INTELLIGENT TECHNOLOGY & EQUIPMENT

GREENHOUSE PRODUCTION

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PROTECTED AGRICULTURE INSTITUTE

CHINESE ACADEMY OF AGRICULTURAL ENGINEERING PLANNING & DESIGN
1. Developing Status for GH

2. Indoor Environment control

3. Clusters water-fertilizer supply
1. Developing Status for GH
By the end of 2016, the amount of greenhouse was 2082.8 thousand ha in China (not include small tunnels), which took more than 80% of the world.

51.8 thousand ha for gutter connected greenhouses, 661.4 thousand ha for Solar greenhouses, 1.3697 million ha for plastic pipe-houses.
## 1. Developing Scale

<table>
<thead>
<tr>
<th>Rank</th>
<th>Province</th>
<th>Scale (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Jiangsu</td>
<td>338028</td>
</tr>
<tr>
<td>2</td>
<td>Shandong</td>
<td>296286</td>
</tr>
<tr>
<td>3</td>
<td>Liaoning</td>
<td>292016</td>
</tr>
<tr>
<td>4</td>
<td>Hebei</td>
<td>216382</td>
</tr>
<tr>
<td>5</td>
<td>Hubei</td>
<td>97878</td>
</tr>
<tr>
<td>6</td>
<td>Gansu</td>
<td>87600</td>
</tr>
<tr>
<td>7</td>
<td>Inner Mongolia</td>
<td>79050</td>
</tr>
<tr>
<td>8</td>
<td>Sichuan</td>
<td>76214</td>
</tr>
<tr>
<td>9</td>
<td>Henan</td>
<td>74644</td>
</tr>
<tr>
<td>10</td>
<td>Shanxi</td>
<td>68823</td>
</tr>
</tbody>
</table>
2. Cultivation Varieties

More than **88%** of the greenhouse is used for vegetable production

6.2% for flowers production, increasing fast  
5% for fruit production, (including Berry)
3. Main Achievements

For supply

In 2016, the output of vegetables from greenhouse is about **250 million tons**, accounting for **30.5% of the total vegetable output** of the country. For every people, with an average per capita share of 180 kg.

For promoting income

The net output value of greenhouse horticulture is more than **570 billion yuan**. The income of every rural people increase more than 980 yuan by greenhouse horticulture.
4. Challenges

With the development of economy, demand for high quality and safety horti-products is increasingly strong.

From Market

Green Safe Fresh Delicious for products
4. Challenges

**From labor cost**

Labor cost takes more and more shares of total cost for greenhouse productions, which restricts the scale development of industry.

For grafting seedlings **22%~25%**  
For GH vegetable more **50%**

For saving labor and making precise production  
**the application of intelligent technology and equipment for GH necessary!**
5. Developing status

Gutter connected greenhouse is easy to combine with intelligent tech&equip

——More equipment ventilation, cooling, heating, artificial lighting

——More indoor space easy for automatic operation

——Stable process harvest time and production can be forecast
5. Developing status

Automatic production of whole process for pot flower (Tianjin)  Anthura

-基质破碎
-基质填装
-种苗移栽
-移动喷灌+潮汐灌
-智能检测、分级

Substrate mixture  Pot filling  Transplant  Tidal irrigation  Classify
5. Developing status

Automatic production of whole process for seedling (Inner Mongolia)

2ha greenhouse, investment 30 million yuan, 80 million seedling can be harvest

Mixture  Seeding  Transplant  fill the gaps
搅拌  播种  移栽  补苗
5. Developing status

Solar GH&Plastic pipe-house are main types of China. They also have demands for intelligent production.

--- Few equipment;
--- Few indoor space;
--- Non-stable for production;

Production link Labor using

<table>
<thead>
<tr>
<th>生产环节</th>
<th>劳动比重</th>
</tr>
</thead>
<tbody>
<tr>
<td>转整地</td>
<td>3%</td>
</tr>
<tr>
<td>定植</td>
<td>2%</td>
</tr>
<tr>
<td>灌溉施肥</td>
<td>23%</td>
</tr>
<tr>
<td>植株管理</td>
<td>30%</td>
</tr>
<tr>
<td>温室环境管理</td>
<td>19%</td>
</tr>
<tr>
<td>采收</td>
<td>15%</td>
</tr>
<tr>
<td>输送</td>
<td>6%</td>
</tr>
<tr>
<td>商品化处理</td>
<td>0%</td>
</tr>
<tr>
<td>秸秆废弃物处理</td>
<td>3%</td>
</tr>
</tbody>
</table>
2. Indoor Environment control
1. Technic Demands

Ventilation is the most frequently environmental control method for solar greenhouse, and it is also an important link affecting the quality and output of products.

The temperature and humidity of the greenhouse change abrupt when opening and closing the air outlet manually.
2. machine design

Gear motor → Drive steel cable → Vent rope → Vent open
3. Control Principle

Automatically adjust ventilation according to indoor temperature changes.

Separating the GH with several subsections for ventilation control. Each section detects temperature and gives a signal for ventilation. Solve the temperature difference in the greenhouse.
4. APP Interface
The 3 section control mode has the lowest temperature fluctuation.
5. Application effect
3. Clusters water-fertilizer supply
1. Technic Demands

- Reduction of water and fertilizer;
- Water and fertilizer cluster management of greenhouses in the park;
2. Technical principle

1. Design of fertilizer distribution pipeline
2. Equipped Water-fertilizer supply machine
3. Setting Cluster control
4. Establish Integrated irrigation-fertilization mode
For a greenhouse production area,
The PIPENET pipe network simulation software is used to provide speed, pressure and flow network design for the greenhouse.
4. Water-fertilizer supply machine

PID+PWM algorithm module (enhance control accuracy)
Channel ratio adjustment module (adjust fertilizer ratio)
Irrigation management module (automatic irrigation)

EC adjustment error is less than (+8%);
pH adjustment error is (+0.05);
response time is less than 120 s
Based on the control of "**startup time** + **irrigation frequency** + **irrigation volume**", intelligent irrigation control is carried out.
5. Cluster control

- **Wired**: 2 line decoding, 2 lines to achieve communication, feedback and power supply, reduce the use of lines and quantities.

- **Wireless**: LoRa, low energy consumption wide area wireless Internet of things communication technology to achieve remote automatic control.
Used in Beijing, Hebei, Shandong, Ningxia, Guangdong,
Used for soil cultivation, substrate cultivation, water cultivation

90% labor saving
40% water saving
20% production increase
Institute of Protected Agriculture

The earliest research and promotion of greenhouse horticulture in China

Establish National Greenhouse Horticulture research center
敬请帮助指正