New Technologies and Systems for High Quality Citrus Fruit Production, Labor-saving and Orchard Conservation in Mountainous Areas of Japan

Kunihisa MORINAGA

National Agricultural Research Center for Western Region, NABRO
Background of utilization in mountainous areas of Japan

- Slope land areas are suitable for producing evergreen fruit trees, particularly citrus because of warm climate.
- Slope land areas provide good drainage and sunny condition.

One of major Citrus producing areas, Arida, Wakayama
More than 50% of the citrus growing area is on slopes which have been on inclination angle of more than 15 degrees.
Slope lands have harsh topographic conditions.
Most of the cultivation in citrus orchards has been manually carried out.
Because of aging of growers and long hard work, there is remarkable decrease in the number of successors in the fruit industry.
Strategy to activate citrus fruit production in south western mountainous areas of Japan

- The establishment of labor-saving methods by mechanized production system
- A high quality fruit production system
- Slope land conservation system
The Citrus Research Projects

- The Research Center (WeNARC) has organized research project team to resolve the problems for the last 10 years

1) Simplified construction process of farm path
2) Small sized machinery system

2nd: 1997–2002
The first stage of the citrus project (1993–1997)

Simplified construction process of farm path

We proposed a simplified creation method of a farm path which could be constructed on slope lands.

Farm paths in citrus orchards
A computer aided farm path designing system

- First, the grower draws the farm paths of target orchards on computer display.
- Then, the program calculates the information such as the length and partial gradient of the paths based on the topographic data.
- Several plans could be indicated before making the final plan.
Small-sized machinery system

- Walking type air-blast sprayer for pest and disease control
- Crawler type transporters
- Portable weed controllers
The second stage of the citrus project

1. A high quality fruit production system
2. Labor–saving methods on steep slope lands by mechanized production system
3. Orchards on slope lands conservation system

These new technologies have been based largely upon development of computer programming, utilization of new materials, information processes and so on.
Recent new technologies and systems

1. A high quality fruit production system

Drip irrigation and Liquid fertilization system with Year-round plastic Mulching (DLYM)
Irrigation time controller

Liquid fertilizer system

fertilizer mixer
filter
tank

drip tube

Drip irrigation tube and year-round plastic mulching

plastic mulching

Water Source

control
Water sources for drip irrigation

A dam for debris-slide protection

Pump river water up by solar panels from a river

A water tank

Storage tank of rain water

Water tanks (6 tons each)

Storage water tank from mountain stream
Liquid fertilization system

- Liquid fertilizer tank
- Fertilizer-water mixer
Automatic irrigation time controller

- Time controller
- Electromagnetic valves
Drip irrigation tube and Year-round plastic mulching
It is also clear that sugar content shifted to a higher range.

Average sugar contents of fruit under DLYM cultivation increased 1–2 % compared to fruit from control trees.
Effects of DLYM on fruit quality

Fruit rind color

- Fruit rind color was improved.
- There was earlier coloring and higher uniformity of coloring.
- The coloring could advance harvest season.
Introduction of the DLYM system

• This system had been introduced in several major citrus producing areas in western Japan such as Wakayama, Kagawa and Ehime in recent years. • High potential has been indicated for activating citrus cultivation in these areas.
Recent new technologies and systems

2. **Labor-saving methods on steep slope lands by mechanized production system**

New transportation system by combination of the monorail and contour narrow farm paths on steep orchards
The monorail system has been introduced since the 1960s to transport harvested fruits and agricultural materials. The monorail truck can be utilized until a slope of 45 degrees. The monorail system remarkably contributed to the reduction of transportation work load.
Narrow farm path excavation by small cultivator

The working environment is still hard, because the grower has to stand and work on the surface of steep sloping orchard.
The narrow path connected to the monorail system

It is effective to provide a horizontal surface for working space and the new transporting method.
The small walking cultivator for construction of the narrow farm paths

- The width of contour narrow farm path is only about 50 cm which is just enough for a grower to move.
- This small walking cultivator is used for ridge making and a ditch scoop for pushing up soil.
New transporting system using by combination of the monorail and the narrow farm path on steep slope lands

- Remote control winder of hose
- Working space provided
- Turntable style carrier
- Narrow farm path excavation
- Small transporter
Recent new technologies and systems

3. *Orchards on slope lands conservation*

The multi-purpose and high-functional farm path and disaster prevention mapping system to conserve slope orchards
The multi-purpose and highly-functional farm path to conserve slope lands

A tank which reserve drained underground water for irrigation

and highly-functional farm path
The multi-purpose and highly-functional farm path to conserve slope lands

- After this farm path foundation, upward frequency of underground water was dramatically decreased and underground water did not reach the soil surface.
- The farm path foundation on the upward flow areas of orchards was effective for disaster prevention.
The mapping can show zones of both upward and downward seepage flow of underground water during heavy rains. This mapping is effective for the management of orchards and prevention of soil loss on slope lands.

<table>
<thead>
<tr>
<th>Inflow index</th>
<th>Outflow index</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>0.8</td>
<td>0.8</td>
</tr>
<tr>
<td>0.6</td>
<td>0.6</td>
</tr>
<tr>
<td>0.4</td>
<td>0.4</td>
</tr>
</tbody>
</table>

**Outflow index 0.8-1.0 areas need a management to prevent soil loss**
Further technologies and systems are required to reinvigorate mountainous areas of south western Japan

The 3rd phase of citrus project (2003—07)