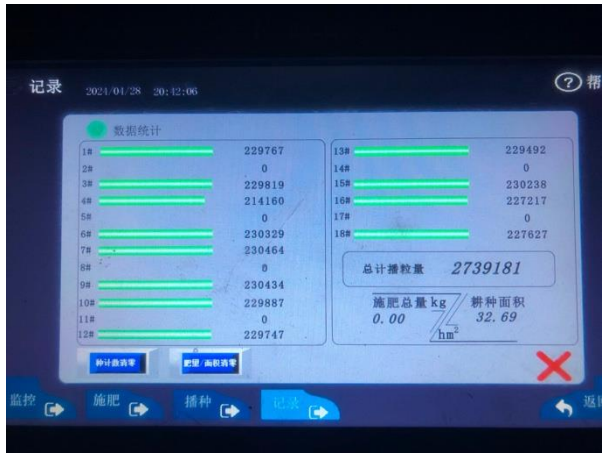


Electric-Driven Seed Metering (No ground wheel)

- Seed Metering Shaft Drive: Motor-Driven, Replacing Ground-Wheel Drive
- Seed Metering Shaft Speed: Intelligent Speed Sensing, Replacing Ground-Wheel Speed

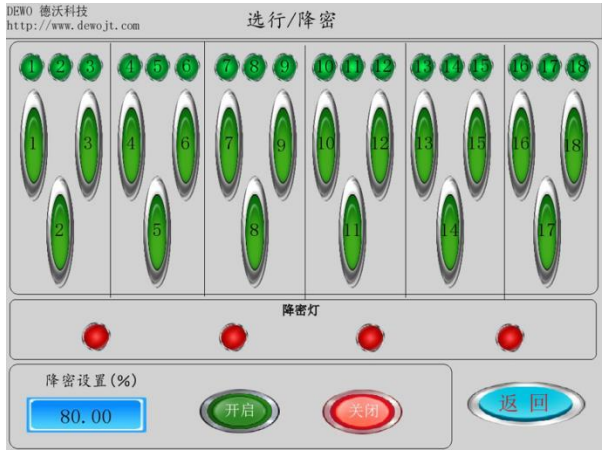


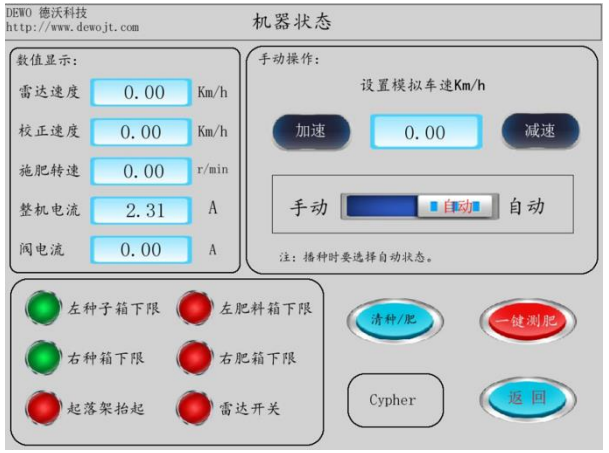
Precise and Convenient Seeding Rate Adjustment













播种量精准、快捷调整

No tillage high-speed Corn Seeders



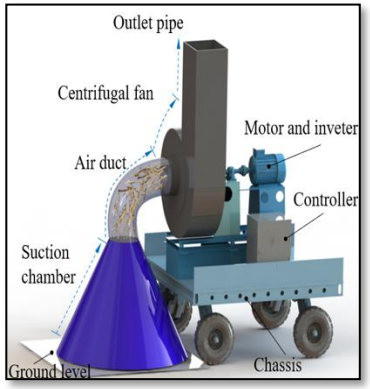


◆ Higher speed ◆ Precision planting ◆ Higher ability of stubble cleaning

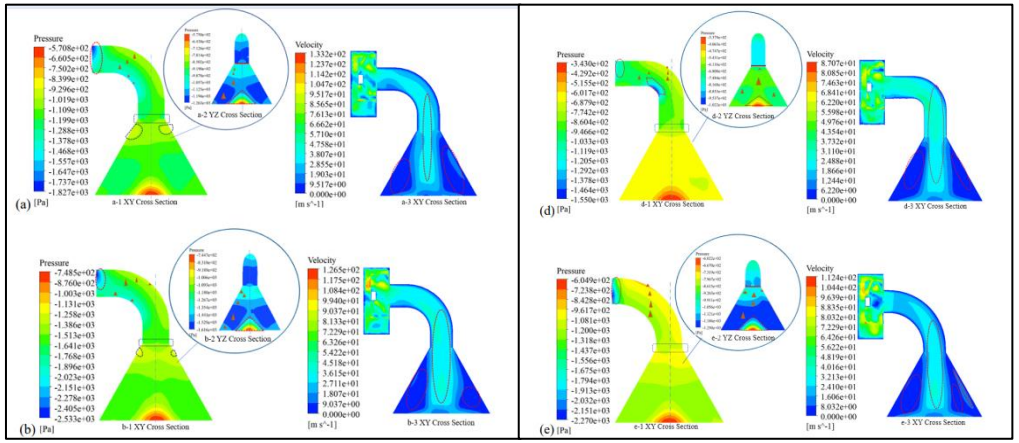
免耕、高速、精量玉米免耕播种机

You can see such machines in Hall S12, Booth A01

Intelligent Detection of Straw Cover Amount





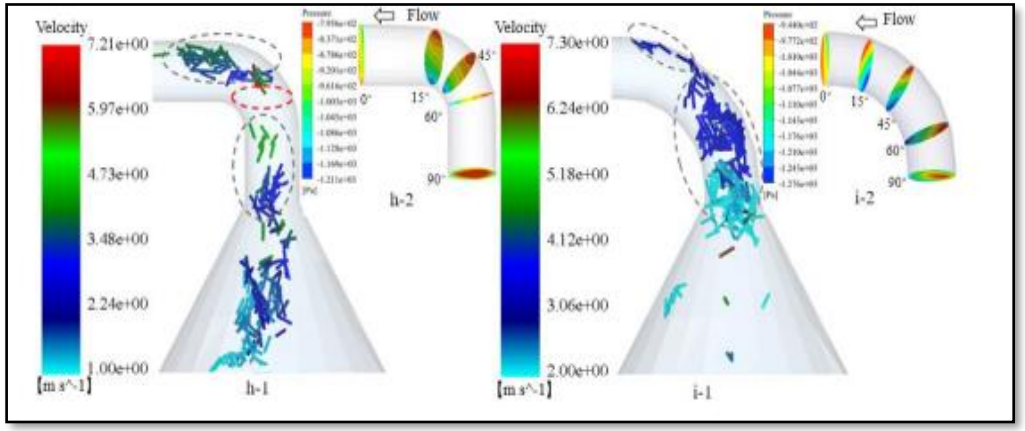




Straw Anchoring



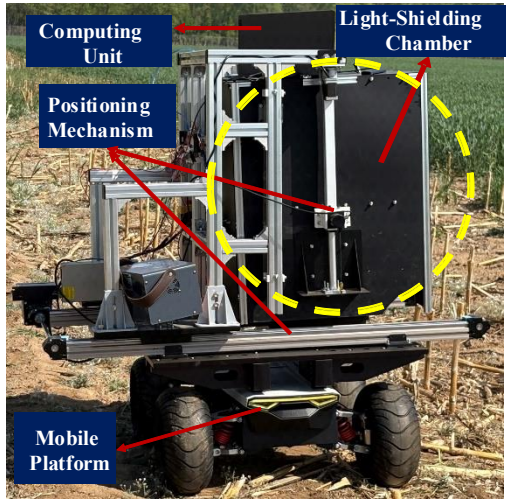
Separate Straw Inside and Outside the Target Area

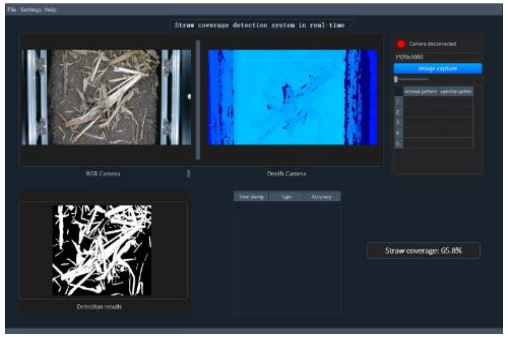


地表秸秆覆盖量自动检测

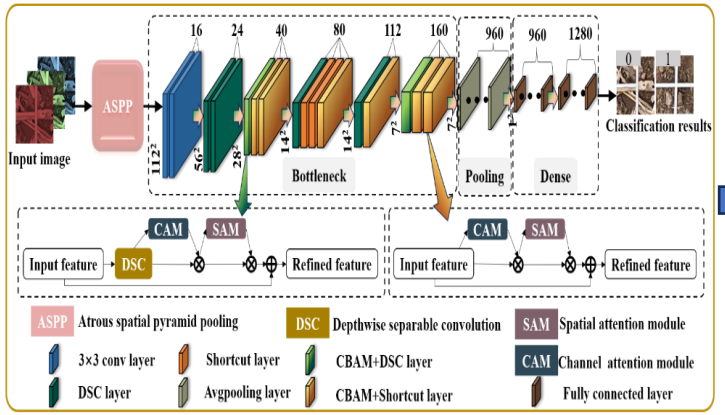
Straw Cover Rate Detection

秸秆覆盖率自动检测

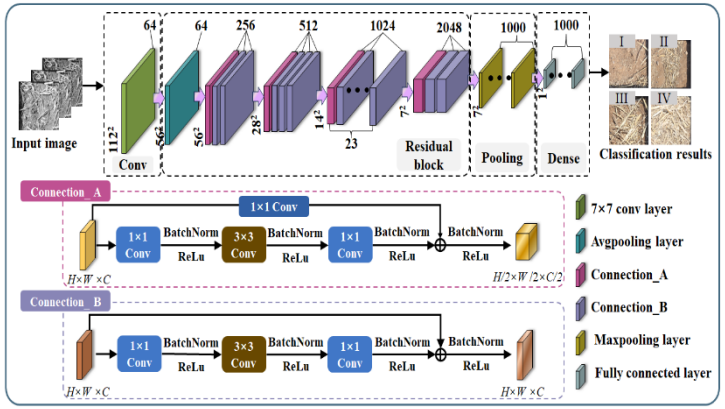




- Image Acquisition Inside the Light-Shielding Chamber
- Detection Result Visualization

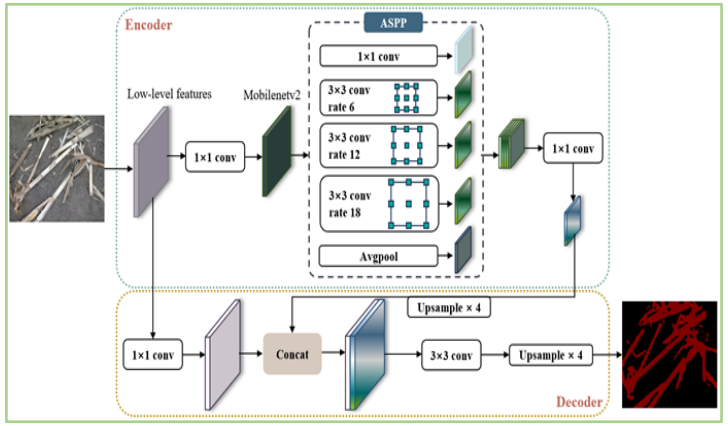


AC-Mobilenet Network
for local sliced image classification



Resnet101 Network
for straw coverage level classification



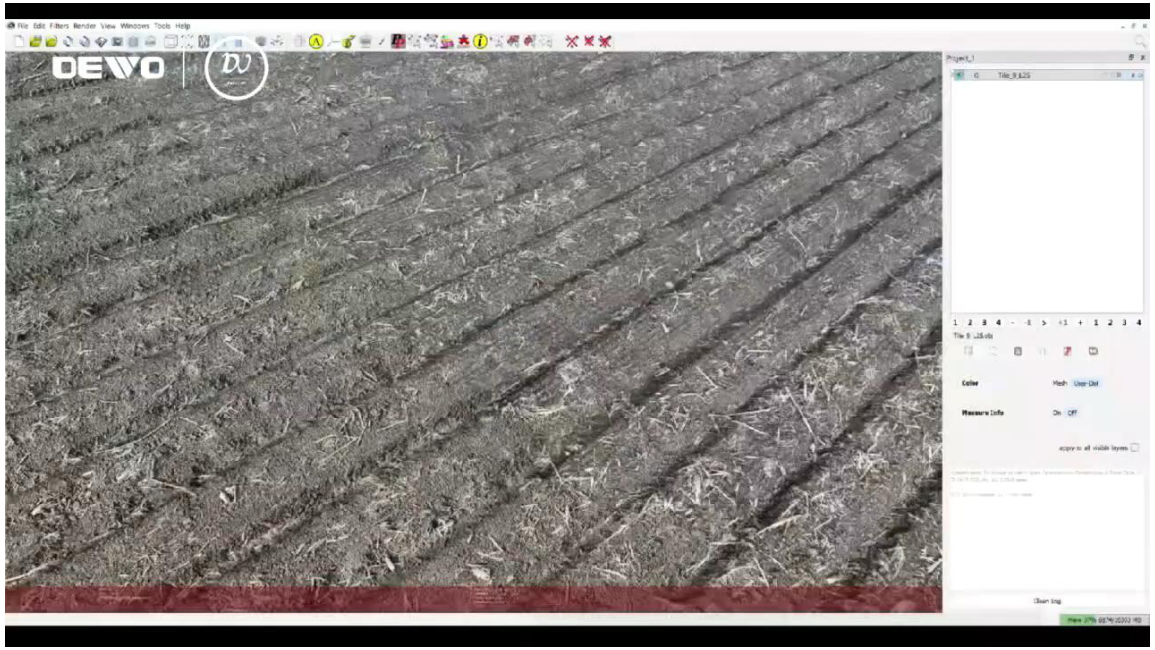


Deeplabv3+ network
for straw semantic segmentation

Seeding Robot

播种机器人





You can see such machines in Hall S12, Booth A01

Popular Science Book
Exchanging Experience with Conservation Agrculture towards Climate Resilience

https://openknowledge.worldbank.org/entities/publication/2f6975bd-0445-5c5a-85d5-ead566d703a7

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Publication: Exchanging Experience with Conservation Agriculture : Towards Climate Resilience

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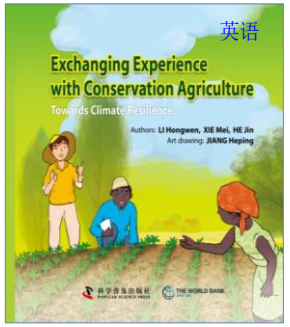
Abstract

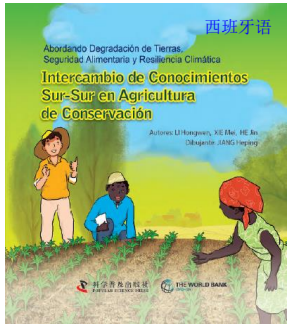
This booklet offers advice for farmers and extension workers interested in using conservation agriculture techniques to boost crop yields, soil quality and water retention. These practices represent some of the many ways we can become more climate smart, which is essential if we are to sustainably produce more food on less land to feed our growing planet.



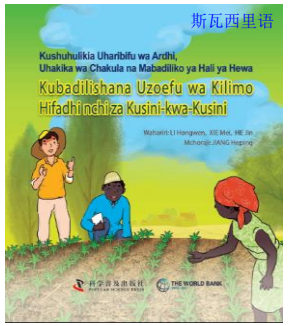
English



French



Spanish



Swahili

Conservation Tillage popularization book

保护性耕作科普书







粮农组织网站

Food and Agriculture Organization of the United Nations

العربية 中文 English Français Русский Español

https://www.fao.org/conservation-agriculture/resources/en/?my_type=88488

Conservation Agriculture

Overview | Impact | In practice | Case studies | News | Resources

Resources

Results filtered by: **Technical guidelines**

Exchanging Experience with Conservation Agriculture (Chinese) Chinese
2014
Technical guidelines -

Exchanging Experience with Conservation Agriculture (Bangla) Bangla
2014
Technical guidelines -

Exchanging Experience with Conservation Agriculture (Chinese and Mongolian)
2014 Mongolian
Technical guidelines -

Exchanging Experience with Conservation Agriculture (Thai) Thai
2014
Technical guidelines -

Exchanging Experience with Conservation Agriculture (Swahili) Swahili
2014
Technical guidelines -

1 2 3 4

Resources

Exchanging Experience with Conservation Agriculture (Russian)
2014 Russian
Technical guidelines -

Exchanging Experience with Conservation Agriculture (Spanish)
2014 Spanish
Technical guidelines -

Exchanging Experience with Conservation Agriculture (Arabic)
2014 Arabic
Technical guidelines -

Exchanging Experience with Conservation Agriculture
2014













Summary of Conservation Tillage Development in China

- **Policy** — In No. 1 Central Document，11 years。中央一号文件11年
- **Law**—In Black Soil Protection Law。 列入黑土地保护法
- **Equipment**—From no suitable machine, to all necessary conservation tillage machines can be produced in China. 装备从无到有
- **Area**– more than 7 million ha. 超1亿亩
- **Award**--6 National Science and Technology Progress Awards 6项国家奖

International Recognition

全球免耕史上
里程碑意义的30项研究

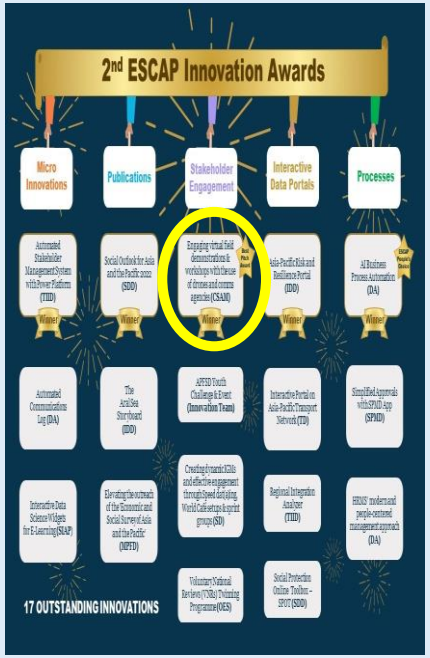


The 30th U.S. National No-Till Conference (1940-)



FAO

2020年联合国亚太经社会
第二届创新比赛奖



The 2nd ESCAP Innovation Awards



More CA Information in China

He, J. & Jiang, S. 2023. Conservation agriculture in China – Development status, innovations in machinery, investment challenges and opportunities. FAO Investment Centre Country Highlights No. 19. Rome, FAO. **https://doi.org/10.4060/cc2091en**

PDF:

(English) **www.fao.org/3/cc2091en/cc2091en.pdf**

(Chinese) **www.fao.org/3/cc2091zh/cc2091zh.pdf**

The fundamental way out for agriculture lies in agricultural mechanization

Welcom to 10WCCA, China, 2028



THANK YOU

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