

# **TECHNOLOGICAL REQUIREMENTS OF SOYBEAN PRODUCTION IN CHINA**

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Since the mid-1990s, the soybean industry in China has experienced dramatic changes. China has become the biggest soybean importer in the world due to the increasing demand of edible oil and plant protein. In 2011, China imported 52.64 million tons of soybeans, and its self-sufficiency percent decreased to about 21.58%. By contrast, soybean production increased slowly. Compared with the data in 1996-1998, the planting area, production and yield of soybean in 2009-2011 were only increased by 5.25%, 3.35% and -1.44%, respectively. In order to determine the main constraints and the technological requirements for the development of soybean production in China, the National Soybean Industry Technology R&D Centre organized an overall and in-depth survey of 2268 farmers, processors, consumers and experts in the years 2009, 2010 and 2011. The survey was targeted at the soybean production forefront and the administration departments of the three major soybean producing regions, including the Northern Spring Soybean Region, the Yellow-Huai-Hai River Valleys Summer Soybean Region and the Southern Multi-cropping Soybean Production Region. Systematic analysis of this information presented further knowledge of the soybean production status, major problems, and the basic technological requirements of China. The technological requirements fell into 6 categories: improved varieties, farming management, plant protection, machinery, processing, and policy and information services. The technical requirements to new varieties, farming management techniques and pest control ranked in the first 3 places among the three main soybean production regions. Based on the information from the survey, measures to increase soybean yield and enhance the market competence of soybean in China were proposed.

# **Technical Demands of Soybean Industry in China**

**Tianfu Han**

**Institute of Crop Science  
Chinese Academy of Agricultural Sciences**



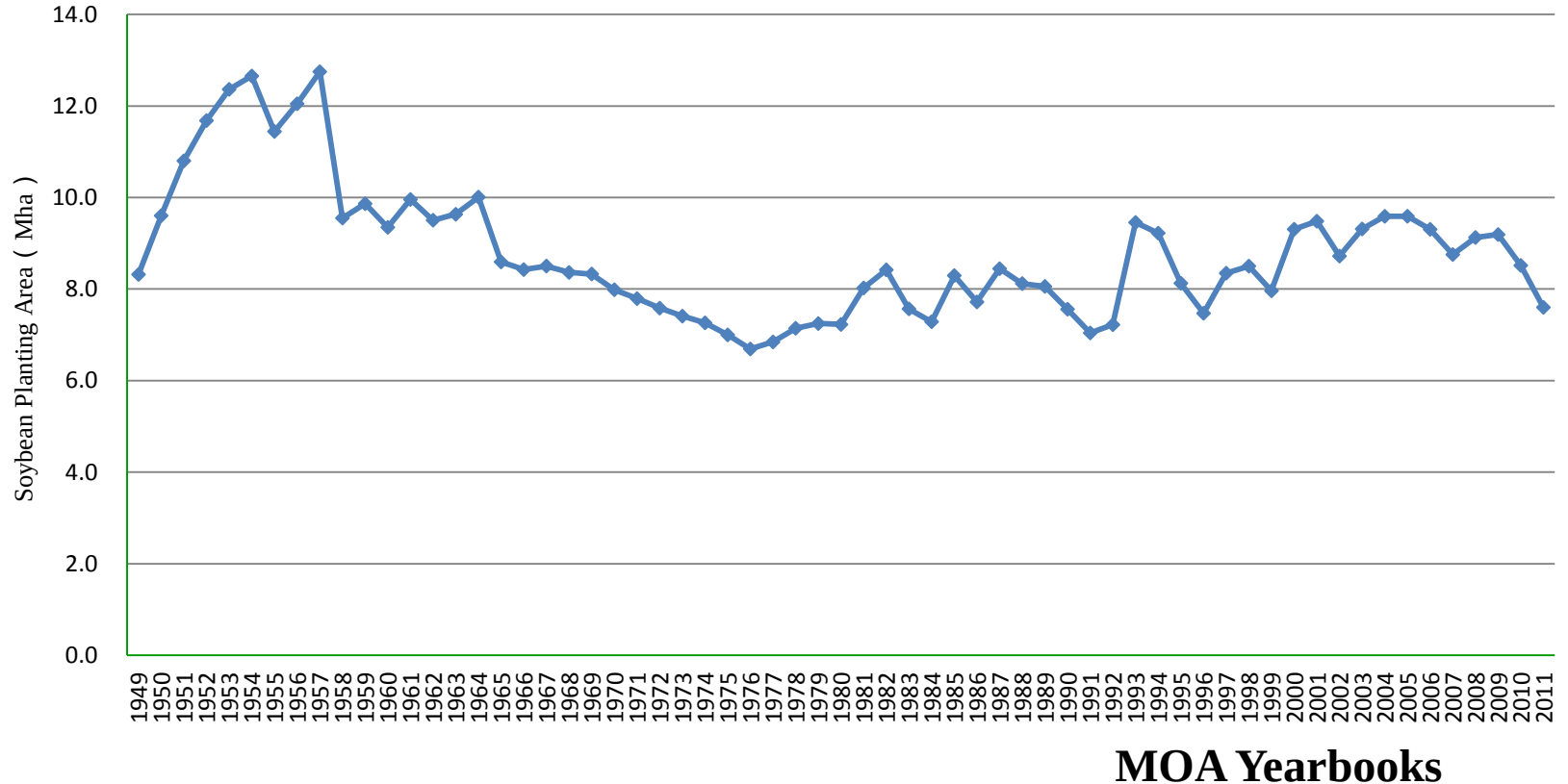
# Content

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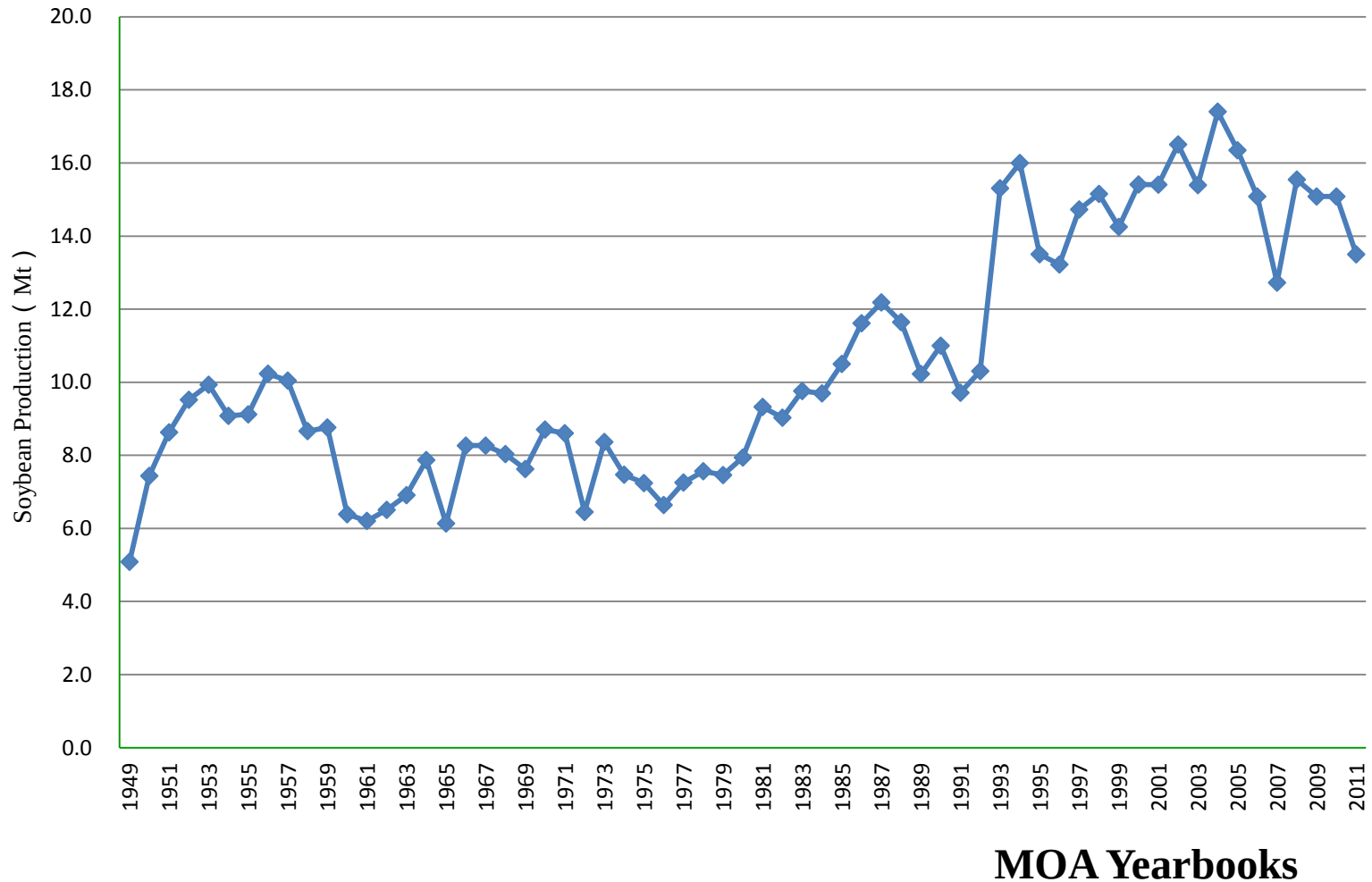
- 🟡 **Overview of soybean industry in China**
- 🟡 **Current status of technical applications**
- 🟡 **Technical demands of soybean industry in China**
- 🟡 **Prospect and strategies**

# Overview of soybean industry in China

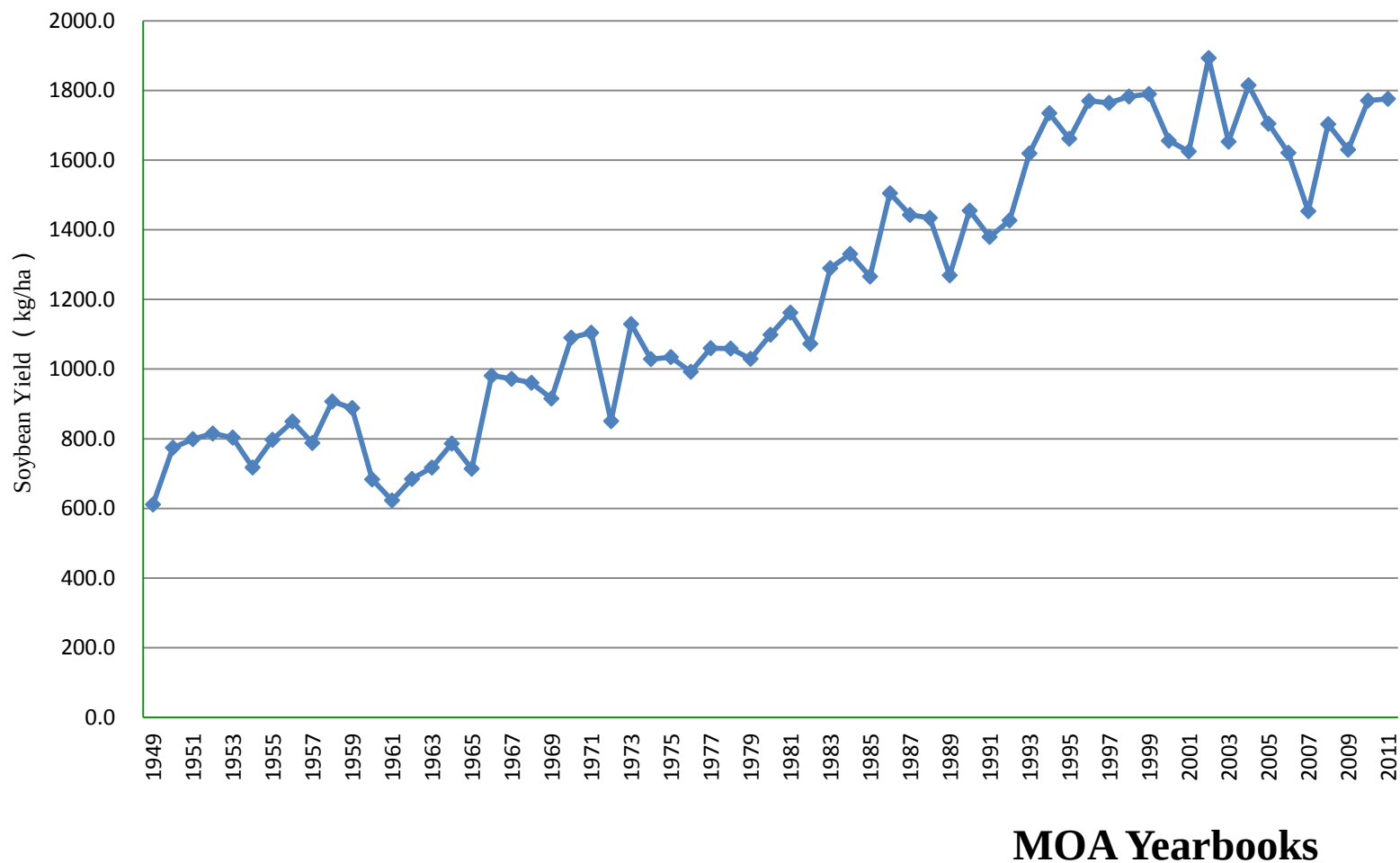
## Soybean planting area in China (1949-2011)



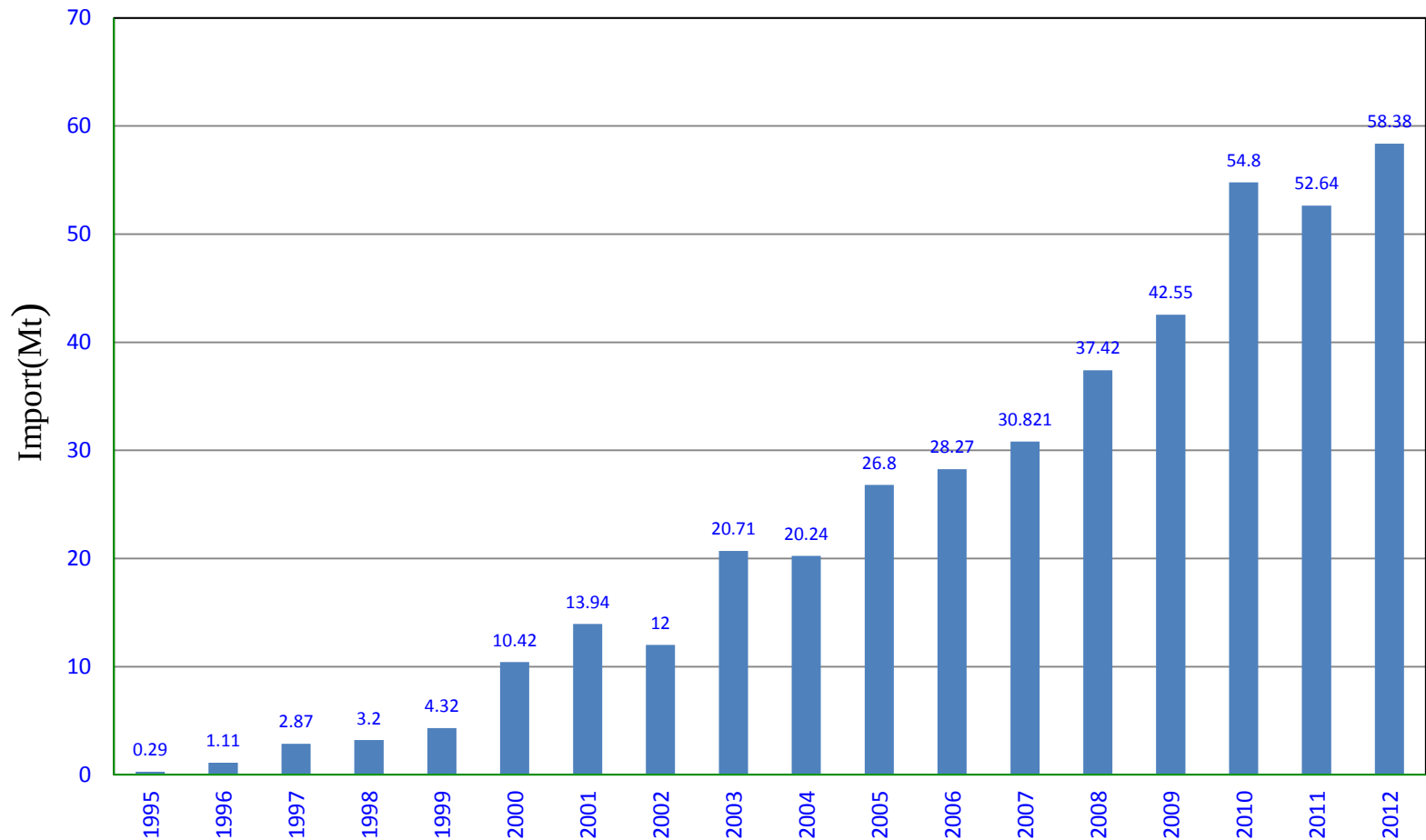
# Change of soybean production in China (1949-2011)



# Change of soybean yield in China (1949-2011)



# Importation of soybean to China (1995-2012)



China Customs data

# Content

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- 🟡 Overview of soybean industry in China
- 🟡 **Current status of technical applications**
- 🟡 **Technical demands of soybean industry in China**
- 🟡 **Prospect and strategies**

# Current status of technical applications

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- 🟡 **Cultivation models**
- 🟡 **Variety improvement**
- 🟡 **Record yields**
- 🟡 **Poor management in individual farms**
- 🟡 **Problems in R&D system**

# Soybean cultivation models in China

| Region                        | Frost free period (day) | $\geq 10^{\circ}\text{C}$ active accumulative temperature | Climate                                | Cultivation model                                                                                 |
|-------------------------------|-------------------------|-----------------------------------------------------------|----------------------------------------|---------------------------------------------------------------------------------------------------|
| Northeast                     | 110 ~ 170               | 1500 ~ 3500 $^{\circ}\text{C}$                            | Arid, semi-arid                        | “Ridge 3” Model , Narrow Row-Dense Planting, Wide Ridge and Dense Planting                        |
| Yellow-Huai-Hai Rivers Valley | 175 ~ 220               | 3500 ~ 4500 $^{\circ}\text{C}$                            | Abundant in light\heat\water resources | Direct Seeding with Wheat straw mulching, maize /Soybean intercropping                            |
| Northwest                     | 110 ~ 170               | 2500 ~ 4500 $^{\circ}\text{C}$                            | Arid, semi-arid                        | Single cropping, intercropping (Watermelon/soybean, Potato/soybean, wheat/soybean, etc.)          |
| South China                   | >210                    | >4500 $^{\circ}\text{C}$                                  | Rich in rainfall and heat resources    | Wheat/maize + soybean/sweet potato, wheat/maize/soybean, sugarcane/soybean, cassava/soybean, etc. |

# Ridge 3 cultivation model in the northeast



Sub-soiling the **ridge** base

Fertilizing with stratification under the **ridge**

Two-row precision drilling on the **ridge**

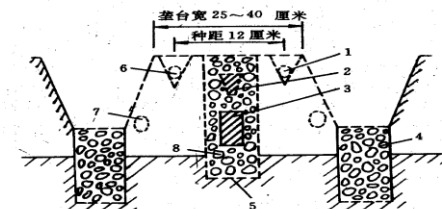


图 7—1 种子、肥料分布示意

1. 播种深度 3~5 厘米
2. 种肥深度 4~7 厘米
3. 底肥深度 10~16 厘米
4. 垄内深松部位(耕层下 8~15 厘米)
5. 垄底深松部位(耕层下 8~12 厘米)
6. 种子
7. 追肥部位
8. 犁底层

# Dense planting on the wide ridge



黑龙江, 2004

# Deep-chisel-tillage and narrow row-dense planting



**Deep-Chisel-Tillage**  
**Narrow Row**  
**Dense Planting**

# Inter-row plastic mulching on the ridges



# Inter-row plastic mulching on the ridges



# Direct seeding with traw mulching after winter wheat



4155.5 kg/ha

# Intercropping and relay systems in south China



# Intercropping and relay system in Northwest China



**Zhang Guohong, 2013**



**Soybean/potato intercropping**



**Soybean/wheat intercropping**



**Soybean/watermelon intercropping**

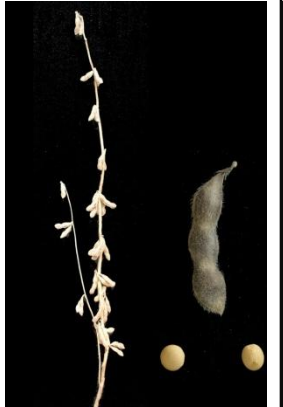
# Variety improvement

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- ◆ 1913-2012, China released about 1800 soybean varieties.
- ◆ In 2011, varieties with more than 50 000 mu or 3333 ha amounts to 304.

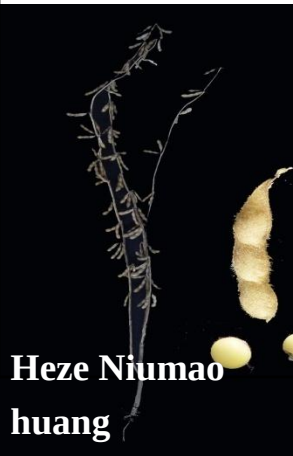
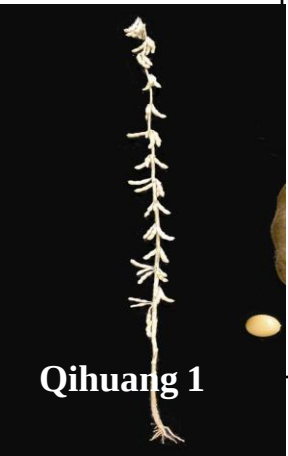


# Wildly-planted soybean varieties in Heilongjiang Province

| 1950s                                                                                               | 1960s                                                                                                | 1970s                                                                                                | 1980s                                                                                                 | 1990s                                                                                                  | 2000s                                                                                                  |
|-----------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|
| Jingshanpu<br>Zhi 2<br>Mancangjin                                                                   | Dongnong 4<br>Hejiao 8<br>Hejiao 6                                                                   | Heinong 16<br>Suinong 3<br>Hefeng 22<br>Heinong 26                                                   | Suinong 4<br>Hefeng 25<br>Heinong 33                                                                  | Heinong 35<br>Suinong 10<br>Hefeng 35<br>Suinong 14                                                    | Heinong 43<br>Heinong 44<br>Hefeng 45<br>Hefeng 50                                                     |
|  <p>Jingshanpu</p> |  <p>Dongnong 4</p> |  <p>Heinong 16</p> |  <p>Hefeng 25</p> |  <p>Suinong 14</p> |  <p>Heinong 43</p> |



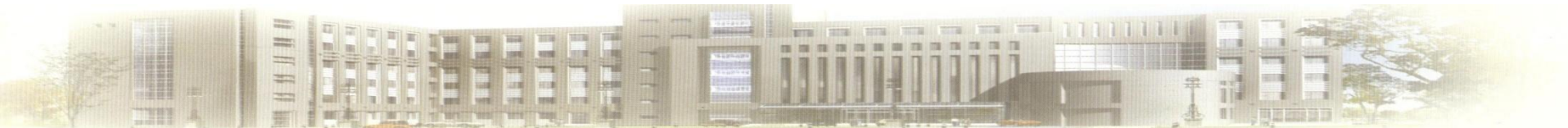
# Wildly-planted soybean varieties in the Yellow-Huai-Hai Valleys

| 1950s                                                                                                          | 1960s                                                                                               | 1970s                                                                                              | 1980s                                                                                              | 1990s                                                                                                | 2000s                                                                                                     |
|----------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|
| Hezeniumaohuan<br>g<br>Yupingdinghuang<br>Xinhuangdou<br>Xiaoyoudou                                            | Lvquan 23<br>Qihuang 10<br>Yanhuang 1<br>Qihuang 1                                                  | Fengshouhuang<br>Henanzaofeng 1<br>Wenfeng 7<br>Yuejin 5<br>Xudou 2                                | Jidou 4<br>Ludou 4<br>Yudou 2                                                                      | Zhongdou 19<br>Kefeng 6<br>Jidou 7<br>Ludou 11<br>Jidou 12                                           | Yudou 22<br>Zhonghuang 13<br>Zheng 92116<br>Handou 5<br>Xudou 9                                           |
|  <p>Heze Niumao<br/>huang</p> |  <p>Qihuang 1</p> |  <p>Yuejin 5</p> |  <p>Ludou 4</p> |  <p>Jidou 12</p> |  <p>Zhonghuang 13</p> |



# Wildly-planted soybean varieties in South China

| 1950s                                                                                          | 1960s                                                                                        | 1970s                                                                                           | 1980s                                                                                            | 1990s                                                                                          | 2000s                                                                                                      |
|------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|
| Jinda 332<br>Jimuzun<br>Lanxidaqingdou                                                         | Nannong 4931<br>58 - 161                                                                     | Taixingheidou<br>Aijiaozao<br>Edou 2<br>Xiangdou 4<br>Suidaohuang                               | Ningzhen 1<br>Zhechun 1<br>Zhechun 2<br>Liuyuebao<br>Gongdou 2                                   | Xiangchundou<br>10<br>Edou 4<br>Zhongpin 661<br>Pudou 8808                                     | Xiangchundou<br>15<br>Nandou 12<br>Guixiadou 3                                                             |
| <br>Jinda 332 | <br>58-161 | <br>Aijiaozao | <br>Liuyuebao | <br>Edou 4 | <br>Xiangchundou<br>15 |



## Record yield of soybean in China

| Variety       | Location         | Yield (t/ha) |
|---------------|------------------|--------------|
| Zhonghuang 35 | Shihezi, 2012    | 6.33         |
| Zhonghuang 35 | Shihezi, 2010    | 6.09         |
| Zhonghuang 35 | Shihezi, 2009    | 6.04         |
| Xindadou 1    | Shihezi, 1999    | 5.96         |
| Liaodou 14    | Haicheng, 2000   | 4.91         |
| Zhonghuang 13 | Xiangyuan, 2004  | 4.69         |
| MN413         | Mengcheng, 2000  | 4.73         |
| JN96-2343     | Jining, 2000     | 4.63         |
| Youchu 4      | Dengzhou, 1994   | >4.5 (3yrs)  |
| Zhechun 3     | Zhongxiang, 2000 | 3.78         |
| Nannong 88-31 | Dafeng, 2002     | 3.76         |

# Zhonghuang 35 hit the national soybean yield records



**Drip irrigation under  
plastic mulching**

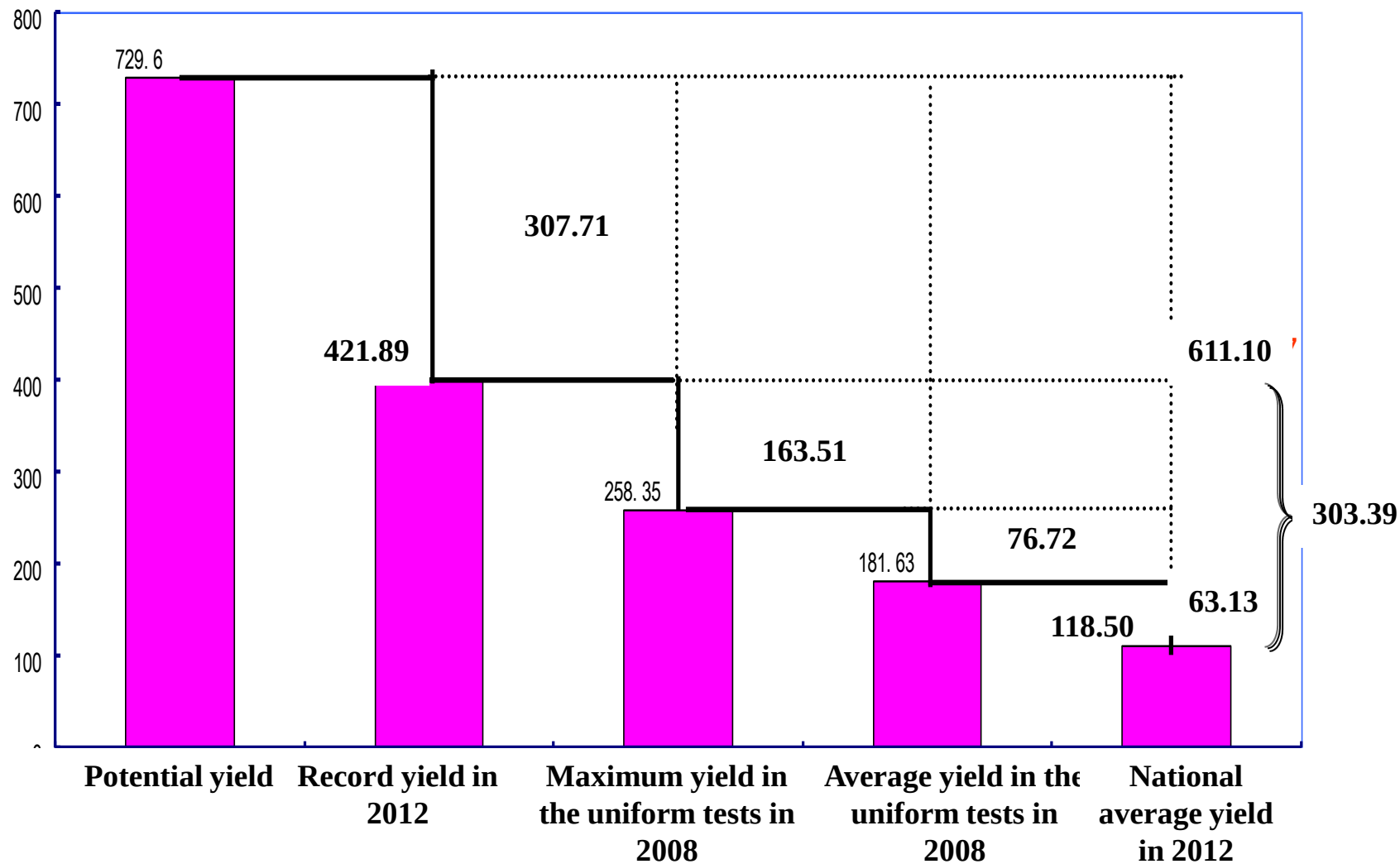
**5470.20 kg/ha in 2009  
6088.35 kg/ha in 2010  
6328.35 kg/ha in 2012  
(Shihezi, Xinjiang )**

# Poor management in individual farms



# Gaps between record yield and farmers' yield

Yield (kg/666.7m<sup>2</sup>)



## Problems in R&D system

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- 🟡 **Top-down R&D system**
- 🟡 **SCI-oriented research**
- 🟡 **Conventional technology transfer strategies**
- 🟡 **Farmers' technical demands are not well known**

# Content

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- Overview of soybean industry in China
- Current status of technical applications
- Technical demands of soybean industry in China
- Prospect and strategies

# A questionnaire technical demand survey

- Organized by CARS-Soybean
- Three years: 2008-2010
- 2787 respondents from 22 provinces
- 1849 soybean growers
- 938 researchers, field staff,  
engineers and administrators
- Participatory Rural Analysis



## Nationwide technical demand of soybean industry

| Priority order | Technical demand field                | Number of respondents | Percentage of total respondents |
|----------------|---------------------------------------|-----------------------|---------------------------------|
| 1              | New variety                           | 1394                  | 30.69                           |
| 2              | Plant protection techniques           | 1322                  | 22.02                           |
| 3              | Farming management and fertilization  | 1000                  | 29.11                           |
| 4              | Agricultural mechanization            | 623                   | 13.72                           |
| 5              | Market information services           | 105                   | 2.31                            |
| 6              | Post-harvest treatment and processing | 98                    | 2.16                            |
|                | Total                                 | 4542                  | 100                             |

# Demand priority for the new varieties

| Priority order | Variety type or technique                        | Number of respondents | Percentage of total respondents (%) |
|----------------|--------------------------------------------------|-----------------------|-------------------------------------|
| 1              | High-yielding varieties                          | 685                   | 49.14                               |
| 2              | Stress-tolerant varieties                        | 257                   | 18.44                               |
| 3              | Disease- and insect-resistant varieties          | 192                   | 13.77                               |
| 4              | High-protein varieties                           | 84                    | 6.03                                |
| 5              | Shade-tolerant and lodging resistant varieties   | 74                    | 5.31                                |
| 6              | Selection and management techniques of varieties | 48                    | 3.44                                |
| 7              | High-oil varieties                               | 28                    | 2.01                                |
| 8              | Special purpose varieties                        | 20                    | 1.43                                |
| 9              | Breeding methods                                 | 5                     | 0.36                                |
| 10             | Biotech varieties                                | 1                     | 0.07                                |
|                | <b>Total</b>                                     | <b>1 394</b>          | <b>100</b>                          |

# Technical demand priority for farming management and fertilization

| Priority | Technical demand                      | Number of respondents | Percentage of total respondents |
|----------|---------------------------------------|-----------------------|---------------------------------|
| 1        | Cultivation techniques                | 546                   | 54.60                           |
| 2        | Fertilizing techniques                | 247                   | 24.70                           |
| 3        | Plant Nutrition management techniques | 73                    | 7.30                            |
| 4        | Tillage techniques                    | 50                    | 5.00                            |
| 5        | Soil improvement techniques           | 39                    | 3.90                            |
| 6        | Standard specifications               | 30                    | 3.00                            |
| 7        | Water-saving irrigation techniques    | 13                    | 1.30                            |
| 8        | High yield formation theory           | 2                     | 0.20                            |
|          | Total                                 | 1 000                 | 100                             |

# Technical demand priorities for plant protection

| Priority order | Technical demand                                                   | Number of respondents | Percentage of total respondents |
|----------------|--------------------------------------------------------------------|-----------------------|---------------------------------|
| 1              | Integrated weed control techniques                                 | 198                   | 14.98                           |
| 2              | Control of <i>phytophthora sojae</i> and other soil-borne diseases | 151                   | 11.42                           |
| 3              | Control of soybean pod borer                                       | 121                   | 9.15                            |
| 4              | Control of soybean aphid ( <i>Aphis glycines</i> )                 | 105                   | 7.94                            |
| 5              | Control of soybean stem and foliar diseases                        | 102                   | 7.72                            |
| 6              | Control of soybean mosaic virus                                    | 101                   | 7.64                            |
| 7              | Chemical application techniques                                    | 90                    | 6.81                            |
| 8              | Control of underground pests                                       | 88                    | 6.66                            |

# Technical demand priorities for plant protection

| Priority order | Technical demand                                  | Number of respondents | Percentage of total respondents |
|----------------|---------------------------------------------------|-----------------------|---------------------------------|
| 9              | Control of soybean cyst nematode                  | 82                    | 6.20                            |
| 10             | Control of carmine spider mite                    | 59                    | 4.46                            |
| 11             | Mitigation of continuous soybean cropping hazards | 45                    | 3.40                            |
| 12             | Herbicide phytotoxicity removal                   | 29                    | 2.19                            |
| 13             | Control of soybean parasitic seed plants          | 9                     | 0.68                            |
| 14             | Control of other leaf-feeding insect pests        | 142                   | 10.74                           |
|                | Total                                             | 1 322                 | 100                             |

# Weeds in soybean fields



**crab grass**



**eleusine indica**



**moleplant seed**



**green bristlegrass**



**amaranthus retroflexus**

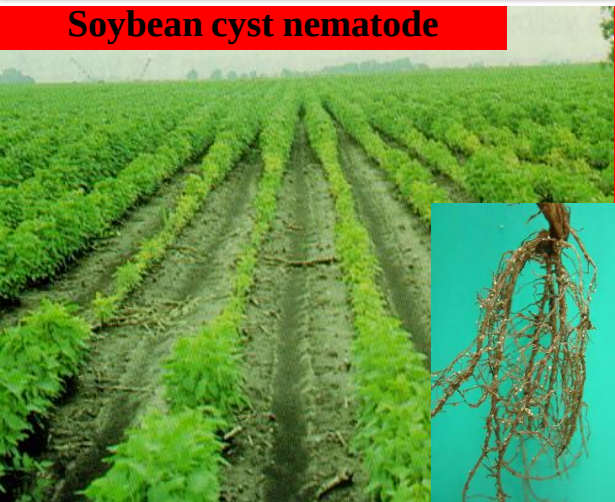
**amaranthus blitum**

**cyperus microiria**

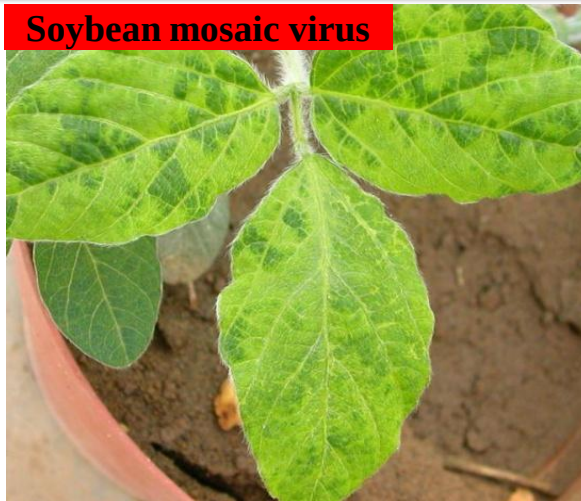
**barnyard grass**

# Soybean diseases

**Soybean cyst nematode**



**Soybean mosaic virus**



**Soybean downy mildew**



**Soybean grey speck disease**



**Soybean Sclerotinia**



**Soybean rust**



# Soybean insect pests



**Grub**



**Soybean pod borer**



**soybean stem-miner**



**Soybean aphid**



**Carmine spider mite**



**Loxostege sticticalis**

# Soybean insect pests



Snail, Li Suzhen, 2013



Leafhopper, Li Suzhen, 2013



*Riptortus pedestris* (Fabricius), Xu Ran, 2013

# **“Zhengqing” Phenomena of soybean in the Yellow-Huai –Hai Valleys**



# Technical demand priority for agricultural mechanization

| Priority order | Technical demand                                                                  | Number of respondents | Percentage of total respondents |
|----------------|-----------------------------------------------------------------------------------|-----------------------|---------------------------------|
| 1              | Sowing machinery                                                                  | 144                   | 23.11                           |
| 2              | Harvesting machinery                                                              | 135                   | 21.67                           |
| 3              | Tillage machinery                                                                 | 123                   | 19.74                           |
| 4              | Irrigation and water conservancy facilities                                       | 89                    | 14.29                           |
| 5              | Cultivating and plant protection machinery                                        | 74                    | 11.88                           |
| 6              | Accessory protective cultivation machinery                                        | 26                    | 4.17                            |
| 7              | Seed processing equipments                                                        | 15                    | 2.41                            |
| 8              | Key technique and equipment for variable rate operations in precision agriculture | 11                    | 1.77                            |
| 9              | Stalk treatment equipment                                                         | 6                     | 0.96                            |
|                | Total                                                                             | 623                   | 100                             |

# Poor quality of summer soybean seeding in Huang-huai-hai regions due to wheat straw



# Technical demand priority for post-harvest treatment and processing

| Priority order | Technical demand                               | Number of respondents | Percentage of total respondents |
|----------------|------------------------------------------------|-----------------------|---------------------------------|
| 1              | Enzyme engineering techniques                  | 27                    | 25.71                           |
| 2              | Soybean protein engineering techniques         | 26                    | 24.76                           |
| 3              | Fermentation engineering techniques            | 19                    | 18.10                           |
| 4              | Membrane separation techniques                 | 14                    | 13.33                           |
| 5              | Modern separation techniques                   | 8                     | 7.62                            |
| 6              | Traditional soybean food processing techniques | 3                     | 2.86                            |
| 7              | Microencapsulation techniques                  | 2                     | 1.90                            |
| 8              | Extrusion and expanding techniques             | 2                     | 1.90                            |
| 9              | Genetic engineering techniques                 | 1                     | 0.95                            |
| 10             | High-frequency electric field techniques       | 1                     | 0.95                            |
| 11             | Superfine comminution techniques               | 1                     | 0.95                            |
| 12             | High-pressure processing techniques            | 1                     | 0.95                            |
|                | Total                                          | 105                   | 100                             |

# **Demand priority for policies and market information services**

| <b>Priority order</b> | <b>Demand</b>                                          | <b>Number of respondents</b> | <b>Percentage of total respondents</b> |
|-----------------------|--------------------------------------------------------|------------------------------|----------------------------------------|
| <b>1</b>              | <b>Measures or policies to reduce production costs</b> | <b>43</b>                    | <b>43.88</b>                           |
| <b>2</b>              | <b>Market information service</b>                      | <b>19</b>                    | <b>19.39</b>                           |
| <b>3</b>              | <b>Price protection</b>                                | <b>17</b>                    | <b>17.35</b>                           |
| <b>4</b>              | <b>Large-scale production</b>                          | <b>15</b>                    | <b>15.30</b>                           |
| <b>5</b>              | <b>Early warning system</b>                            | <b>4</b>                     | <b>4.08</b>                            |
|                       | <b>Total</b>                                           | <b>98</b>                    | <b>100</b>                             |

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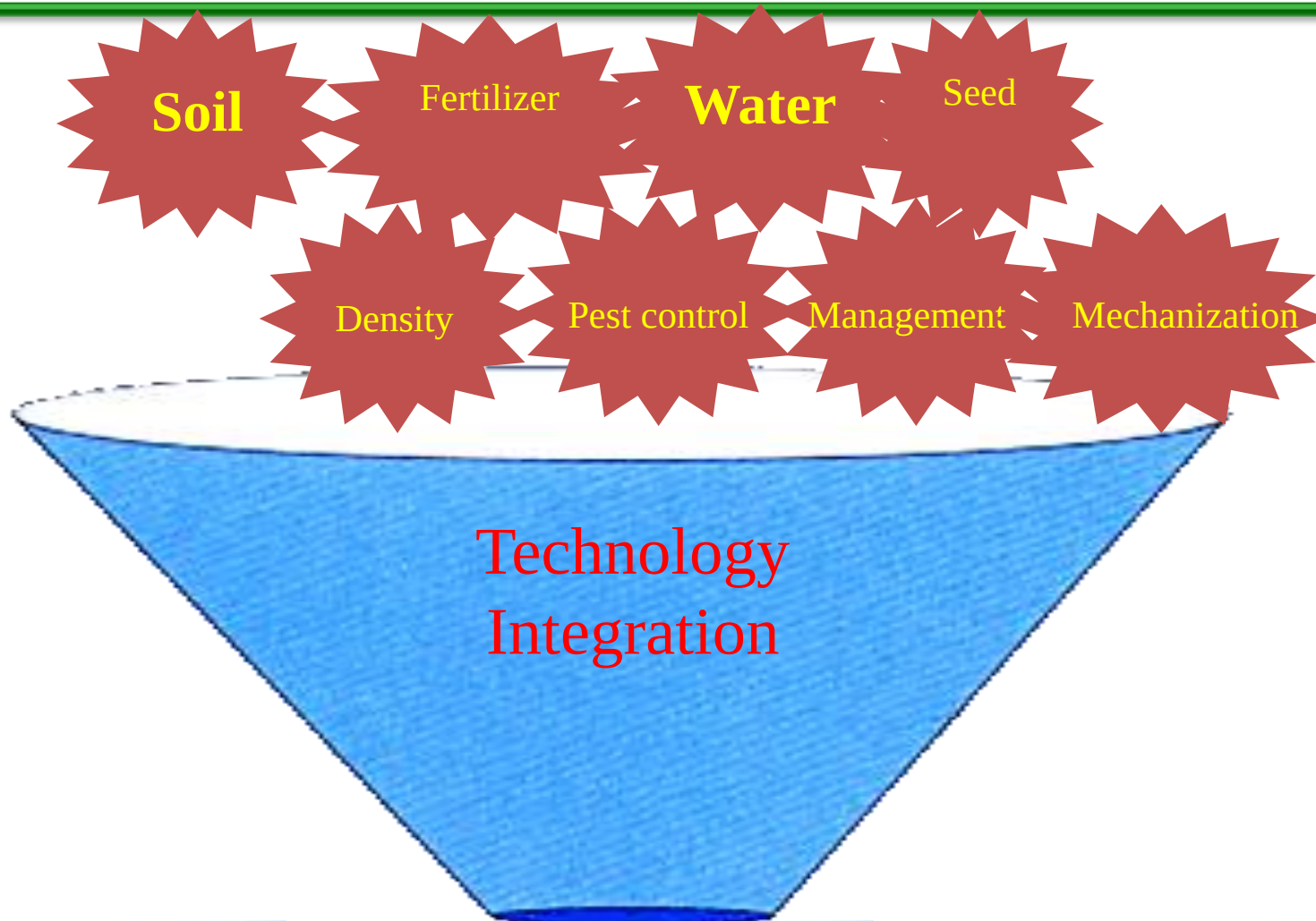
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- 🟡 Prospect and strategies

# Prospect and strategies

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- ❑ Improving production condition of individual farms to increase the yield
- ❑ Optimizing distribution of production regions and stabilizing the planting area
- ❑ Broadening farm scale to enhance production efficiency
- ❑ Promoting science and technology innovation
- ❑ Enhancing extension of agricultural technology
- ❑ Improving information service

# Improving production condition to increase the yield

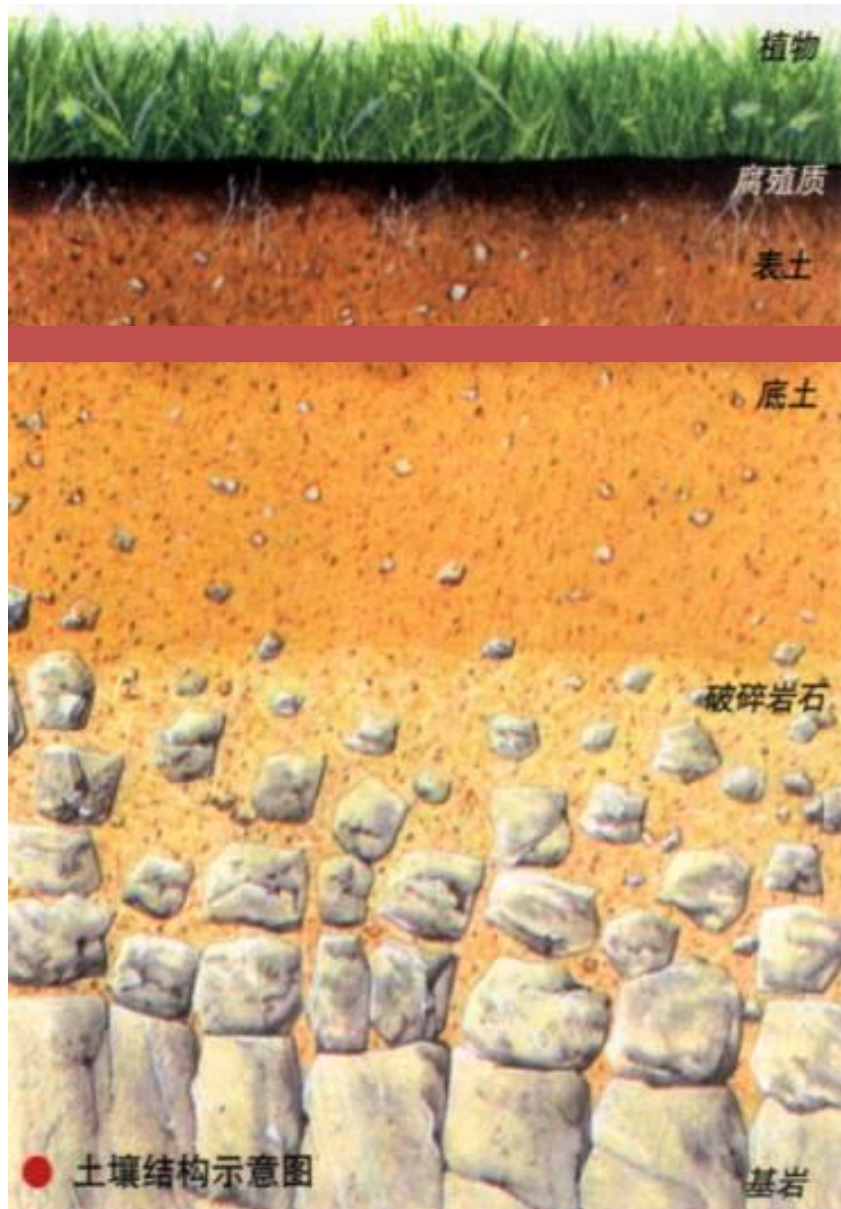


# No tillage soybean sowing in Argentina



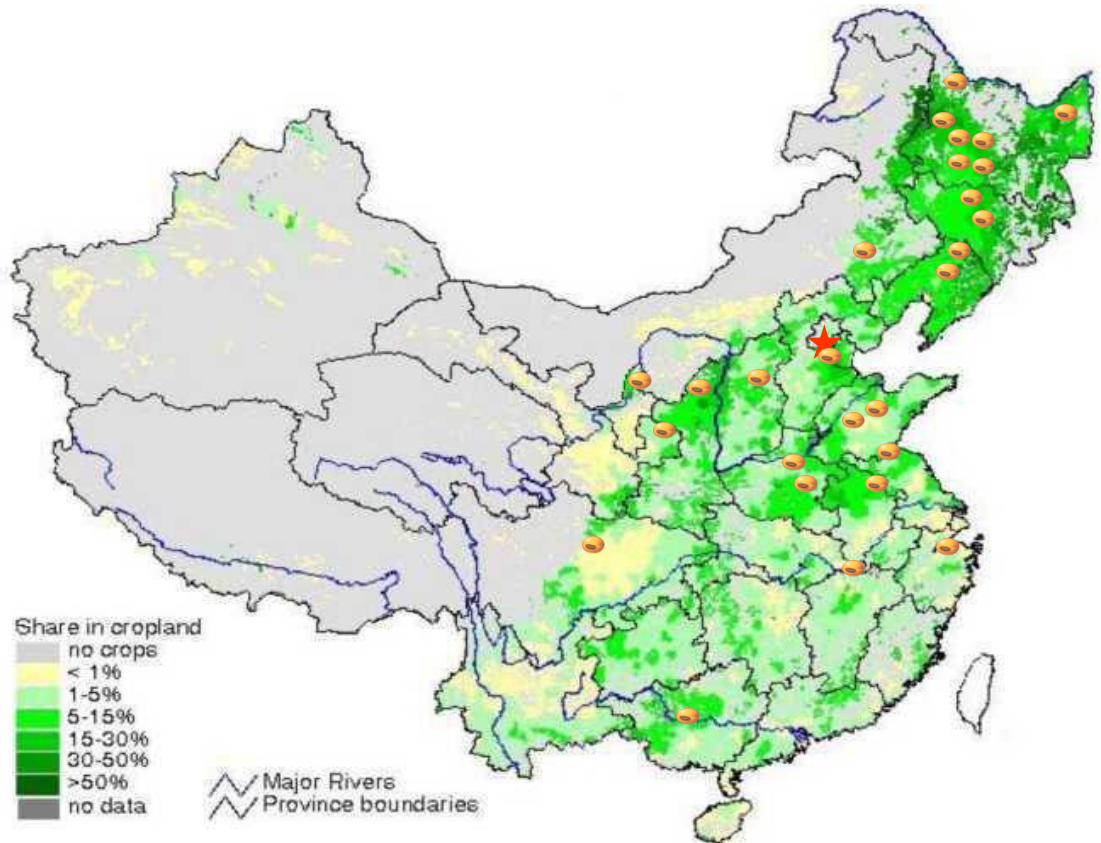
Picture source: Hu Guohua

# Deep chisel tillage to conserve soil water



# Optimizing distribution of soybean production

- Reinforcing leading role of Northeast soybean region
- Further developing Huang-Huai-Hai soybean region
- Expanding the planting area in South China



# Broadening farm scale to enhance production efficiency

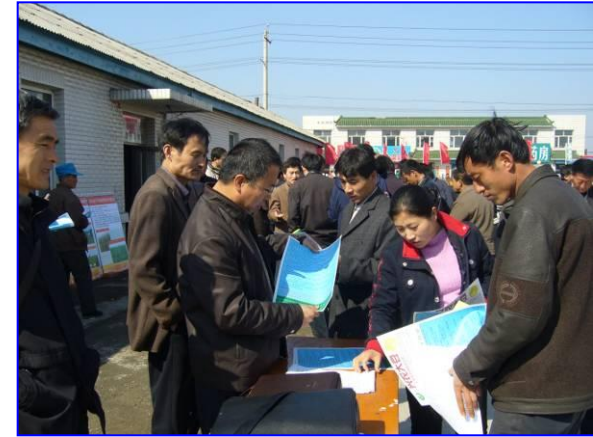


# Promoting science and technology innovation

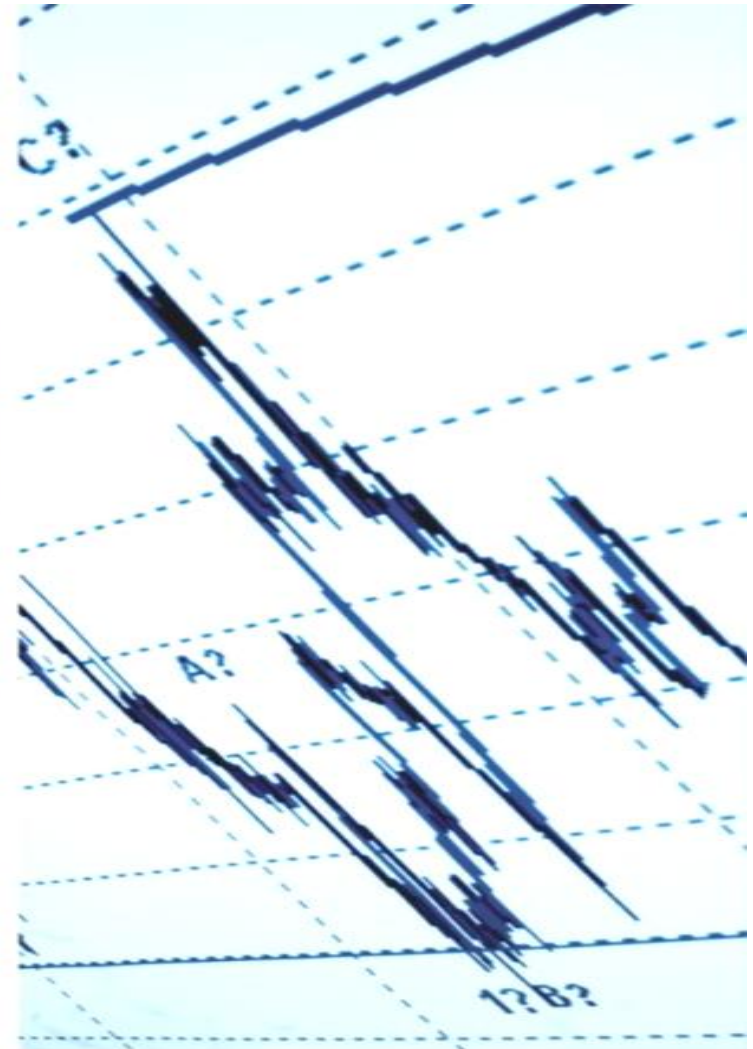
**Biotech varieties are needed**



# Enhancing extension of agricultural technologies



# Improving information service



# Supporting policies

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- ❑ **Trade policy adjustment**
- ❑ **Equal supports to soybean as high-yielding crops**
- ❑ **To develop food soybean industry**
- ❑ **Respect the right for farmers to use biotech**
- ❑ **Compensation to losers of free trade**

# Acknowledgement

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- Colleagues from National Soybean Industrial Technology System
- Experts from USA, Brazil, and Argentina, etc.
- Other soybean experts in China
- Pictures from News Media
- Guangming Yang and Wenwen Song for data analysis
- China Agriculture Research System (CARS-04)

