Vegetable Production in Taiwan: a Survey of 300 Farmers

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ASIAN VEGETABLE RESEARCH & DEVELOPMENT CENTER
Vegetable Production in Taiwan: a survey of 300 farmers

by

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Foreword

To understand vegetable production in Taiwan, where an advanced, capital-intensive agriculture has developed, the agricultural economics group at the Asian Vegetable Research and Development Center surveyed 300 vegetable producing households in 1974 and 1977. We chose Changhua district, where specialized production areas have helped to give it the greatest area planted to vegetables; and Tainan district, to represent general vegetable production.

By studying the changes in the same sample over a 3-year period, we assessed the relationship between cultural techniques and the cropping systems, the constraints to vegetable production and ways to overcome them, and the effects of farm size and man/land ratio on cropping intensity. We drew a set of integrated conclusions and policy recommendations.

The results can be useful not only in Taiwan, where a labor shortage has already forced complex cropping systems in some areas to give way to monoculture, but as a key to general principles of farm decision-making, which includes vegetables, for other tropical nations where cropping intensity is increasing.

The Authors
About this report

Data in this report are presented in metric units. Monetary values have been converted to U.S. dollars at the current (May, 1978) exchange rate.

A double asterisk (**) means significant at the 1% level; a single asterisk (*) means significant at the 5% level; and a cross (+) means significant at the 10% level.

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CHAPTER ONE: INTRODUCTION

Reasons for the Present Study

The tropical to subtropical climate of Taiwan allows heavy production of vegetables, concentrated in the off-season for rice. In addition to domestic demand, there is a substantial and growing export market. In the total value of agricultural products in Taiwan, vegetables climbed from 6.3% in 1967 to 12.8% in 1976 (Table 1). In the latter year, vegetable production reached 2 million metric tons with a total value of US$239 million, second only to rice (Table 2).

Table 1. The growth of vegetable production value as a percentage of the value of total agricultural production, 1967-1976; AVRDC, 1978.

<table>
<thead>
<tr>
<th>Year</th>
<th>Value of agricultural production US$ million</th>
<th>Value of vegetables %</th>
<th>Vegetables/Agricultural production %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1967</td>
<td>726</td>
<td>46</td>
<td>6.3</td>
</tr>
<tr>
<td>1968</td>
<td>775</td>
<td>65</td>
<td>8.5</td>
</tr>
<tr>
<td>1969</td>
<td>742</td>
<td>78</td>
<td>10.6</td>
</tr>
<tr>
<td>1970</td>
<td>801</td>
<td>90</td>
<td>12.3</td>
</tr>
<tr>
<td>1971</td>
<td>792</td>
<td>93</td>
<td>11.7</td>
</tr>
<tr>
<td>1972</td>
<td>868</td>
<td>103</td>
<td>11.8</td>
</tr>
<tr>
<td>1973</td>
<td>1,112</td>
<td>141</td>
<td>12.6</td>
</tr>
<tr>
<td>1974</td>
<td>1,643</td>
<td>191</td>
<td>11.6</td>
</tr>
<tr>
<td>1975</td>
<td>1,868</td>
<td>217</td>
<td>11.6</td>
</tr>
<tr>
<td>1976</td>
<td>1,867</td>
<td>239</td>
<td>12.8</td>
</tr>
</tbody>
</table>

\(^a\)Ref. 11. \(^b\)Does not include watermelon, seedmelon, and cantaloupe.

Table 2. Area and production of main agricultural crops in Taiwan, 1976; AVRDC, 1978.

<table>
<thead>
<tr>
<th>Rank</th>
<th>Harvested area 1000 ha</th>
<th>Production 1000 t</th>
<th>Total value US$ million</th>
<th>% of total value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice</td>
<td>786</td>
<td>2,713</td>
<td>927</td>
<td>49.6</td>
</tr>
<tr>
<td>Vegetable (^b)</td>
<td>161</td>
<td>2,127</td>
<td>239</td>
<td>12.8</td>
</tr>
<tr>
<td>Sweet potato</td>
<td>124</td>
<td>1,851</td>
<td>87</td>
<td>4.7</td>
</tr>
<tr>
<td>Sugarcane</td>
<td>109</td>
<td>8,728</td>
<td>153</td>
<td>8.2</td>
</tr>
<tr>
<td>Fruit</td>
<td>96</td>
<td>1,374</td>
<td>193</td>
<td>10.3</td>
</tr>
<tr>
<td>Peanut</td>
<td>59</td>
<td>89</td>
<td>45</td>
<td>2.4</td>
</tr>
<tr>
<td>Corn</td>
<td>41</td>
<td>114</td>
<td>19</td>
<td>1.0</td>
</tr>
<tr>
<td>Soybean</td>
<td>36</td>
<td>53</td>
<td>16</td>
<td>0.8</td>
</tr>
<tr>
<td>Others</td>
<td></td>
<td></td>
<td>189</td>
<td>10.2</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>1,868</td>
<td>100.0</td>
</tr>
</tbody>
</table>

\(^a\)Ref. 11. \(^b\)Does not include watermelon, seedmelon, and cantaloupe.
Vegetables constitute an economical source of vitamins, protein, and minerals for lower income families. Higher quality vegetables are demanded more and more by higher income households as the standard of living rises. Per capita consumption of vegetables in Taiwan has jumped from 56 kg in 1962 to 118 kg in 1976. Over the same period, real per capita income increased from US$203 to $406. Thus, overall income elasticity of demand for vegetables is 0.96, one of the highest in the world.

But vegetable production in Taiwan suffers from a limited arable area, soaring costs of labor, environmental factors, and great seasonality in production volume. The winter has low temperature, rainfall, and pest and disease incidence, making cultivation easy and yield high. In the summer the temperature is high, rainfall excessive, pests and diseases severe, and typhoons frequent, which lower yield and production volume. However, consumer needs have no seasonality. Thus, excessive supply in the winter causes prices to plummet (Fig. 1), while summer scarcity causes them to soar.

Therefore, planners face the problem of inducing the farmer to increase summer production and regulate winter production, so that both producers and consumers face acceptable prices.

Objectives and Scope of the Report

The present report is in two parts. The first (Chapter Two) will use secondary data to investigate the general conditions such as planted area, yield, location, major species by region, and the relationship between price and transaction volume. The second part (Chapters Three through Five) will use survey data on individual vegetable producing farm households to focus on farmers' decision making, choice of cropping system and types of vegetables, the planting environment, and how farmers cope with production problems.

Vegetable production undergoes technological improvements as the economy develops. New varieties, changes in cultivation methods and environment, changes in income, and inflation all modify the rates of adoption of such improvements. The present study will:

1) Portray general vegetable production in Taiwan.

2) Analyze the decision making process on individual farms.

3) Assess the relationship between cultural techniques and the cropping system.

4) Determine the constraints to vegetable production and how to overcome them.

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1962-1976, Food Balance Sheets, JCRR.

2Taiwan Statistical Data Book, 1976, Economic Planning Council Executive Yuan, ROC.
5) Draw integrated conclusions and policy recommendations.

We shall also test the following hypotheses:

1) Summer production has become more evenly distributed as a result of technological advances, while winter production has become concentrated into areas with a comparative advantage.

2) Vegetable transaction volume and price are strongly related, with prices less stable than those of other agricultural commodities.

3) Farmers grow vegetables for profit not home consumption.

4) The motivations for vegetable growing have shifted over time.

5) Cropping systems in vegetable production areas are based chiefly on winter vegetables.

6) Farmers in specialized areas have diversified species grown more than those in general production areas.

7) Increases in the man/land ratio lead to higher vegetable cropping intensity.

8) Natural factors influence vegetable production more than economic factors.
9) The main barrier to expanding production is lack of inputs, rather than prices or natural conditions.

10) Farmers join group marketing and contractual production primarily for high and stable profit.

Survey Procedure

The data presented derive primarily from surveys in 1974 and 1977 of 300 vegetable production households and local Farmer Association personnel.

1) Survey areas. We selected two production areas: Changhua County to represent specialized production, and Tainan County to represent general production.

2) Sampling technique. A mixture of sampling techniques was used. Purposive sampling was used to select eight population centers, five in the more highly developed production region of Changhua, and three in the less developed Tainan. As significant differences might be evident on the basis of distance from such population centers, we drew imaginary bands around each center, one at 0-1 km and the other at 1-2 km.

Our goal was to interview 20 cultivators in each band. We randomly selected 3 villages per band and drew the names of 20 possible sample farmers for each village from the local Farmer Association list of those applying for fertilizer for vegetable production. We selected one village at random and set as a maximum 10 farmers to be interviewed. We followed the same procedure in the second village. If by interviewing at most 10 farmers in the second village, we still lacked some farmers to make up the 20 sample households in the band, we went on to the third.

Of the 300 farmers interviewed in 1974, 80% were re-interviewed in 1977. The remainder were substitute households from the original lists. Thus we could measure the changes in vegetable cultivation practices and attitudes in essentially the same sample. Fig. 2 shows the location and Table 3 the household distribution of the 1977 sample.

3) Type of farmers and time of sampling. All farmers grew at least one species of vegetable, to be defined in the next chapter. Only farmers selling more than 50% of their vegetables were included.

Students from the Department of Agricultural Economics at Chung-Hsing University helped with the first survey. Students from the Chia Yi Agricultural Vocation College helped with the second survey. In both cases, the students asked questions concerning the 12 month period immediately preceding the interview. We appreciate their contribution.
Table 3. The sample distribution of surveyed vegetable producers in Changhua and Tainan Areas, 1977; AVRDC, 1978.

<table>
<thead>
<tr>
<th>Surveyed location</th>
<th>No. of surveyed vegetable producer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 km</td>
</tr>
<tr>
<td>Changhua City</td>
<td>20</td>
</tr>
<tr>
<td>Hsinhu</td>
<td>20</td>
</tr>
<tr>
<td>Erhlin</td>
<td>14 (19)</td>
</tr>
<tr>
<td>Yungching</td>
<td>20</td>
</tr>
<tr>
<td>Pei-tou</td>
<td>13 (20)</td>
</tr>
<tr>
<td>Hsinying</td>
<td>5 (8)</td>
</tr>
<tr>
<td>Matou</td>
<td>20</td>
</tr>
<tr>
<td>Tainan</td>
<td>19 (20)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>131 (147)</strong></td>
</tr>
</tbody>
</table>

*Numbers in parentheses represent sample size in 1974, where different from that in 1977. Vegetable production in Hsinying, an industrial area with many factories, lies far from the center of the township.

**SURVEY LOCATIONS**

Fig. 2. The 8 target counties surveyed in Changhua and Tainan Districts, 1974 and 1977; AVRDC, 1978.
CHAPTER TWO: THE GENERAL SITUATION OF VEGETABLE PRODUCTION IN TAIWAN

Categories of Production

Vegetables in this report include: 1) leafy vegetables, such as cabbage and spinach, 2) flower vegetables, such as cauliflower and flower leek, 3) stem vegetables, such as asparagus and bamboo shoots, 4) root vegetables, such as carrot and potato, 5) bulb vegetables, such as garlic and onion, 6) fruit vegetables, such as sponge-gourd and tomato, and 7) legume vegetables, such as lima bean and string bean.

Vegetables are produced in Taiwan for three purposes: commercial, about 73% of total production; home gardens, 26%; and, seed and seedlings, 1%. Some home garden vegetables reach commercial channels when over-produced for family needs. Most of the area planted to seed and seedlings is in the cool season for the farmer himself.

Trends Over Time

The steady rise in both value and consumption of vegetables in Taiwan has induced increases in planted area and per hectare yield, as shown in Table 4. Planted area has risen 56% and overall production 127% in the past 10 years. At the same time production value grew 143%. Thus, while real value per unit of output has increased only marginally, yields have more than doubled as a result of rapid improvements in technology. In particular, area planted to processing vegetables (tomato, eggplant, cucumber) and for cold storage (potato, carrot, pea) has increased, while that to leaf and flower vegetables has remained constant.

The Distribution of Production

As vegetables are highly perishable, production areas must be close to final consumption areas or have convenient access to efficient marketing channels. In Taiwan, Changhua District has the largest vegetable area (Fig. 3), located in central Taiwan with good road access. Next in importance are Yunlin, Tainan, and Pingtung districts.

Greatest production volume, on the other hand, is in Tainan and Yunlin, each producing 12% of the total, followed by Changhua and Pingtung. These figures show that per hectare yield varies by location.

Changes in planted area. Yunlin and Changhua increased vegetable area between 1974 and 1976, but the percentage of total planted area declined. This is because they were already specialized vegetable production districts, planting close to the maximum area available.

Faster rates of expansion occurred in Tainan, Nantou, and Taipei, non-specialized areas with much available land and great leeway in
Fig. 3. Vegetable production in Taiwan, 1974 and 1976; AVRDC, 1978.\textsuperscript{a}

\textsuperscript{a}Adapted from ref. 11.

Table 4. Vegetable\textsuperscript{a} production in Taiwan, 1967-1976; AVRDC, 1978.\textsuperscript{b}

<table>
<thead>
<tr>
<th>Year</th>
<th>Planted area</th>
<th>Production</th>
<th>Value in constant 1976</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1000 ha</td>
<td>1000 t</td>
<td>$1000\textsuperscript{US}$</td>
</tr>
<tr>
<td>Index</td>
<td></td>
<td>Index</td>
<td>Index</td>
</tr>
<tr>
<td>1967</td>
<td>104</td>
<td>938</td>
<td>98,326</td>
</tr>
<tr>
<td>1968</td>
<td>107</td>
<td>1,096</td>
<td>129,828</td>
</tr>
<tr>
<td>1969</td>
<td>220</td>
<td>1,310</td>
<td>148,068</td>
</tr>
<tr>
<td>1970</td>
<td>125</td>
<td>1,430</td>
<td>179,133</td>
</tr>
<tr>
<td>1971</td>
<td>129</td>
<td>1,461</td>
<td>164,328</td>
</tr>
<tr>
<td>1972</td>
<td>126</td>
<td>1,461</td>
<td>176,465</td>
</tr>
<tr>
<td>1973</td>
<td>129</td>
<td>1,585</td>
<td>223,517</td>
</tr>
<tr>
<td>1974</td>
<td>148</td>
<td>1,746</td>
<td>206,362</td>
</tr>
<tr>
<td>1975</td>
<td>164</td>
<td>1,971</td>
<td>222,762</td>
</tr>
<tr>
<td>1976</td>
<td>161</td>
<td>2,127</td>
<td>238,961</td>
</tr>
</tbody>
</table>

\textsuperscript{a}Does not include watermelon, seedmelon, and cantaloupe. \textsuperscript{b}Ref. 11.
...adopting new species. Much rotation land permitted Tainan to expand the area planted to vegetables. For example, the area planted to processing tomatoes has increased recently by from 2 to 4 thousand hectares per year. Thus, Tainan had dramatic absolute and relative growth, to become the district with the largest area planted to vegetables in 1976. The main reason for the expanded area in Nantou, Taipei, and Kaohsiung has been the increased planting of summer vegetables.\(^d\)

Changes in production volume. The specialized areas of Changhua and Yunlin increased production volume between 1974 and 1976 in absolute terms, but relative growth declined. This was mainly because Tainan farmers planted more land to new lines of winter processing tomato, which were extremely high-yielding (50-60 t/ha). Nantou farmers also increased their yields through summer production of such vegetables as bamboo shoots and highland vegetables.

Seasonality in Production

Fig. 4 shows seasonal effects on the volume of shipments from various production areas to the Taiwan Area Fruit and Vegetable Corporation.

The summer season (May to September) has only half the transaction volume of the winter. Changhua is the greatest supplier, followed by Nantou and Taichung. Tainan and Kaohsiung do not appear in Fig. 4 because vegetables produced in these counties are consumed locally. Moreover, much of the produce of these last two counties is used for processing, including such commodities as bamboo shoots and asparagus. Still, total summer production is not as great as in Changhua.

In the winter (October to April), the central-southern area has the greatest transaction volume, with Changhua highest, followed by Yunlin and Chiayi. Tainan and Kaohsiung districts in winter, as in summer, channel most of their production to the nearby cities or processors, and therefore do not contribute significantly to the Taipei market.

Changhua District contains many specialized vegetable-areas, so that it has the highest transaction volume in both summer and winter. The three districts of Changhua, Yunlin, and Chiayi are specialized in vegetable production because of custom (Table 6) and the adaptability of their cropping systems.

In the period 1975/76-1976/77, the Changhua supplies of summer and winter production increased from 23 to 31% and from 32 to 39% respectively showing a concentration of production in both seasons to the areas with comparative advantages in vegetables. In the summer, in particular, the coefficient of variation in volume marketed increased from 0.11% to 0.15%. Therefore, we must reject the first half of hypothesis 1, that

\(^d\)In Nantou, bamboo shoots and radish; Taipei, non-heading Chinese cabbage, water convolvulus and amaranthus; and Kaohsiung, cucumber and water convolvulus.
Summer production has become more evenly distributed as a result of heat-tolerant cultivars and other technological advances. But we may accept the second half of the hypothesis, that winter production has become concentrated into areas with a comparative advantage. It is significant that cabbage is grown in Nantou and Changhua counties, and, to a lesser extent, in Taichung and Yunlin counties. The production areas of the cabbage is indicated in Figure 4.

**Figure 4.** Production areas of vegetable sold in the Taipei market, 1975-77; AVRDC, 1978.\(^a\)

\(^a\)Adapted from Monthly Statistics of Fruit and Vegetable Marketing, May 1975-April 1977, Taipei, Taiwan.
The relationship between volume and price. Price fluctuations caused by unstable supplies are significant (Fig. 1, p. 7). The total transaction volume for May through September in the period 1972-76 was about 61,000 tons, only 35% of the annual average. The transaction volume in June was the lowest, with an index number of 80, compared with a high of 132 in December. The variance in monthly transaction volume (17%) also shows the great seasonality of supply. Prices follow the inverse pattern.

The correlation between volume and price is -0.76. At the same time, the seasonality of volume is greater than of price. Summer volume has a variance of 6% while winter volume has one of 12%, because summer volume is more constrained by climate and land availability. Therefore, while summer volume is smaller, its variability is smaller.

Among the farm-gate prices for rice, soybean and vegetables, the instability was highest for vegetables (Table 5). Within vegetables, flower vegetables had the highest variance (43), followed by leafy vegetables (38) and fruit vegetables (26). Variability was lowest in root vegetables (22). These patterns are due to relative suitability to growth environment and storage. We may accept hypothesis 2, that vegetable transaction volume and price are strongly related with prices, less stable than those of other agricultural commodities.

Table 5. Seasonal price indices of major agricultural products, 1972-76; AVROC, 1978.

<table>
<thead>
<tr>
<th></th>
<th>Ponlai Rice</th>
<th>Soybean</th>
<th>Tomato</th>
<th>Carrot</th>
<th>Cauliflower</th>
<th>Chinese cabbage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan</td>
<td>97.75</td>
<td>100.28</td>
<td>145.56</td>
<td>149.82</td>
<td>81.47</td>
<td>78.30</td>
</tr>
<tr>
<td>Feb</td>
<td>105.22</td>
<td>101.19</td>
<td>97.89</td>
<td>93.34</td>
<td>51.51</td>
<td>40.14</td>
</tr>
<tr>
<td>Mar</td>
<td>102.51</td>
<td>100.57</td>
<td>91.96</td>
<td>80.80</td>
<td>73.38</td>
<td>62.27</td>
</tr>
<tr>
<td>Apr</td>
<td>102.98</td>
<td>96.81</td>
<td>76.52</td>
<td>72.97</td>
<td>69.49</td>
<td>95.40</td>
</tr>
<tr>
<td>May</td>
<td>100.15</td>
<td>99.00</td>
<td>63.80</td>
<td>74.21</td>
<td>79.68</td>
<td>107.43</td>
</tr>
<tr>
<td>Jun</td>
<td>96.26</td>
<td>98.15</td>
<td>97.21</td>
<td>102.07</td>
<td>143.02</td>
<td>135.37</td>
</tr>
<tr>
<td>Jul</td>
<td>95.34</td>
<td>100.35</td>
<td>111.78</td>
<td>120.44</td>
<td>156.97</td>
<td>158.61</td>
</tr>
<tr>
<td>Aug</td>
<td>96.13</td>
<td>101.28</td>
<td>78.28</td>
<td>111.80</td>
<td>165.18</td>
<td>148.30</td>
</tr>
<tr>
<td>Sep</td>
<td>96.81</td>
<td>102.36</td>
<td>134.05</td>
<td>95.62</td>
<td>145.48</td>
<td>122.37</td>
</tr>
<tr>
<td>Oct</td>
<td>97.38</td>
<td>105.14</td>
<td>122.99</td>
<td>95.19</td>
<td>110.17</td>
<td>113.20</td>
</tr>
<tr>
<td>Nov</td>
<td>101.04</td>
<td>98.54</td>
<td>108.39</td>
<td>113.21</td>
<td>84.74</td>
<td>92.92</td>
</tr>
<tr>
<td>Dec</td>
<td>108.45</td>
<td>96.27</td>
<td>71.55</td>
<td>90.54</td>
<td>39.95</td>
<td>45.74</td>
</tr>
</tbody>
</table>

Variance 4.13  2.45  25.57  21.66  42.81  38.43

Ref. 10.

Significant at the 1% level.
CHAPTER THREE: THE DECISION-MAKING PROCESS OF VEGETABLE PRODUCERS

Motivations

The responses from the 1977 sample fell into 8 categories (Table 6):

1) To maintain a high cash flow and higher income than from other crops. Vegetables are cash crops which can be produced in 1-2 months to 3-6 months. Many can be harvested continually, providing a constant source of cash income for daily living expenses.

2) To fully use land. On average, farms in the sample had only 0.77 ha of land and families of 7.4 people. One system that makes full use of land is to plant vegetables between the harvest of summer rice one year and the planting of spring rice the next year, as a monocrop, relay crop, or intercrop.

A second system is to plant short-term vegetables on narrow or uneven pieces of land or in areas where nothing else can be profitably grown.

3) To follow custom and experience. Many vegetable growers in Taiwan are carrying on traditions started by their fathers or grandfathers.


<table>
<thead>
<tr>
<th></th>
<th>Total 76-77</th>
<th>73-74</th>
<th>Changhua 76-77</th>
<th>73-74</th>
<th>Tainan 76-77</th>
<th>73-74</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency of cash income and good return</td>
<td>31</td>
<td>49</td>
<td>30</td>
<td>49</td>
<td>34</td>
<td>50</td>
</tr>
<tr>
<td>Fully use land</td>
<td>17</td>
<td>15</td>
<td>17</td>
<td>14</td>
<td>14</td>
<td>17</td>
</tr>
<tr>
<td>Soil quality is suitable for growing vegetables</td>
<td>12</td>
<td>-</td>
<td>11</td>
<td>-</td>
<td>13</td>
<td>-</td>
</tr>
<tr>
<td>Custom and experience for growing vegetables</td>
<td>10</td>
<td>-</td>
<td>10</td>
<td>-</td>
<td>10</td>
<td>-</td>
</tr>
<tr>
<td>Improve soil quality and as a rotation crop</td>
<td>9</td>
<td>6</td>
<td>10</td>
<td>9</td>
<td>6</td>
<td>-</td>
</tr>
<tr>
<td>Fully use family labor</td>
<td>7</td>
<td>10</td>
<td>7</td>
<td>10</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>Nearness to vegetable market</td>
<td>3</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>Home consumption</td>
<td>1</td>
<td>11</td>
<td>1</td>
<td>10</td>
<td>1</td>
<td>13</td>
</tr>
<tr>
<td>Others a</td>
<td>10</td>
<td>9</td>
<td>11</td>
<td>8</td>
<td>14</td>
<td>12</td>
</tr>
</tbody>
</table>

aFollow neighbors, guaranteed price, and save labor and fertilizer.
4) To suit soil conditions. Generally, vegetables do best on well-drained soils. They also may suit rotation systems or land which can not be irrigated for rice or other crops. Land on the periphery of cities often is profitable for vegetable growing.

5) To improve the soil. Cropping systems sometimes must include short term crops such as vegetables to relieve the stress of planting the same crops year after year. Soils may carry over insects and diseases unless crops are rotated.

6) To make full use of family labor, especially in households with a high man/land ratio and in the off-season between rice crops. Older members of the household can also help to use available land more fully. Thus, a return is generated from otherwise unemployed individuals.

7) Proximity to market. Because vegetables require numerous harvests and are perishable, many farmers consider nearness to market a major incentive for growing them.

8) Home consumption. About 99% of all vegetables produced are destined for the market. There has been a drop in the percentage of vegetables destined for home consumption between 1973/74 and 1976/77.

Table 6 shows that the motivations for growing vegetables in the 1973/74 and 1976/77 samples were quite similar. These were primarily 1) cash flow and relative profitability, 2) full use of land and labor, and 3) custom and experience. We may accept hypothesis 3, that farmers grow vegetables for profit not home consumption. But we must reject hypothesis 4, that the motivations for vegetable growing have shifted over time.

Because the production environment and crop rotation systems differ among villages, the ranking of motivations in each may differ considerably (Table 7).

Reasons for Planting the Same Species Year after Year

The decision to plant a given species depends on experience and/or the farmer's understanding of available technology, soil, rotation, climate, demand, and price. The species planted by over 80% of producers were the same from year to year. Table 8 shows differences by location. Production in Changhua is favored in the winter because of the cropping system, where peas are the principal crop. Erhlin grows asparagus because of the sandy loam soils. Hsinying conditions favor winter vegetables, like tomatoes. Tainan farmers prefer leafy crops in winter because of their experience with them. Hsihu and Yungching are specialized vegetable production areas, so the turnover in types grown is higher, showing great flexibility in responding to market demand.

Table 9 shows why most farmers grow the same vegetables year after year. Each farmer has his own cultivation practices. Unless there is a change in consumer preference or a serious price decline, most farmers prefer to stay with the same crops.

<table>
<thead>
<tr>
<th></th>
<th>Changhua</th>
<th></th>
<th></th>
<th></th>
<th>Tainan</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Changhua</td>
<td>Hsihu</td>
<td>Erlin</td>
<td>Yung-ching</td>
<td>Peitou</td>
<td>Total</td>
<td>Hsin-ying</td>
</tr>
<tr>
<td>Frequency of cash income and good return</td>
<td>30</td>
<td>20</td>
<td>35</td>
<td>20</td>
<td>36</td>
<td>35</td>
<td>34</td>
<td>27</td>
</tr>
<tr>
<td>Fully use land</td>
<td>17</td>
<td>17</td>
<td>14</td>
<td>15</td>
<td>14</td>
<td>23</td>
<td>14</td>
<td>18</td>
</tr>
<tr>
<td>Soil quality suitable for vegetable growing</td>
<td>11</td>
<td>2</td>
<td>7</td>
<td>23</td>
<td>18</td>
<td>5</td>
<td>13</td>
<td>10</td>
</tr>
<tr>
<td>Custom and experience in growing vegetables</td>
<td>10</td>
<td>22</td>
<td>12</td>
<td>7</td>
<td>4</td>
<td>4</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Improve soil quality and as a rotation crop</td>
<td>10</td>
<td>11</td>
<td>5</td>
<td>3</td>
<td>15</td>
<td>18</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Fully use family labor</td>
<td>7</td>
<td>16</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>10</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Nearest to vegetable market</td>
<td>3</td>
<td>-</td>
<td>13</td>
<td>0</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Home consumption</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Othersa</td>
<td>11</td>
<td>9</td>
<td>8</td>
<td>26</td>
<td>10</td>
<td>5</td>
<td>14</td>
<td>32</td>
</tr>
</tbody>
</table>

*aFollow neighbors, guaranteed price, save labor, and save fertilizer.*
The minority of farmers who vary their planted species are more business minded and feel they can predict future demand to maximize sale value. Their main reasons are fluctuations in demand and price, crop rotation and soil improvement (Table 10).

Reasons for Preferring Certain Species

We selected three species from summer and winter vegetable types in each village or city and investigated the reasons for farmers preference as a reference for policy-makers and extension workers.

Generally important were experience with the crop, full use of land, frequent cash income, and high price and yield. However, since species vary widely by locality, great benefits may flow from establishing additional specialized production areas to best use comparative advantages.

Table 8. Percentages of farmers who plant the same kinds of vegetables year after year; AVRDC, 1978.

<table>
<thead>
<tr>
<th>Area</th>
<th>Percentages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Changhua city</td>
<td>95</td>
</tr>
<tr>
<td>Hsihu</td>
<td>72</td>
</tr>
<tr>
<td>Erhlin</td>
<td>88</td>
</tr>
<tr>
<td>Yungching</td>
<td>73</td>
</tr>
<tr>
<td>Peitou</td>
<td>66</td>
</tr>
<tr>
<td>Changhua area</td>
<td>78</td>
</tr>
<tr>
<td>Hsinying</td>
<td>95</td>
</tr>
<tr>
<td>Matou</td>
<td>72</td>
</tr>
<tr>
<td>Tainan city</td>
<td>90</td>
</tr>
<tr>
<td>Tainan area</td>
<td>84</td>
</tr>
<tr>
<td>Changhua and Tainan areas</td>
<td>80</td>
</tr>
</tbody>
</table>
Table 9. Reasons for planting the same kinds of vegetables year after year, 1977; AVRDC, 1978.

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>Changhua area</th>
<th>Tainan area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experience and custom</td>
<td>36</td>
<td>42</td>
<td>28</td>
</tr>
<tr>
<td>Soil suitable</td>
<td>28</td>
<td>29</td>
<td>26</td>
</tr>
<tr>
<td>Fits seasonal crop rotations</td>
<td>9</td>
<td>10</td>
<td>7</td>
</tr>
<tr>
<td>More profit than other vegetables, good price, &amp; frequent cash income</td>
<td>8</td>
<td>6</td>
<td>11</td>
</tr>
<tr>
<td>Save vegetable labor</td>
<td>4</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>Consumer-preferred vegetable</td>
<td>3</td>
<td>0</td>
<td>9</td>
</tr>
<tr>
<td>Others</td>
<td>12</td>
<td>12</td>
<td>12</td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>Changhua area</th>
<th>Tainan area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply and demand of vegetables and price</td>
<td>39</td>
<td>43</td>
<td>31</td>
</tr>
<tr>
<td>Rotation crop, improve soil, and control pests</td>
<td>38</td>
<td>41</td>
<td>31</td>
</tr>
<tr>
<td>Personal interest</td>
<td>7</td>
<td>2</td>
<td>19</td>
</tr>
<tr>
<td>Production season constraint</td>
<td>7</td>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>Others</td>
<td>9</td>
<td>5</td>
<td>19</td>
</tr>
</tbody>
</table>
CHAPTER FOUR: VEGETABLE CULTIVATION AND CROPPING SYSTEMS

Natural Factors

Temperature, rainfall, soil, irrigation and drainage, and wind velocity in Taiwan determine not only which vegetables will be grown, but in which cropping systems.

Temperature and rainfall. During 1961-1970, monthly temperatures in the central region of Taiwan (Fig. 5) were lowest in January (10.5°C) and highest in July (33.2°C). Minimum rainfall also was in January (25.6 mm) with the maximum in June (362.1 mm). The annual average high temperature was 28.4°C, with an average low of 18.6°C and mean 22.7°C. Average annual rainfall was 1,224 mm.

The major winter (Oct - Apr) vegetables are cauliflower, pea, cabbage, tomatoes, leek, celery, spinach, leaf-mustard, Chinese cabbage, coriander, limabean, pai-tsai, scallion, kohlrabi, and asparagus. In the summer (May - Sep), major species are leek, water-convolvus, cabbage, cucumber, cauliflower, pai-tsai, scallion, Chinese cabbage, eggplant, bitter gourd, oriental pickling melon, sponge gourd, leek flower, bamboo shoot, and asparagus.

Soil characteristics. Vegetables grow best in well-drained soils with pH ranging from slightly acidic to slightly basic. Specific requirements, however, vary by commodity. Some, such as bottle gourd, are highly tolerant to acid soils; others, like Chinese cabbage, have intermediate tolerance; and, lettuce has no tolerance.

The central region of Taiwan has become the major vegetable production area, in part because of its fertile alluvial soils. Slate, sandstone, and shale alluvial soils are distributed in the Chi-tan Nan Plain in the south; the Changhua Plain and the basins of Taichung, Nantou, and Puli in the central region; and, the Hsinchu and Lan-yang Plains, the Taipei Basin, and the mountain valleys in the east. The northern soils are moderately acidic (pH 5.5-6.5) with light soil texture, while the central soils are moderately acidic to slightly basic (5.6-8.0) with moderate texture; and eastern soils are mildly acidic to mildly basic (6.6-8.0).

Cropping Patterns

The survey results from 1973/74 and 1976/77 revealed 8 major cropping systems in the Changhua and Tainan regions (Fig. 6).

\[\text{\textsuperscript{a}}\] A type of non-heading Chinese cabbage.

\[\text{\textsuperscript{b}}\] N.J. Su, The Fertility of Taiwan Soils, Provincial Department of Agriculture and Forestry (Taichung, 1973), p. 12.
Fig. 5. The relationship among vegetable production, temperature, and rainfall, 1961-70; AVRDC, 1978.\textsuperscript{a}

\textsuperscript{a}Taiwan, 1974, Central Weather Bureau, Meteorological Bulletin 20(3).
<table>
<thead>
<tr>
<th>Cropping pattern</th>
<th>Cultivation calendar</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>J J A S O N D J F M A M J J A S O</td>
</tr>
<tr>
<td>I</td>
<td>2nd rice</td>
</tr>
<tr>
<td>II</td>
<td>Vegetables (more than one year)</td>
</tr>
<tr>
<td>III</td>
<td>2nd rice</td>
</tr>
<tr>
<td>IV</td>
<td></td>
</tr>
<tr>
<td>V</td>
<td></td>
</tr>
<tr>
<td>VI</td>
<td>Vegetables</td>
</tr>
<tr>
<td>VII</td>
<td>2nd rice</td>
</tr>
<tr>
<td>VIII</td>
<td>Misc. crops</td>
</tr>
</tbody>
</table>

Fig. 6. Types of vegetable cropping patterns in Changhua and Tainan areas, 1976-77; AVRDC, 1978.

Cropping pattern I includes vegetables in the slack period between the summer and spring rice crops. Pattern II, found in historically specialized production areas, involves the rotation of rice or another crop on land grown year-round to vegetables to neutralize pH and otherwise improve the soil. Pattern III features planting vegetables after the harvest of second rice, but rotating in a rice crop after two or three other crops to maintain soil fertility. Pattern IV is perennial asparagus. Pattern V involves planting vegetables year-round on either small parcels or garden land, largely in the suburbs, or on upland to supply urban consumers. Pattern VI involves planting a heat and rain resistant crop after spring rice to take advantage of high summer vegetable prices. Pattern VII involves a single winter vegetable crop, planted in rotation with rice and field crops. Pattern VIII occurs on unirrigated lands which have enough pumped ground water to plant vegetables in rotation with field crops.

Cropping changes over time. Figure 7 shows the relative importance of each of the above cropping patterns in the years 1973/74 and 1976/77. Not only is cropping pattern I the most popular, it also increased from 24% to 32% of the planted area between the two periods. Because of the guaranteed price for rice in effect since 1973, area planted to rice increased from 724 to 786 thousand hectares, with a resultant rise in winter vegetable production. The multiple cropping index on sample farms increased from 267 in 1973/74 to 277 in 1976/77 (Table 11).
Pattern V: There was a reduction in area planted to this pattern as a result of the absorption of areas close to cities for building.

Pattern VI: Because of the increase in summer vegetable prices, the area planted to vegetables per household in the summer has risen (0.38 to 0.41 ha over the 3-year period).

Pattern VII: Cropping adjustments stemming from the newly constructed (1973) Tsengwen Dam allowed farmers to increase the area planted to rice rotated with field crops.

From the above analysis, we may conclude that cropping pattern I is the most common and accept hypothesis 5, that cropping systems in vegetable production areas are based chiefly on winter vegetables.

Vegetable Cultivation and Multiple Cropping

The multiple cropping index (MCI) is defined as the percentage of area grown to crops per year per farm unit. As the value of the MCI is influenced by the amount of arable land, cropping system, soil quality, agricultural work force, and climate, MCI differs widely by location. In general, the higher the value, the more intensive the cropping system, and the more diversification in cropped species.

\[ MCI = \frac{\text{total crop area}}{\text{total cultivable area per farm}} \times 100 \]

a-Taiwan Provincial Food Office, Taiwan Food Statistics, 1977.

b-MCI = (total crop area / total cultivable area per farm) \times 100. This index is not as accurate as CCI (to be defined) but allows for comparison with other farm samples in Taiwan.
Table 11. Multiple cropping indices of general and vegetable farms by location and year, 1973-77; AVRDC, 1978.

<table>
<thead>
<tr>
<th></th>
<th>General farm 1975</th>
<th>Vegetable farm 1973-74</th>
<th>1976-77</th>
</tr>
</thead>
<tbody>
<tr>
<td>Changhua city</td>
<td>235</td>
<td>271</td>
<td>308</td>
</tr>
<tr>
<td>Hsihu</td>
<td>271</td>
<td>336</td>
<td>293</td>
</tr>
<tr>
<td>Erhlin</td>
<td>237</td>
<td>234</td>
<td>235</td>
</tr>
<tr>
<td>Yungchung</td>
<td>221</td>
<td>288</td>
<td>320</td>
</tr>
<tr>
<td>Peitou</td>
<td>201</td>
<td>259</td>
<td>210</td>
</tr>
<tr>
<td>Hsinying</td>
<td>157</td>
<td>223</td>
<td>248</td>
</tr>
<tr>
<td>Matou</td>
<td>183</td>
<td>228</td>
<td>248</td>
</tr>
<tr>
<td>Tainan</td>
<td>205</td>
<td>276</td>
<td>255</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>213</strong></td>
<td><strong>267</strong></td>
<td><strong>277</strong></td>
</tr>
</tbody>
</table>

\(^{a}\)The General Situation of Statistics of Rural Economics in Taiwan, Provincial Food Bureau 34 (1976).

Table 11 shows the MCI values for the surveyed areas in Changhua and Tainan Counties. Among vegetable producing households, the MCI increased from 267 in 1973/74 to 277 in 1976/77, as compared with a general value for all farm households in the surveyed area in 1975 of 213.\(^{a}\) Because of the shorter duration of vegetable crops and their relatively flexible planting dates, it is possible to grow more crops per year, so that the rate of land use as measured by MCI is higher.

While the overall MCI has risen, the crop intensity in Changhua City and Yungchung has increased greatly; in Hsihu, Pei-t'ou and Tainan City it has declined; and in the remaining areas it has remained constant. The reasons are the rise in winter vegetables in Changhua and Tainan City, the increase in summer vegetables in Yungchung, and Hsihu's decrease in summer vegetables.

**Farm Size and Cropping Intensity**

The multiple cropping index. Operators of small farms, especially interested in obtaining the highest possible and/or most frequent cash income, plant relatively short-term crops with quick turnover. On a fixed land area, they have a very high MCI. By contrast, large farm operators do not need to plant many different crops on the same piece of land to maintain a high cash flow.

Table 12 shows a strong inverse correlation between farm size and cropping intensity (MCI). Moreover, cultivable area on vegetable farms is smallest in Yungchung and Changhua City (0.61-0.62 ha), which have the highest MCI's. We may accept hypothesis 6, that farmers in specialized areas have diversified species grown more than those in general production areas.

\(^{a}\)The MCI for Taiwan as a whole has been declining steadily since 1964 and is reported to be 175 in 1976 (11).

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0.49</td>
<td>291.3</td>
<td>299.4</td>
<td>86.7</td>
<td>90.5</td>
<td>35.6</td>
<td>34.6</td>
<td>56.4</td>
<td>53.8</td>
<td>8.7</td>
<td>11.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.50-0.99</td>
<td>262.5</td>
<td>268.7</td>
<td>81.5</td>
<td>85.7</td>
<td>38.3</td>
<td>38.6</td>
<td>41.4</td>
<td>45.4</td>
<td>15.8</td>
<td>16.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.0 -1.49</td>
<td>249.2</td>
<td>260.9</td>
<td>76.8</td>
<td>90.3</td>
<td>40.8</td>
<td>37.4</td>
<td>39.8</td>
<td>38.1</td>
<td>9.9</td>
<td>24.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.5 -1.99</td>
<td>248.3</td>
<td>252.5</td>
<td>81.8</td>
<td>90.9</td>
<td>43.6</td>
<td>36.9</td>
<td>42.6</td>
<td>43.2</td>
<td>13.7</td>
<td>19.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.0 above</td>
<td>224.5</td>
<td>231.5</td>
<td>74.7</td>
<td>96.4</td>
<td>55.2</td>
<td>34.3</td>
<td>28.7</td>
<td>34.2</td>
<td>11.1</td>
<td>31.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>267.1</td>
<td>277.4</td>
<td>82.1</td>
<td>88.8</td>
<td>29.3</td>
<td>36.7</td>
<td>45.8</td>
<td>46.8</td>
<td>11.7</td>
<td>16.5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[ \begin{align*}
MCI^{a} & = 282.97 - 20.07x \\
r & = -0.91 \\
RRI1 & = 33.24 + 6.83x \\
r & = 0.99 \\
RVII & = 52.57 - 7.79x \\
r & = -0.80 \\
RFII & = 11.78 + 0.04x \\
r & = 0.02
\end{align*} \]

\(^{a}\)See Fig. 1 for meaning of symbols; \(^{b}\)Standard deviations in 1974 and 1977 were 1.11 and 0.90, respectively, in all relationships; \(^{i}\)significant at 10% level.

The relative rice, vegetable, and field crop intensity indices.\(^{a}\) The survey data from 1973/74 show an almost perfect correlation between farm size and the relative intensity of rice cultivation (Table 12).

\[^{a}\]CCI: The percentage of total hectare-months of available farm land actually cultivated to all crops on the farm in a 12-month period.

\[ CII = \frac{\sum A_i T_i}{A_T} \times 100, \quad \text{where} \ i = \text{individual crops} \quad T = \text{crop duration} \quad A = \text{area or time} \]

The CII shows the length of time occupied by crops in the field. The larger the value, the more intensive the land use and the less idle field-time.

RII: The percentage of total hectare-months of available farm land actually cultivated to rice on the farm in a 12-month period.

\[ RRII = \frac{RII}{CII} \]

VII: The percentage of total hectare-months of available farm land actually cultivated to vegetables on the farm in a 12-month period.

\[ RVII = \frac{VII}{CII} \]

RFII: The percentage of hectare-months actually cultivated on the farm which were devoted to field crops.

For details, see ref. 9.
As a result of the world food crisis in 1972, the government of the Republic of China encouraged farmers to expand rice planting by establishing a guaranteed price. There was a high response, particularly on large farms. This helps to explain the high correlation. The correlation between farm size and relative vegetable cropping intensity is negative, demonstrating high labor requirements. The impact of farm size on the relative intensity of field crop (melons, grain legumes, sesame, corn, sweet potato) cultivation is insignificant ($r=0.02$), partly because of the difficulty of expanding field crop area on the larger farms where more and more rice has been planted.

In 1976/77, 1) the correlation between farm size and relative rice intensity was negative and not highly significant, 2) the correlation between farm size and vegetable intensity changed little from the earlier period, but the impact of farm size on field crop intensity became strongly positive. This is because the price of field crops rose while vegetable prices remained fairly stable. 3) Rice area declined but larger farms still grew more of the crop than smaller farms.

Farm Workers Per Hectare and Cropping Intensity

The multiple cropping index. According to the survey statistics (Table 13) the number of farm workers per hectare has a significant correlation with the MCI. Although there has been an increase in mechanization, labor availability still largely determines cropping intensity.

The relative rice, vegetable, and field crop intensity indices. According to the 1976/77 data, the influence of farm workers per ha on the RRII is negative. This is because rice is a major and long-term crop which can use hired labor, or even machines, to relieve peak labor demand. Hence, when there are many workers per hectare, it is more profitable to grow less rice.

There is a strong positive relationship between the number of workers per hectare and the relative intensity of vegetable cropping. Vegetables are relatively labor intensive crops (Table 14) for which it is hard to hire workers throughout the season and which are not easily mechanized. We may accept hypothesis 7, increases in the man/land ratio lead to higher vegetable cropping intensity.

The relationship between field crop intensity and the man/land ratio is negative because the fewer the workers, the more attractive become the laborsaving, long-term crops which characterize the field crop category.

---

$^a$In other words, as farm size increases, the number of workers per hectare tends to decline (see next section), and labor becomes insufficient to plant vegetables, which are generally labor intensive (Table 13).

$^b$See reference 11.
Table 13. The relationship between labor availability and various crop intensity indices, 1976-77; AVRDC, 1978.\(^b\)

<table>
<thead>
<tr>
<th>Range</th>
<th>Avg. (x)</th>
<th>MCI</th>
<th>CII</th>
<th>RRII</th>
<th>RVII</th>
<th>RFII</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-4.9</td>
<td>2.9</td>
<td>252.0</td>
<td>88.7</td>
<td>39.4</td>
<td>40.2</td>
<td>18.4</td>
</tr>
<tr>
<td>5-9.9</td>
<td>7.2</td>
<td>282.7</td>
<td>87.2</td>
<td>36.0</td>
<td>50.8</td>
<td>10.3</td>
</tr>
<tr>
<td>10-14.9</td>
<td>12.4</td>
<td>310.9</td>
<td>88.8</td>
<td>41.0</td>
<td>48.9</td>
<td>6.0</td>
</tr>
<tr>
<td>15-19.9</td>
<td>16.7</td>
<td>315.8</td>
<td>94.8</td>
<td>29.9</td>
<td>60.6</td>
<td>4.3</td>
</tr>
<tr>
<td>20 above</td>
<td>25.1</td>
<td>308.4</td>
<td>95.2</td>
<td>27.0</td>
<td>63.9</td>
<td>9.9</td>
</tr>
</tbody>
</table>

\(^b\) Relationships:

- MCI = 262.06 + 2.48x
- RRII = 42.04 - 0.57x
- RVII = 39.67 + 1.03x
- RFII = 14.43 - 0.36x

\(^c\)See Fig. 1 for meaning of symbols; \(^b\)Standard deviation is 8.6 for all relationships; \(^f\) Significant at 10% level.

Table 14. Comparison of labor use and production cost for selected field and vegetable crops, Taiwan; AVRDC, 1978.\(^d\)

<table>
<thead>
<tr>
<th>Field Crops</th>
<th>Labor Time Index</th>
<th>Production costs Amount Index</th>
<th>Crop duration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>hrs/ha</td>
<td>US$/ha</td>
<td>No. months</td>
</tr>
<tr>
<td>Pongal Rice</td>
<td>769   100</td>
<td>1,020 100</td>
<td>4</td>
</tr>
<tr>
<td>- spring</td>
<td>752   98</td>
<td>999 98</td>
<td>3.5</td>
</tr>
<tr>
<td>- summer</td>
<td>918   119</td>
<td>703 69</td>
<td>3</td>
</tr>
<tr>
<td>Corn (spring)</td>
<td>660   86</td>
<td>550 54</td>
<td>3</td>
</tr>
<tr>
<td>Soybean (winter)</td>
<td>1,160   151</td>
<td>669 66</td>
<td>3</td>
</tr>
<tr>
<td>Mungbean</td>
<td>1,141  148</td>
<td>749 74</td>
<td>5-6</td>
</tr>
<tr>
<td>Sweet potato (spring)</td>
<td>5,013 652</td>
<td>3,174 311</td>
<td>3.5</td>
</tr>
<tr>
<td>Pea (summer)</td>
<td>1,196  156</td>
<td>877 86</td>
<td>2.5</td>
</tr>
<tr>
<td>Pickling melon</td>
<td>2,890  376</td>
<td>1,786 175</td>
<td>1</td>
</tr>
<tr>
<td>Non-heading Chinese cabbage</td>
<td>2,940  382</td>
<td>1,952 191</td>
<td>3</td>
</tr>
<tr>
<td>Common cabbage - summer</td>
<td>1,848  240</td>
<td>1,609 158</td>
<td>3</td>
</tr>
<tr>
<td>- winter</td>
<td>1,499  195</td>
<td>1,563 153</td>
<td>3</td>
</tr>
<tr>
<td>White potato</td>
<td>2,760  360</td>
<td>1,911 187</td>
<td>2.5</td>
</tr>
<tr>
<td>Heading Chinese cabbage - summer</td>
<td>1,780  232</td>
<td>1,447 142</td>
<td>2.5</td>
</tr>
<tr>
<td>- winter</td>
<td>8,020  1,043</td>
<td>3,718 365</td>
<td>5.5</td>
</tr>
<tr>
<td>Tomato - fresh market - processing</td>
<td>1,640  213</td>
<td>1,340 132</td>
<td>4.5</td>
</tr>
</tbody>
</table>

\(^d\)Taiwan Provincial Department of Agriculture and Forestry, 1975. A Report on the Survey of Production Cost of Taiwan's Agricultural Products. Taichung, Taiwan.

\(^b\)Production cost surveys conducted by AVRDC in 1974 and 1975.
CHAPTER FIVE: CONSTRAINTS TO VEGETABLE PRODUCTION AND HOW TO RELIEVE THEM

Current Production Constraints

The rapid industrialization of Taiwan has drawn many young people away from the villages and into the cities. Labor is short and wages high, both serious constraints to vegetable cultivation. Moreover, summer production of vegetables is limited by environmental problems. Because production inputs are high, the costs of production are always great, but the seasonality of prices causes great variations in returns.

Table 15 shows the main factors regarded by the sample vegetable farmers as the most limiting. Of these, the farmers ranked first natural factors, then the price of production inputs, variable quality of pesticides, and low prices and profits.

Therefore, to improve vegetable production in Taiwan, it is necessary to investigate a) heat tolerant varieties, b) effective insect and disease control practices, c) ways to reduce production costs, d) ways to mechanize as a partial substitution for human labor, and e) the implementation of guaranteed prices.

Table 15. Most frequently mentioned constraints affecting vegetable production, Changhua and Tainan districts, 1977; AVRDC, 1978.

<table>
<thead>
<tr>
<th>Responses</th>
<th>Total (N=1649)</th>
<th>Changhua (N=1077)</th>
<th>Tainan (N=572)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climatic factors (temperature, heavy rain, typhoon, etc.)</td>
<td>15</td>
<td>14</td>
<td>18</td>
</tr>
<tr>
<td>High price of input (pesticides, fertilizer, machine)</td>
<td>11</td>
<td>9</td>
<td>13</td>
</tr>
<tr>
<td>Low price and profit of vegetables</td>
<td>10</td>
<td>9</td>
<td>12</td>
</tr>
<tr>
<td>High price fluctuation</td>
<td>9</td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td>Insect damage</td>
<td>9</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Disease damage</td>
<td>8</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>Lack of water supply</td>
<td>7</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>Lack of family labor</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Poor drainage system</td>
<td>5</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Difficult to hire labor and/or high wage</td>
<td>5</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>Limited farm size</td>
<td>2</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Others*</td>
<td>13</td>
<td>14</td>
<td>13</td>
</tr>
</tbody>
</table>

*Lack of new cultivation; too much labor required; bad condition of farm road; difficult to transport; production doesn't match the market demand; vegetables cannot be stored; perishable crop; production cost too high, yield unstable, poor soil quality.

<table>
<thead>
<tr>
<th></th>
<th>Total (N=1243)</th>
<th>Changhua (N=819)</th>
<th>Tainan (N=424)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Limited by farm size</td>
<td>30</td>
<td>14</td>
<td>16</td>
</tr>
<tr>
<td>Lack of family labor</td>
<td>24</td>
<td>5</td>
<td>23</td>
</tr>
<tr>
<td>Difficult to hire labor and high wage</td>
<td>7</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>Climatic factor (temperature, heavy rain, typhoon, etc.)</td>
<td>5</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Low price and profit of vegetables</td>
<td>5</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>Lack of water supply</td>
<td>5</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>High price fluctuation</td>
<td>4</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>High price of input factors</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>(pesticides, fertilizer, machine)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insect damage</td>
<td>1</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Disease damage</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Poor drainage system</td>
<td>1</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Othersq</td>
<td>15</td>
<td>14</td>
<td>16</td>
</tr>
</tbody>
</table>

qOthers include: lack of new cultivation; too much labor for crop culture; bad condition of farm road; difficult to transport; production doesn’t match the market demand; vegetable cannot be stored; perishable crop; production cost is too high; yield unstable, poor soil quality.

Table 15 also allows us to accept hypothesis 8, that natural factors influence vegetable production more than economic factors.

Factors Limiting Expanded Production

Table 16 shows the relative importance of factors limiting the expansion of vegetable production. The primary response was limited farm size. In 1975 the average size of a Taiwan farm was 1.05 ha, and the man/land ratio 17.6 per ha. With labor already being used intensively on the farm, there is increasing competition from high nonagricultural wages.

Vegetable farms in the sample now average only 0.77 ha, considerably smaller than the Taiwan average. It also is necessary to grow rice and field crops to diversify cropping, spread risk, reduce losses, and/or increase profit.

The other limiting factors are, in order, lack of family and hired labor, natural conditions, lack of a water source, low price and profit, and variability in prices. We accept hypothesis 9, the main barrier to expanding production is lack of inputs, rather than prices or natural conditions.
Priority Problems to Be Solved

Which constraints do farmers feel should be removed first? Table 17 shows that, in order of importance, they suggest to:

1) Guarantee prices.

2) Reduce the prices of production inputs and strictly supervise their quality. With the increasing use of chemical fertilizers and pesticides, there has been tampering with quality, with adverse effects on plant growth and resistance to insects and diseases.

3) Provide sufficient irrigation water and improve drainage.

4) Expand vegetable exports. Every summer, when the supply of vegetables marketed is reduced, the government limits exports with adverse effects on profit. If the government did not control exports, farmers could be encouraged to grow more vegetables.

5) Supervise production and provide expanded marketing services.

Thus, farmers feel government can help most to relieve not major limiting factors such as small land size and natural constraints, but economic factors. This is because small farm size and labor shortages are not amenable to amelioration. Farmers wisely single out areas in which government may be most effective.

Contractual Production and Group Marketing

Contractual production and group marketing of vegetables are not widespread. Only processing tomato, seed, vegetables for export, and

Table 17. Priority solutions to vegetable production problems in Changhua and Tainan districts, 1977; AVRDC, 1978.

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>Changhua</th>
<th>Tainan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guarantee vegetable prices</td>
<td>35</td>
<td>41</td>
<td>21</td>
</tr>
<tr>
<td>Reduce the price of chemical</td>
<td>14</td>
<td>10</td>
<td>23</td>
</tr>
<tr>
<td>fertilizer and pesticides, control</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>the quality of pesticides</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Open vegetable export</td>
<td>8</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>Provide efficient irrigation</td>
<td>8</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>Government guidance and performance</td>
<td>7</td>
<td>9</td>
<td>5</td>
</tr>
<tr>
<td>of vegetable production &amp; marketing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construct drainage systems</td>
<td>5</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>Efficient control methods for pest and insect damage and varieties resistant to pests and insects</td>
<td>4</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Resolve lack of rural labor and reduce high wages</td>
<td>4</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Others</td>
<td>15</td>
<td>10</td>
<td>25</td>
</tr>
</tbody>
</table>
Table 18. Reasons for participating in cooperative marketing (or contractual production), 1977; AVRDC, 1978.

<table>
<thead>
<tr>
<th>Reason</th>
<th>Total (N=88)</th>
<th>Changhua (N=70)</th>
<th>Tainan (N=18)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guaranteed price</td>
<td>49</td>
<td>46</td>
<td>64</td>
</tr>
<tr>
<td>Encouraged by farmer association</td>
<td>13</td>
<td>15</td>
<td>4</td>
</tr>
<tr>
<td>Decrease transportation cost and inconvenience</td>
<td>7</td>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>Personal interest</td>
<td>7</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>High price</td>
<td>5</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Save labor</td>
<td>4</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Others</td>
<td>15</td>
<td>13</td>
<td>20</td>
</tr>
</tbody>
</table>

asparagus, are exceptional enough to require contract production. Only Yungching, Hsihu, and HsiLo, all major vegetable production areas, have adopted group marketing.

Even in these areas not all farmers participate in contractual production or group marketing (37% in Changhua, 18% in Tainan). Table 18 reveals the motivations of participating farmers. They ranked guaranteed price first, followed by encouragement from the farmers' association, the reduction in transportation responsibility and personal interest. We may thus accept hypothesis 10, farmers join group marketing and contractual production primarily for high and stable profits.

The main reasons for not participating were no local program, limitations in volume, and small planted area (Table 19). Therefore, contractual production and group marketing seem to merit large-scale expansion by the government. Farmers with small planted areas and volumes, for whom such programs are not convenient, may use their extra labor to market their own produce.

Table 19. Reasons for not participating in group marketing or contractual production, 1977; AVRDC, 1978.

<table>
<thead>
<tr>
<th>Reason</th>
<th>Total</th>
<th>Changhua (Group marketing)</th>
<th>Tainan (Contract production)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No available cooperative organization</td>
<td>41</td>
<td>51</td>
<td>45</td>
</tr>
<tr>
<td>Low production volume</td>
<td>24</td>
<td>34</td>
<td>22</td>
</tr>
<tr>
<td>Fear of fleecing by middlemen</td>
<td>8</td>
<td>13</td>
<td>1</td>
</tr>
<tr>
<td>Small planted area</td>
<td>6</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>Others</td>
<td>21</td>
<td>18</td>
<td>26</td>
</tr>
</tbody>
</table>
Summer Production

According to the 1976/77 sample, summer vegetables represent only 28% of total cultivated area and are grown by 55% of the farmers, with an average planted area of 0.4 ha per farm in the summer versus 0.6 ha in the winter.

Table 20 shows why the sample farmers were not willing to grow vegetables in the summer:

1) Climatic factors. Farmers hope that, as with hot season tomatoes at AVRDC, improvements may be made through plant breeding research.

2) Planting rice. Conditions unfavorable for vegetable cultivation suit rice, which has stable yields, a guaranteed price, and, hence, reliable returns. In the 1973/74 sample, 89.4 ha were planted to summer vegetables but the figure fell to 63.4 ha in 1976/77. In contrast, the area planted to rice increased from 400 to 426 thousand hectares over the same period.

3) Lack of farm labor. Movement of young labor to the cities has increased the average age per household head from 48 years in 1974 to 50 years in 1977. Labor available for vegetable cultivation continues to decrease.

4) Serious diseases and insect problems. High temperature and rainfall favor diseases and insects which attack vegetables. Thus, pest control costs increase in the summer. Plant breeding could both increase yields and decrease costs by producing pest-resistant (high-yielding) varieties.

5) Unstable profit. Because of the above factors, the yield per hectare of vegetables is low, sometimes nil, and the risk is great in terms of both yield and prices received.


<table>
<thead>
<tr>
<th>Reason</th>
<th>Total</th>
<th>Changhua</th>
<th>Tainan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural factors (rainfall, temperature, typhoon, etc.) and perishability</td>
<td>31</td>
<td>23</td>
<td>42</td>
</tr>
<tr>
<td>Grow rice</td>
<td>20</td>
<td>23</td>
<td>16</td>
</tr>
<tr>
<td>Labor shortage</td>
<td>11</td>
<td>15</td>
<td>6</td>
</tr>
<tr>
<td>Serious pests</td>
<td>11</td>
<td>14</td>
<td>6</td>
</tr>
<tr>
<td>Instability of return</td>
<td>6</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>Others(^2)</td>
<td>22</td>
<td>17</td>
<td>26</td>
</tr>
</tbody>
</table>

"No experience, soil quality not suitable, poor drainage, plant other crops."
The natural environment and biological factors greatly reduce the yield of summer vegetables. The vegetables are grown at high costs, and these costs, coupled with increasing demand, lead to increased prices. One could adopt a 3-pronged strategy to improve vegetable production: plant breeding to further reduce pest damage, guaranteed prices to stabilize profit, and economic measures to reduce production costs.
CHAPTER SIX: CONCLUSIONS AND RECOMMENDATIONS

Conclusions

1) The planted area and production in specialized vegetable areas such as in Changhua district are more stable and include more different species than general production areas. The latter areas, however, have adopted certain species on a larger scale because they had more less-intensively cultivated farmland.

2) Production of both summer and winter vegetables has become more concentrated into areas with comparative advantages, notably Changhua district. Summer transaction volume is smaller and more stable than in winter, but has larger price variability.

3) The motivations for growing vegetables are stable despite the growth in vegetable production - over 127% in the past 10 years. These motives include high cash income, full use of land, and custom and experience. Of lesser importance were soil conditions, full use of family labor, proximity to market, and home consumption.

4) Over 80% of farmers plant the same species from year to year because of familiarity with cultural practices, suitability of land and climate, and good profit. Farmers who change species from year to year are more business minded.

5) Of the 8 cropping patterns in Changhua and Tainan districts, planting vegetables between the summer and spring rice crops is becoming more predominant. It allows farmers to fully use their land and labor as they increase their earnings.

6) Among vegetable producing households in Changhua and Tainan the multiple cropping index increased from 267 in 1973/74 to 277 in 1976/77, compared with a general value for these districts of 213 and for Taiwan as a whole of 175. Farms in specialized vegetable areas are 33% smaller than the Taiwan average, and there is a strong negative correlation between farm size and the relative intensity of vegetable cropping.

7) The number of workers per hectare is strongly related to intensity of vegetable cropping. In response to increasing either farm size or the man/land ratio, the relative vegetable cropping intensity moves in an opposite direction from the relative rice and field crop cropping intensities.

8) Contractual production and cooperative marketing of vegetables have been successful in Taiwan. The major reasons the farmers participate are guaranteed price and encouragement by their farmers' associations.

9) The influence of natural factors on vegetable production in Taiwan is greater than that of economic factors. However, farmers
believe the main barrier to expansion of production areas is lack of production inputs, rather than natural conditions. The priority problems they list are such economic ones as variable prices, high input costs, insufficient irrigation, artificially limited summer exports, and lack of government supervision of marketing.

Recommendations

1) More specialized vegetable production areas could be established, with careful selection of the vegetables in which each has a comparative advantage. Such programs could work through the farmers’ association network to encourage joint pest control, mechanized cultivation, reduced production costs, and the benefits of large scale farming.

2) Given that farmers rank the elimination of high priced, adulterated pesticides as their second most important policy suggestion, the quality of production inputs such as pesticides could be carefully monitored.

3) There could be an open summer vegetable export policy to induce the farmer to plant more summer vegetables.

4) More technical guidance is needed for producing summer vegetables. Farmers could then change the cultivation environment through such techniques as net house cultivation, and increase the area and production in highland areas.

5) A program to better plan the production and marketing of selected vegetables could be established. Production contracts and guaranteed prices are important to the farmer and could stabilize supply, especially in the summer. Which vegetables should be grown in which areas must, however, be decided by the government of the Republic of China, in connection with recommendation 1.

6) Programs of processing and export promotion could expand the demand for and, hence, increase the price and profitability of vegetables produced during the winter. Winter exports to, say, Korea could be balanced by summer imports to benefit both countries.

7) Further plant breeding is necessary to develop varieties resistant to disease, insects, high temperature, and moisture damage during the summer.
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