

**Land and Water Management for Cultivation Under in the Kinki District (I)**  
– A case of study of the investigation of the actual conditions in Kyoto,  
Osaka, and Hyogo prefectures –

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**Abstract**

Land and water management on the crop cultures of the cultivation under cover are different from the crop, soil, meteorology, and the other conditions. This study was conducted to clarify how their managements are actually controlled in the cultivation under cover. Kyoto, Osaka, and Hyogo prefectures which have big cities were selected as the districts of the investigation object. In these prefectures, the management areas of vegetables were distinctly found to be much developed in the cultivation under cover as the culture area of the main crops, but the management areas of some of the other crops like fruit trees and cut flowers are not so developed yet at present. However, the management area of them tends to increase in the cultivation under cover. On the other hand, the technical methods of the land and water management are supposed not to be established because their managements are clearly dependent on the experiences of each farmer who has conducted them for a long time. Therefore, the establishment of the technical method on the appropriate land and water management has been waiting to be introduced.

**Introduction**

Crops which are abundantly planted in the cultivation under cover are vegetables in the Kinki district. In Kyoto prefecture, each of the culture areas of tomatoes, cucumbers, and strawberries is more than 20 ha respectively. In Osaka prefecture, the culture area of egg-plants is about 65 ha, and that of tomatoes or cucumbers is each more than 20 ha. And also, each of the culture areas of grapes is about 87 ha, and that of cut flowers is about 33 ha. In Hyogo prefecture, each of the culture areas of tomatoes is about 94 ha, and that of strawberries and cucumbers about 75 ha and 28 ha respectively. Again, to the culture area of cut flower is about 100 ha. In this way, the culture areas of the crops in the cultivation under cover of each of prefecture, are different from each other, and their characteristics are different as mentioned above. On the other hand, the actual conditions are not yet clarified though many studies on the land and water management are have been reported. And also, many views expressing that the land and water management are very difficult and cannot maintain the best conditions are often heard here and there. So the studies for the land and water management in the actual cultivation under cover must be investigated to grasp the actual conditions at once. This study was carried out to clarify the actual conditions on the land and water management to the crop culture which are mainly planted in the Kinki district, but care was taken as much as possible to avoid repetition of the same crop and their investigations were conducted by hearings and observations.

### I. Actual conditions of the land and water management in Kyoto prefecture

Places where the crop culture in the cultivation under cover is actively popular are the southern and the northern parts of Kyoto prefecture. The northern places are Maizuru city and Miyazu city, and the southern places are Kameoka city, Kyoto city, Uji city, Kumiya town, etc. In these places, the main crops are vegetables. On the other hand, fruit trees are not much planted except in Yamashiro town. And cut flowers are planted at Kyoto city, Uji city, Joyo city, and Kumiya town. At first, the management areas in the cultivation under cover and the different management areas of main vegetables are shown in Table 1 and Table 2. Then one case of the actual conditions is shown in Fig. 1 on the culture form of the crops. Fig. 1 shows the time when the tomatoe seedlings are planted at the end of March and the harvesting is done from the first part of May to the end of June. Spinaches planted the seeds at the end of August and the harvesting is done at the middle of October. After that, spinaches or chrysanthemum coronarium are planted the seeds at the first part of the November and the harvesting is done from the first part of December to the end of January. In this way, their cultures are conducted through all seasons in the cultivation under cover. The culture styles are that the furrow width is about 20 cm, the bed width about 100 cm, and the bed height about 10 or 20 cm. The land foundation improvement which was investigated was completed in this vinyl house and the security of irrigation water or the establishment of the irrigation systems was accomplished. As the soil texture is of the sandy loam soil type, its per-

Table 1 The management area of the cultivation under cover in Kyoto prefecture (agricultural census, unit: ha)

year	vegetables	cut flower	fruit tree
1970	52.5	5.8	1.0
1980	100.2	13.5	3.4

Table 2 The culture area of different vegetables in Kyoto prefecture (agricultural census, unit: ha)

year	tomato	cucumber	egg-plant	green pepper	strawberry
1970	9.8	14.9	7.7	1.4	4.3
1980	20.0	20.0	4.7	1.2	21.5

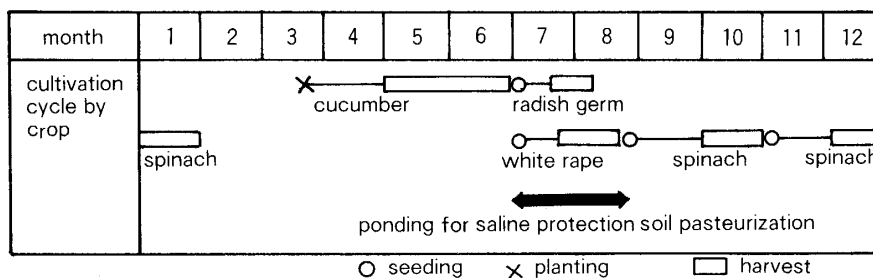


Fig. 1 A case of the culture form in Kumiya town.

meability is supposed to be high, but the groundwater level is about 1 m, the soil pasteurization is conducted during the hot period of August. And also, the ponding of saline protection is conducted through 24 hours and the amount of its water was estimated to be about 200 mm. On the other hand, with regard to the water management, the water source is the groundwater. The overhead irrigation method is applied by the spray nozzle system of both side direction type against vegetables having soft leaves, but to the crops which dislike to be wetted, the surface irrigation method is applied by the perforated tube system. The amount of each irrigation in the spray nozzle systems is estimated to be around 2 mm to 4 mm everyday and that in the perforated tube systems is estimated to be around 3 mm to 6 mm everyday or at two days interval. The differences of their values depend on the dry or wet situations of soil surface. The results thus obtained are very different from the reviews which showed results regarding to the amount of each irrigation, irrigation interval, irrigation timing, and so on. The reason which is attributed is that most farmers are dependent on their experiences which they have obtained for a long time, and yet, the index of the reviews often show the special cases.

## II. Actual conditions of the land and water management in Osaka prefecture

Places where the crop culture in the cultivation under cover are actively popular are located at the northern, the eastern, and the southern parts of Osaka prefecture. Main crops planted are vegetables. But fruit trees and cut flowers are abundantly planted too. Vegetables culture is found at a part of the northern places, Minamikawachi through Kitakawachi, and the Senshu region from the southern places of Sakai city. Fruit trees are planted at the sloping lands and the hill of Katano city, Kashihara city, Habikino city, Taishi town, and other places of Osaka prefecture. Furthermore, cut flowers are cultivated at Mino city, Yao city, Higashiosaka city, Izumi city, Sennan city, and other places. The management area in the cultivation under cover and the different management areas of main vegetables are shown in Table 3 and Table 4. Therefore, the results which were actually investigated were selected as follows with regard to the samples of vegetables and grapes.

Table 3 The management area of the cultivation under cover in Osaka prefecture (agricultural census, unit: ha)

year	vegetables	cult flower	fruit tree
1970	174.6	21.5	10.0
1980	235.5	32.6	87.1

Table 4 The culture area of different vegetables in Osaka prefecture (agricultural census, unit: ha)

year	tomato	cucumber	egg-plant	green pepper	strawberry
1970	8.9	13.7	58.7	1.7	12.9
1980	21.3	23.9	65.0	0.2	15.1

(1) *A case of the grape trees culture in Taishi town*

As stated above, grape trees in Taishi town are mainly planted at the sloping lands and hills. Originally, grape trees are cultivated at the conditions of the openfield culture, but recently the culture system was converted to the culture of the cultivation under cover because the harvesting time could be made faster and the income thus increased. Usually the land foundation is not yet improved. Therefore, the soil layer improvement and the security of irrigation water are carried out by each farmer. Then, plastic sheets are spread over grape trees at the middle or the end of January, and then, they are torn away at about June. After that, grapes are harvested from the end of June to the end of July. On the other hand, with regard to the water management, the water sources are dependent on the storage tank of rainfall which is constructed as the upper side of orchard and small reservoir (called Tameike in Japan). But usually rainfall is introduced to the soil surface from the joint of plastic sheets. Irrigation is conducted by the small spray nozzles, for example, Rainbird No. 25, by the use of water in the storage tank or Tameike at the time of drought or the lack of rainfall. Watering hours are about 60 minutes and the amount of each irrigation is estimated to be about 5 mm. Irrigation interval and timing are dependent on the farmers' experiences which are judged from the growth stages or the conditions of soil surface.

(2) *A case of the rotational culture of vegetables in Suita city.*

Usually, the harvests of vegetables are conducted 2 or 3 times a year in the cultivation under cover. But in this place, the harvests are conducted 7 times a year. Its culture form is shown in Fig. 2. The rotation of the crop culture is found to consist of 7 kinds of vegetables. These are chrysanthemum coronarium – chrysanthemum coronarium – cucumber or tomato – stem of taro – chrysanthemum coronarium – chrysanthemum coronarium – chrysanthemum coronarium. In case of chrysanthemum coronarium culture, the harvesting is done only 40 days after sowing the seeds, in case of cucumber, the harvesting begins at 40 days after planting and continues for about 2 months, and in case of stem of taro, the harvesting is done only for 40 days after the seeds have been sowed. Furthermore, the culture styles of these vegetables are that the furrow width is about 20 cm, the bed width about 70 cm, and the bed height about 10 cm. The soil pasteurization is not conducted by the agricultural chemicals, but only the ponding of the saline protection is conducted for about 10 days after the third harvesting. On the other hand, with regard to the water management, the furrow irrigation method is applied by the direct intake from the agricultural irrigation canal. The amount of each irrigation is estimated to be about 37 mm at intervals of 5 or 7 days. This value is considered to be larger than the usual value reviewed. The reason may be that the furrow irrigation method is applied and the percolation loss is high because of the existence of being sandy soil in

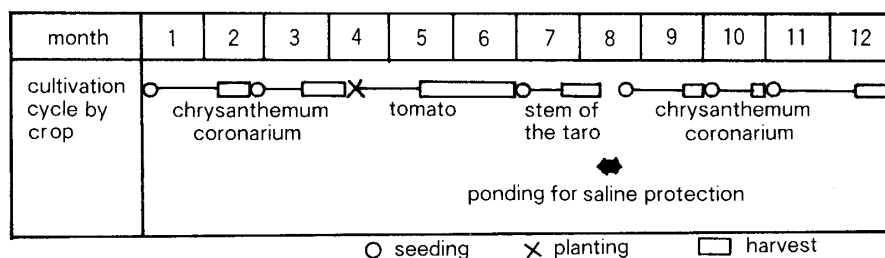


Fig. 2 A case of the culture form in Suita city.

this land. The problem is the influence of deterioration of the water quality in future because the water source is the agricultural irrigation canal located at the urbanized place.

(3) *A case of the butterbur culture in Izumisano city*

Recently, the butterbur culture in the cultivation under cover has been actively developed at the Senshu region. Butterbur harvesting is done three times a year. Its culture form is shown in Fig. 3. The butterbur seedlings are planted at the first part of September, and the harvesting is done three times a year, that is, in November, February, and May. The land foundation was not officially improved, but the soil dressing is conducted by each farmer to the height of about 100 cm on the original ricefield. Furthermore, the soil pasteurization was not conducted, but the ponding for saline protection is conducted for about 2 weeks from the end of June to the end of July. The culture styles are that the furrow width is about 20 cm, the bed width about 100 cm, and the bed height about 20 cm. On the other hand, with regard to the water management, the water source is Tameike. Irrigation water was taken by pumping through the agricultural water canal from Tameike, and the overhead irrigation method is applied by the nozzle system of the both side direction type. The amount of each irrigation is estimated to be about 2 mm everyday through all growth seasons independent of the meteorological conditions.

(4) *A case of the celery – butterbur culture in Izumisano city*

This case means that celeries are firstly planted and after that butterburs or tomatoes are planted a year. The culture form is shown in Fig. 4. Celeries are found to be planted at the first part of October and the harvesting is done at the middle or the end of January. After that, butterburs, tomatoes or cucumbers are planted at the first part of March, and the harvesting continues from the first part of May to the end of July. The culture styles are that the furrow width is about 20 cm, the bed width about 100 cm, and the bed height about 20 cm. The land foundation is not officially improved because lands cannot be grouped. But the soil dressing is conducted by each farmer to the height of

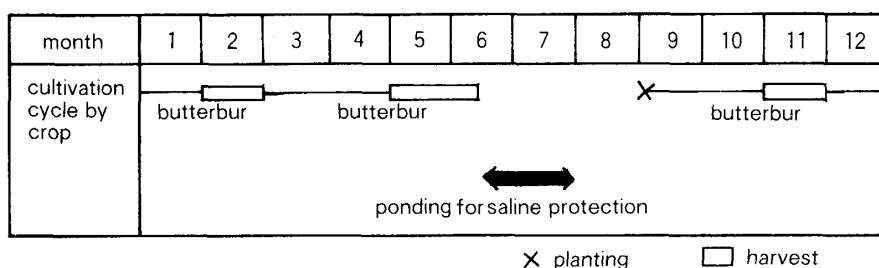


Fig. 3 A case of the culture form in Inzumisano city (butterbur).

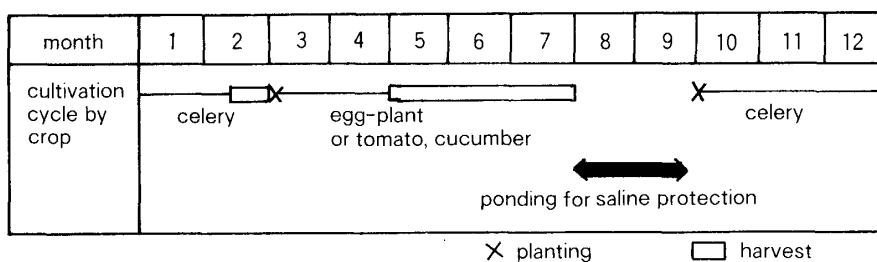


Fig. 4 A case of the culture form in Izumisano city (egg-plant-celery).

about 100 cm on the original ricefield. Furthermore, the ponding for saline protection is conducted for about 10 days of the first part or the middle of August after the harvest of the spring crop, but the soil pasteurization is not conducted by the agricultural chemicals. On the other hand, with regard to the water management, the water source is Tameike, and irrigation water is taken by pumping from Tameike through the agricultural water canal. Irrigation is conducted by the use of the spray nozzle system of the both side direction type through all seasons. The amount of each irrigation is estimated to be about 2 mm everyday to the celery, and about 3 mm everyday to butterbur, tomato or cucumber culture.

### III. Actual conditions of the land and water management in Hyogo prefecture

Places where the crop cultures in the cultivation under cover are actively popular are the northern parts, the southern parts, and the Awaji island of Hyogo prefecture. Main crops planted are vegetables. But cut flowers are abundantly cultivated too; the regions are at Kobe city, Himeji city, Akashi city, Kakogawa city, Kasai city, and other places. But fruit trees are not planted so much. The management areas of the cultivation under cover and the different management areas of vegetables are shown in Table 5 and Table 6. The results obtained are as follows;

#### (1) A case of the egg-plant culture in Kobe city

The egg-plant culture in the cultivation under cover is mainly conducted at the western part of Kobe city and they are planted at all seasons. The land foundation of this cultivation under cover is improved about 15 years ago, and the security of irrigation water, the system which is at the end of the irrigation system as well as the drainage devices are already established. And also, the soil dressing was conducted at the same time. That is, loam soil is laid on the original ricefield having about 25 cm thickness. The culture form is shown in Fig. 5. The egg-plant seedlings are planted at the end of September and the harvesting commences at the first part of November, and the harvesting continues till the end of June. But the main harvesting period is about 2 months from the first part of April to the end of May. The culture styles are that the furrow width is about 50 cm, the bed width about 120 cm, and the bed height about 35 cm. The

Table 5 The management area of the cultivation under cover in Hyogo prefecture (agricultural census, unit: ha)

year	vegetables	cut flower	fruit tree
1970	113.2	52.9	2.8
1980	315.4	101.2	7.5

Table 6 The culture area of different vegetables in Hyogo prefecture (agricultural census, unit: ha)

year	tomato	cucumber	egg-plant	green pepper	strawberry
1970	43.8	12.1	5.7	1.9	18.9
1980	93.5	27.5	5.3	3.4	74.6

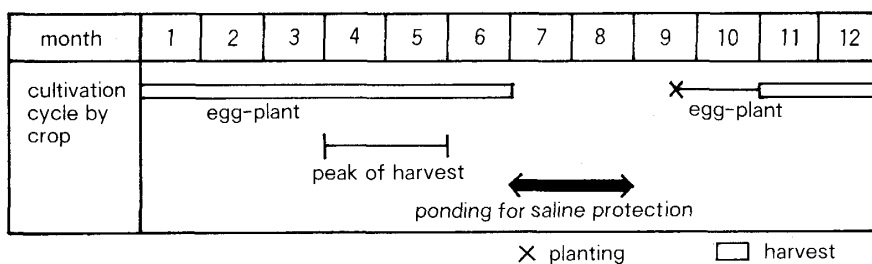


Fig. 5 A case of the culture form in Kobe city (egg-plant).

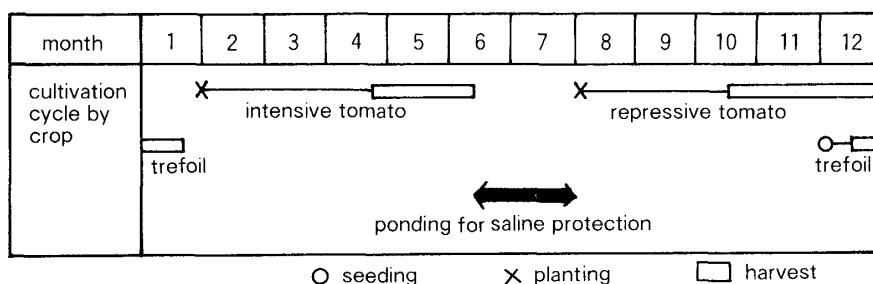


Fig. 6 A case of the culture form in Kobe city (tomato).

characteristics of this egg-plant culture is that the harvest period is very long and its period amounts to be about 8 months. After the first harvest, the soil pasteurization is conducted by the agricultural chemicals, and then the ponding for saline protection is conducted for about 2 weeks within the period beginning from the first part of June to the end of August. On the other hand, with regard to the water management, the water source is Tameike, and irrigation water is directly transported by the pipe line system from there. Irrigation is applied to egg-plants through all growth seasons by the use of the spray nozzle systems of the both side direction type. The amount of each irrigation is estimated to be about 5 mm at 2 or 3 days interval as general, but its value is decided by the growth situations, the meteorological conditions, the dry conditions of soil surface, and so on. And also, if there is a difference in the dry conditions among the various parts, water is sometimes applied by manual operation.

## (2) A case of the tomato culture in Kobe city

The tomato cultures are conducted by the rotational system a whole year in this place. And the land foundation was officially improved, so the security of irrigation water and the irrigation system were established. But the drainage devices were not established. The culture form of tomatoes is shown in Fig. 6. The repressive tomato seedlings are planted at the first part of August. The harvesting commences at the middle of October and ends the last of December. After that, the intensive tomato seedling are planted at the end of January, and the harvesting begins at the end of April and at the middle of June. The soil pasteurization and the ponding for saline protection are conducted for about 2 weeks after the harvest. The culture styles are that the furrow width is about 40 cm, the bed width about 100 cm, and the bed height about 10 cm. On the other hand, with regard to the water management, the water source is the deep well. The automatic irrigation system was initially applied after the land foundation improvement, but it was converted to the manual operation system because the problems of the dry or wet situations

often occurred here and there. The amount of each irrigation is estimated to be about 30 mm at 5 or 6 days interval at first, but after the change of the irrigation system, it is estimated to be about 15 mm at 3 or 4 days interval. As mentioned above, the automatic irrigation system was very advantageous to farmers at first, but problems like the non-uniformity of the spray distribution, the decrease of the productions, the partial dry or wet situations, etc. were often occurred, so the automatic irrigation system may be converted to the manual operation type. That is, more the system is complicated, the more the management or the treatment becomes difficult.

### Considerations

The actual conditions of the land and water management were investigated and clarified on the cultivation under cover in Kyoto, Osaka, and Hyogo prefectures where the big cities of the Kinki district are situated. Consequently, the characteristics of the crop culture are found to be different in each prefecture. Main crops are vegetables in the cultivation under cover, but the kind of vegetables cultivated is very different at each prefecture. And also, the culture area of fruit trees or cut flowers is different in each prefecture too. That is, in Osaka prefecture, the culture area of fruit trees is estimated to be about 100 ha and that of cut flowers to be about 38 ha. Also, in Hyogo prefecture, the culture area of cut flowers amounts to be about 100 ha, but that of fruit trees is only about 10 ha. However, in Kyoto prefecture, the culture area of fruit trees is about 15 ha. On the other hand, the land and the water management are considered to be slightly different. With regard to the land management, the land foundation improvement was not so much conducted officially in the cultivation under cover in each prefecture. If it was conducted, it only concerns with maintaining the security of irrigation water and the irrigation system. So the soil dressing, the drainage devices, and others had to be conducted by each farmer individually. Furthermore, the water sources are very different, for example, the agricultural water canal, Tameike, the groundwater, etc. Therefore, it is clarified that the techniques of the land and the water managements are not to be established yet now.

### Discussions

The actual conditions of the land and the water management in the cultivation under cover were investigated and clarified in this study. Consequently, the land and water management are found to be dependent on the experiences of each farmer who has gained for a long time. Especially, the small size of the lands make their grouping very difficult. Furthermore, the index of the land and water management are imperfect, and their technical method are not established yet.

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