Energy-Saving Plant Factory
Vertical Farm
INTRODUCTION
Summary

KOREA AGRICULTURE SYSTEM & TECHNOLOGY

- National Calibration Laboratories (ISO 17025)
- Awarded Industrial Medal of Honor, Ministry of Commerce, Industry and Energy Award (2 times)
- Creative Economy Award (Gold Statue), 2014
- Best Green Energy Company Award (1st Prize), 2014
- Intertek Certification Marks (C/US), 2016

LED Light Bar Luminaire and Controller

Business Area

- Energy Saving LED LIGHT
- Energy Saving Controller
- Integrated Control System of Vertical Farm
- The Raising of Seedling Facilities
- Intelligent Control System
Company Status

Patents and know how

Certificate of Gyeongbuk Pride Enterprise
Creative Economy Award (Gold Prize)
Best Green Energy Company Award (1st Prize)
Citation of Ministry of Knowledge Economy
Certificate of New Renewable Energy Enterprise
Certificate of Non Agricultural Chemical
Certificate of Green Technology
Certificate of Intertek (Canada/US)
Company Status

Patents and know how

Design Registration
Patent Registration
Patent Registration in Japan

Patent Registration
Patent Registration
Patent Registration
Patent Registration
History

2010년~

01. Vertical Farm for National Academy of Agricultural Science research Center
02. Subway Indoor Farm for Incheon Metropolitan City Government
03. Container type Vertical Farm for Gyeongbuk Agricultural Technology Center
04. Vertical Farm for Zhengyang Co., Ltd., (Busan)
05. High-tech indoor Farm for Daegu Metropolitan City
06. Demonstration indoor farm for Gyeongbuk Agricultural Technology Center
09. Plant Square Plant Factory for Daegu Agriculture Technology Center

Venture Company Registration
National calibration laboratories (ISO 17025)
Patents, Utility model, Registered design
Successful implementation of Industry-Academy-Research project (5)
Awarded Industrial Medal of Honor, Ministry of Commerce, Industry and Energy Award (2)

2012년

04. LED Vertical Farm for ORIENTAL CO., Ltd. system’s first export (Japan)
08. Container type plant factory for PRODIGY CO., Ltd. export (Chongqing City, China)
11. Certificate of Green Technology
12. Container type Vertical Farm in Yeungnam University

2013년

07. High-tech greenhouse plant installation in Kyungpook National University Science Park
09. Yantai nongda Nongshim Vertical Farm (China)

2014년

10. O.C.N indoor Farm for Opaskwayak Cree Nation in Manitoba (Canada)
11. Hybrid Vertical Farm for Han Dong Co., Ltd. (China)
12. Vertical Farm for PGF (Boston, USA)

2015년

10. O.C.N indoor Farm for Opaskwayak Cree Nation in Manitoba (Canada)
11. Hybrid Vertical Farm for Han Dong Co., Ltd. (China)
12. Vertical Farm for PGF (Boston, USA)
Company Status

The installation performance

Chungchowon (Gyeongsan)
Rural Development Administration

Gyeongnam Agriculture Technology Center
KAST Ginseng Container

Daegu Gyeongbuk Science Technology Center
Chungto (Daegu)

Gyeongbuk Agricultural Technology Center
Daegu Agriculture Technology Center

Kyungpook National University Science Park
Zhengyang (Busan)

Subway Indoor Farm (Incheon)
Natural Endo Tech (Seoul)

Seongju Fruits and Vegetables Test Center
KAST Strawberry Container

Boston, USA
O.C.N (Canada)

Yantai Nongda Nongshim (China)
Prodigy (China)
SUMMARY
Summary

What Vertical Farm?

- Next generation Agricultural Platform based on the convergence of Integrated technologies of IT, BT, ET and etc.

- Vertical Farm raises various plants using LED as artificial light source, CO₂, Nutrients, and Water controlled by automatic facilities in closed environment and real-time monitoring.
Summary

Why Vertical Farm?

- Global Warming
- Increasing Self-sufficient of Food Production
- Food Shortage
- Increasing Safe Foods Necessity

WHY?
Summary

Advantages

- 365 days cultivation
- Increase reliability and food safety
- Increase specific nutrient of plants
- Farming at any place
- Multi-layer structure: maximize cultivation area
- Increase product quality and value

- No climate influence
- Minimize Energy Consumption
- Minimize logistics cost
- Water: up to 95% save
- Nutrient: up to 90% save
- No Pesticide & No herbicide:
How to cultivate in Vertical Farm?

- **Light**: LED bar (Red 660nm, Blue 450nm)
- **Air**: CO₂(Leaf), O₂(Root)
- **Water**: DFT or Spray type
- **Soil**: Without soil
- **Nutrients**: Spray(size: 50~80μ) or Periodic Flow
Summary

Vertical Farm Components

- Solar Panel
- Power Controller system
- LED Light & Cultivating System
- Nutrient Solution & Water System
- Main Controller
- Air Conditioning System
- Various Sensors
- Nutrient Solution & Water System
- LED Light & Cultivating System
- CCTV

Centralized SW Control System

Electricity

Power supply

Power & System Control

System Control

Data Gathering, System Control

System Control

System Control

System Control

System Control

System Control

System Control

System Control

System Control

System Control

System Control
Summary

LED Light System

- LED Light: Red 660nm, Blue 450nm
- Adjustable lighting PPFD and Distance
- Designed for minimizing heat generation
- High efficient light source: enough lighting with high efficient LED package
- Very stable lighting solution supported by optimal light source alignment
- Maximize reliability with Minimize maintenance cost
Summary

LED Light Spectrum

Absorption spectrum showing absorption maxima at 450 nm and 660 nm for Chlorophylls a and b, respectively.

Wavelength (nm):
- UV: 380 nm - 460 nm
- Blue: 460 nm - 480 nm
- Green: 480 nm - 520 nm
- Yellow-Green: 520 nm - 590 nm
- Amber: 590 nm - 595 nm
- Orange: 595 nm - 615 nm
- Orange Red: 615 nm - 640 nm
- Red: 640 nm - 700 nm

LED Light Spectrum Summary

- UV: 380 nm - 460 nm
- Blue: 460 nm - 480 nm
- Green: 480 nm - 520 nm
- Yellow-Green: 520 nm - 590 nm
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- Orange Red: 615 nm - 640 nm
- Red: 640 nm - 700 nm

Korea Agriculture System & Technology
LED Light System

- KAST has several patents and a know-how for controlling of Plant-specific optimum wavelengths, wavelength control, pulse wave and Duty rate. --> promotes optimal growth, antioxidants in plants, and implementing electricity savings.

- Because of reservation function, Scheduling brightness and adjustments for wavelength, Pulse and Duty rate are possible (25-50%) – ETL Test Lab Approved.

- Adjustable Power LED 50~250 μmol m⁻² s⁻¹

Summary
Summary

Integrated Control System

■ Centralized control system for lighting, aeroponic, air-conditioning
■ Test and analysis system for R&D: data gathering, condition control (Optional)
  ● Can be monitored and managed easily and conveniently with a computer automatic control system by anyone and anywhere.
  ● The data recording system for Light control, and environmental is useful to analysis the Growing conditions.
  ● Wavelength, Pulse, duty ratio adjustment of the light and the light environment changes applicable by each of the lighting control function.
Summary

Control System

- PC based Monitoring and automatic control system
- Control Timer, Control Box
- Control cultivation condition: Luminous Flux, Lighting time, Humidity, Nutrient and CO₂ supply
- Monitoring cultivation status and data profiling
- Measurement devices: CO₂, Temperature, Humidity, PH, EC

The Control System of Temperature & Humidity

(HVAC) Heating, Ventilating, Air Conditioning system

Fog systems
Summary

Nutrient supply system - Flow

- Raw water tank
- Nutrient solution mixture tank
- Nutrient controller
- Control panel
- Watering pump
- Pressure gauge
- Flowmeter
- EC/pH sensor
- Supply tank
- Solenoid valve
- Nutrient solution mixture tank
- Stirrer
- Solenoid valve
- Flowmeter
- Supply pump/filter
- Water level sensor
- Aeroponic or DFT
- Controller
- Water level sensor
- EC/pH sensor
- EC/pH transmitter
Summary

Nutrient supply system - Sprayed Water Culture System

- Top & Inside of the Chamber System

- Spray of nutrients and water (size: 50-80 microns)

- Spraying rich nutrient solution to the roots of the plant

- A hydro-atomized pure water/nutrient solution is sprayed or misted to the roots for short time period.
- Supply of abundant oxygen to water and nutrients.
Summary

Nutrient supply system - Deep Floor Technique Culture system
Cultivation system with Multi-layer Beds

- **Increasing yields per unit area**
  - The modular configuration: LED light + multi-stage type cultivation racks can save unnecessary costs with the modularity and configuring the space efficiently. -> (increase yields per unit area)
  - Clean cultivation environment and electric safety / fire prevention because electrical wiring and control line are operating separately. (5-48 Voltage)

- **Hydroponic System**
  - Hydroponics can be customized according to the size, usage, and demand.
  - Improve productivity and rationalization of space utilization.
  - Durable and reinforced materials – Bed Frame.

- **Control System**
  - Each configuration of the light intensity and the light spectrum
  - Configuring a high-speed ON / OFF function (pulse) of the LED and a separate control
Summary

Power Supply Method of Plant Factory

1. The Comparison type (All-In-One type)

1) The electrical energy efficiency is low (60-70%)
2) The heat generated from LED Bars in the plant factory, so, cost of air conditioning and operation are increased.
3) 220V AC power feed is dangerous
4) it is difficult to directly connect with the Solar Cell later.
5) Automation is difficult

2. KAST type (Separate type for power and light)

1) High efficiency (85-90%)
2) Because the heat generated from the power supply (Controller) in the outside of plant factory, the load of the air conditioning is low and power costs are decreased.
3) It is safe to low voltage (DC 48V max) power feed in LED Bar.
4) Easy direct connection to Solar Cell and other power supply.
5) It is easy to automate to manage optimal growing condition.
Summary

Facilities & Instruments of Vertical Farm

**HVAC**
- Intake Filter
- Intake
- Outlet
- Warm & Cool A/C

**Automatic Control System**
- LED Light
- Control Computer
- Water Controller
- Temp Humidity Recording

**Air Shower**
- Exit
- Inside
- Clean Wear

**Watering system**
- Watering line
- Stirrer
- Water Tanks
Summary

Business Development Structure

- Plant Factory Technology
- LED Lighting Technology
- Cultivation Technology

Partners

- Plant Factory Building Construction
- Prepare Land
- Human Resource
- Cultivation
- Sales and Marketing
PROPOSAL
Land area: 330 m²

Business Proposal

Standard Vertical Farm
Business Proposal

1. Water Usage
   - 250 liters per bed
   - Total: 20,000 liters

2. LED bar
   - 20 units per bed
   - Total: 160 units

3. Controller
   - 4 units per cultivating frame

4. Cultivated Acreage
   - Land area: 330 m²
   - 10 lanes, 8 layers, 2 floors
   - Total cultivation area: 768 m²

5. Electricity Usage
   - LED bar 64kw
   - Air Conditioner 70kw
   - ETC 5kw
   - Total: Approx. 140kw

6. Yields
   - Approx. 2,073kg per a month
Business Proposal

Outline DWG

2,000 liters tank
5 lines 8 layers
2 floors
## Business Proposal

### Expected production

<table>
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<tr>
<th>Cultivating Line</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
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<tbody>
<tr>
<td>Quantity of each Line</td>
<td>432 Roots</td>
<td>432 roots</td>
<td>432 roots</td>
<td>432 roots</td>
<td>432 roots</td>
<td>432 roots</td>
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<tr>
<td>Quantity of each Layer</td>
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<tr>
<td>Layer/Root/20days Per Line</td>
<td>6,912 roots</td>
<td>6,912 roots</td>
<td>6,912 roots</td>
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<tr>
<td>Total Yields</td>
<td>34,560 roots per a month</td>
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</tbody>
</table>

1) Land Area: 330 m²  
2) Cultivation Area: 768 m²  
3) Weight: 60g per Roots (Lettuce)
Business Proposal

Container Types
Business Proposal

The Scope of Smart Farm Business (Suggested)

- Green Salad
- Dietary
- Supplements
- Grain
- Root/Fruit
- Vegetable Juice

- Clean and Fresh Green Salad Company
- Pesticide-free Vegetable Juice
- Sales and Delivery
- Contraction Based Cultivation for large Distributor or Wholesalers
- Herbs for Oriental Medicine
- Home delivery

- High Quality Cultivation Technique
- Urban Store Type Smart Farm
- Nutrient Solution Well-being Food

- Facilities and Equipments for Smart farm
- Household Aeroponics Appliances
- Export Automated Plant Factory System (For the Poor Weather Condition Area)
Business Proposal

Facilities & Instruments of Vertical Farm

HVAC
- Intake Filter
- Intake
- Outlet
- Warm & Cool A/C

Automatic Control System
- LED Light
- Control Computer
- Water Controller
- Temp Humidity Recording

Air Shower
- Exit
- Inside
- Clean Wear

Watering system
- Watering line
- Stirrer
- Water Tanks
Business Proposal

Vertical Farm Construction Process

1. Arrangement, design and construction plan
2. Construct inside and cultivating frame
3. Install nutrient, pipes and electric system
4. Install lighting system and controller
5. Install air conditioning system and control room
6. Examine Stability and operation training
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<thead>
<tr>
<th>Item</th>
<th>Descriptions</th>
<th>M</th>
<th>M+1</th>
<th>M+2</th>
<th>M+3</th>
<th>M+4</th>
<th>M+5</th>
<th>M+6</th>
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<td>Factory Building</td>
<td>Design Construction Inspection</td>
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<td>This construction must be completed before factory facilities installation.</td>
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<tr>
<td>Contract</td>
<td>Discuss project scope Budgeting Evaluate proposal Contract</td>
<td>M+2</td>
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<td>Contract including technology transfer</td>
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<tr>
<td>Manufacturing</td>
<td>Aeroponic /Hydroponic system LED lighting system Control system</td>
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<tr>
<td>Shipment</td>
<td>Vessel container</td>
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<td>Installation</td>
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<td>Training</td>
<td>On-site, OCN and KAST in Korea</td>
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<td>Despatching consultant &amp; engineers</td>
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<td>Pilot Planting</td>
<td>Item(Vegetable) design Production planning Evaluation Plan for expansion</td>
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</tbody>
</table>
Cultivating Process: Kale

Sowing
1 day after planting
6 day after planting
10 days after planting
15 days after planting
20 days after sowing

Cultivating
10 days after sowing
13 days after planting
15 days after sowing
20 days after sowing

Harvest
13 days after planting
Business Proposal

Production Cycle, Crops

- Lettuce, spinach, parsley, broccoli, other leafy vegetables
- Strawberry, Ginseng, and others are different conditions
- Productivity (example of lettuce)
  - 25 days/cycle
  - 2,236 clumps/cycle (111 clumps/day)
Expected effects

Maximize cultivation
- 365 days cultivation
- No climate influence
- Great reduction of production cycle: 25 days to 6 months
- No damage or reduction from repeated cultivation

Maximize area utilization
- Usability of underused place in urban area
- Multi-layer structure: maximize cultivation area
- Farming at any place

Green Technology
- Minimum use of water, nutrient can minimize energy, CO₂
- Nutrient: up to 90% save
- Pesticide free

Increase reliability and food safety
- Increase reliability: customer can see production process
- Increase product quality and value
- Maximize freshness by direct connection between farm and customer

Increase nutrient of plants
- Produce Functional Plants
- Increase specific nutrient of plants

ETC
- Minimize logistics cost
- Planed farming according to consumption pattern
APPENDICES
Appendix

Ongoing projects in Overseas (Yantai City, China)
Appendix

Ongoing projects in Overseas (Manitoba, Canada)

- Export agreements with O.C.N (Manitoba, Canada), July 2015
Appendix

Ongoing projects in Overseas (Boston, USA)
Appendix

The installation performance (Korea)

Gyeongbuk Agricultural Technology Center, April 2012

Gyeongbuk Agricultural Technology Center, May 2012

Natural Endo Tech (Seoul), August 2011

Poongi Ginseng Test Center, April 2012
Appendix

The installation performance (Korea)

Subway Indoor Farm for Incheon Metropolitan City, April 2012

Yeungnam University, November 2011

Nong Shim plant Factory laboratory, September 2011

Subway Indoor Farm for Incheon Metropolitan City, April 2012
Appendix

The installation performance (Korea)

LED Small System, November 2010

Gyeongnam Agirculture Tecnology Center, November 2011

National Institute of Agricultural Sciences, November 2012

Chungyangmobility, Jun 2012
Appendix

The installation performance (Korea)

Refresh (Hamyang), September 2010

WoonKyung Foundation, Jun 2011

Pukyong university, December 2010

Cham Farm (Gosung) December 2010
Thank you!

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