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REPORT ON SURVEY IN AGRICULTURAL COOPERATIVES IN IRAN

JANUARY 1974

OVERSEAS TECHNICAL COOPERATION AGENCY
GOVERNMENT OF JAPAN

REPORT ON THE PRESENT CONDITION AND THE FEASIBILITY OF DEVELOPMENT OF SERICULTURE IN IRAN

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PREFACE

This survey was conducted at the request of the Minister of Agricultural Cooperation of Iran.

Iran is reported to produce 2,000 tons of cocoon in a year. With a target of increasing cocoon output enough for an additional 1,000-ton yearly production of raw silk, the Ministry of Agricultural Cooperation has formulated a plan to create 12,000 ha of mulberry field, and asked our suggestions concerning its feasibility.

Our survey on the spot, however, was mainly concerned on the technical phase, as we had almost no information on the Iranian sericulture before the survey. We could not afford to cover the way of life of farmers, etc. Generally speaking, agriculture cannot be promoted by the fact alone that the natural environment suits the crop in question; it has a closer relation with the life of farmers. In sericulture, in particular, which requires comprehensive techniques both in mulberry and silkworm, we cannot neglect farmers' feeling.

Accordingly, we could not give direct suggestions as to the feasibility of the additional production of raw silk in this report. Instead, the contents of our survey deal with the actual condition on the technical facet rather in-tail. This is from our wishes that this report may be of use for reference in the future study for the development of Iranian sericulture, as there are few surveys on such subject. In addition, although we paid as much attention as possible during the survey, this report may contain some errors due to lack of understanding. For such inadvertency, if any, we cannot but rely upon lenience on the part of Iranian people concerned.

Now, we conducted on-the-spot surveys in the districts of the Caspian Sea Coast, Esfahan and Khurasan. On the data supplied, furthermore, we examined the problems and necessary countermeasures for the development of Iranian sericulture. As a result, we found not a few appraisable, though sporadic, attempts for higher techniques. In general, however, there remain

many problems which may employ with avail the experience and technique of Japanese sericulture for solution.

Following are our observations based on the findings and our views on the points to be improved.

I. GENERAL PROBLEMS AND OUR OBSERVATIONS

1. Mulberry Field and Silkworm Rearing

In Iran, sericulture is low in productivity, since silkworms are reared only once a year. In order to raise the productivity, it would be very useful to adopt a method of rearing silkworms twice or more during a year. We, survey mission, examined the matter with the feasibility of multiple rearing as the central target.

1) Climate

As regards the Iranian climate, detailed observations are being conducted from district to district; we were provided with data on the districts concerned. Table 1 compares the Iranian climate with that of Japan. There is no big difference in air temperature. As for precipatation, the annual amount on the Caspian Sea Coast does not differ widely from that in Japan. However, if it comes to the monthly distribution, the rainy season of Japan falls in the summer, while it is in winter in the Coastal District. We are afraid therefore that the summer in Iran when mulberry grows actively may lack in moisture. In the dry zone of the Iranian Plateau, precipitation is scarce throughout the year, making it necessary to take care for irrigation in creating mulberry field.

As to humidity, the Caspian Sea Coast enjoys an annual moisture of 70% or above on an average, thanks to the high water table, etc., while on the highland district, it is very dry, with the average humidity during summer hovering around 30%. This means that in silkworm rearing, for example, we should take some technical measures to keep mulberry leaves wet as long as possible. In the Coastal District, mounting environment should be kept dry as far as possible, if the quality of cocoon is to be improved.

Table 1. Climate

1 - 1, Temperature (°C)

Place	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Year
TOKYO*	3.7	4.3	7.6	13.1	17.6	21.1	25.1	26.4	22.8	16.7	11.3	6.1	14.7
SENDAI*	0.1	0.6	3.5	9.0	13.9	17.8	22.0	23.8	19.8	13.8	8.2	2.9	11.3
KAGOSHIMA*	6.6	7.7	10.8	15.1	19.0	22.6	26.8	27.1	24.4	18.9	14.0	9.0	16.8
RASHT	8.4	8.4	9.9	13.9	19.3	22.6	25.0	25.6	22.2	17.4	14.0	10.7	16.5
ESFAHAN	1.9	5.0	9.5	15.0	20.3	25.0	28.1	26.7	22.8	16.4	10.0	4.7	15.6

*: Japan

1 - 2, Precipitation (mm)

Place	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Year
TOKYO	48	73	101	135	131	182	146	147	217	220	101	61	1,563
SENDAI	37	44	62	95	100	155	167	136	191	133	61	50	1,232
KAGOSHIMA	75	116	149	228	249	454	348	220	213	120	90	79	2,337
RASHT	96	103	107	97	58	38	58	69	170	274	108	69	1,247
ESFAHAN	15	10	25	15	5	0	0	0	0	3	15	20	109

1 - 3, Humidity (%)

Place	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Year
TOKYO	60	60	63	68	73	79	80	79	79	77	71	65	71
SENDAI	72	70	68	68	75	83	87	85	82	78	74	74	76
KAGOSHIMA	76	73	74	77	79	82	82	80	80	76	77	77	78
RASHT	75	79	78	74	67	70	67	71	77	87	85	82	76
ESFAHAN	64	54	45	40	39	30	28	29	32	38	50	59	42

Except for the problems mentioned above, the climate of Iran seems suitable for sericulture, as wind, among others, is not so severe. In other words, it is feasible to conduct multiple rearing throughout seasons, we presume, only if necessary irrigation is provided for.

2) Soil

In Iran, the researches of soil science are at high levels. We were shown, at a large Farm Cooperation we visited, classified land utilization maps along with soil maps which were helpful in appraising the site for mulberry field. In other places, however, such data were not available, so we estimated the fitness of land as mulberry field through the observation of local soil and a simple soil analysis.

In Japan, a favorable soil condition for mulberry plantation is compiled as shown in Table 2. Since mulberry sends out main root as deep as 60 cm, it is not desirable to have, near the surface, a layer

Table 2. Favorable Soil condition for mulberry plantation

Items	Limitting Value	Note
Soil Texture	Sandy Loam Clay Loam	
Available Soil Layer	60 cm Top Soil 15 cm	limitting layer: Gley, Clay Gravely layer etc.
Underground Water Table	1 m	from the surface
Content of Air	20%	by volume %
Available Water	50 mm	in available layer
pH (H_2O)	5 ~ 8	
Available P_2O5, K_2O	20 mg %	N/5-HC1 soluble

of sand and gravel, hardpan, or other soil which is detrimental to the growth of root. Root cannot grow in a layer where water stagnates, either. Nor can root breathe well in a perhumid soil stratum where air permeation is poor; underground water level is to be 1 m or deeper. From these conditions, we may say that sandy loam - clayey loam rather than clay or sand are desirable to mulberry plantation.

Now, we will discuss problems common to the areas we have surveyed. The pH of soil was neutral to slightly alkaline. Since we have found no physiological disorder in standing mulberry trees, there will be no trouble. Although bases such as Ca, Mg, K are rich, phosphoric acid is, generally little, which should be supplied as fertilizer. Soil fertility of highland zone is, in general, superior to that of the Caspian Sea Coast where hydromorphic soil prevails. That is to say, in the dry zone of highland, there are many accumulations of carbonates, which, poured with hydrochloric acid, melt producing bubbles. They contain a small amount of available phosphoric acid. On the Caspian Sea Coast, on the other hand, the hydromorphic soil as seen in the Rasht District, for example, is clayey with higher water table and less deposit of carbonates. Underground water level of 1 m or higher makes land unsuitable for mulberry plantation. Even on the same coast, the soil of the Gorgan District was similar to that of the dry zone, and its fertility seemed relatively high. The reclaimed land at Sameskandeh near Sali has, like the survey site at Rasht, a high water table; the land does not fit mulberry field at least as it is.

We saw some drainage works going on in the areas where underground water level was high. As it takes quite a long time till the water table recedes, we should plant, until the time when we can ascertain the retreat, soybeans, alfalfa, etc. instead of mulberry in order to mature the field.

Furthermore, irrigation is a necessary condition in every area since precipitation during summer when mulberry grows is little as stated above while discussing climate.

To sum up, it is feasible to create mulberry field in the areas we surveyed, if and when the conditions of underground water level and irrigation are satisfied.

3) Irrigation

When it comes to a matter of irrigation, there are many advanced points in Iran where the dry zone prevails. Apart from intakes from dams, irrigation from wells are projected, with a part already started. Some well water contained much salt, but our advice will be unnecessary since Iranian people are taking serious consideration of the problem.

The mulberry tree is one of crops which consume a large amount of water. The water consumption of mulberry field as measured in Japan is about 6 mm/day in summer on an average. On the Caspian Sea Coast where relative humidity is high even in summer, the value will be close to that of Japan. In the dry zone on highland, however, it is estimated to be about 10 mm/day, or 100 m^3/ha·day. Incidentally, we obtained some 11 mm/day by calculation from the actual results Mr. Roofoogaran had on the mulberry field.

This subject needs further examination on the spot.

4) Mulberry Varieties

Among conventional mulberry varieties, we found white-fruit mulberry and red-fruit mulberry. The latter were thicker branches with larger and more succulent leaves. Further, some of Japanese varieties had been introduced: Ichinose and Kokuso No. 21 being representative. In Iran, Kokuso No. 21 was rated the highest, though it ranks

second to Ichinose in Japan, a wet climate. Kokuso No. 21 seems to be one of the varieties which fit the dry zone.

In point of leaf yield, it has been proven that the introduction of Japanese varieties produces better results than Iranian natives. However, we cannot make a hasty conclusion which of more than 100 Japanese varieties suit Iran better. That is to say, some races may produce such leaves as harden so early in the dry climate of Iran that they cannot be used for rearing in September. Also, there are races which are weak to a certain disease. Therefore, we cannot select good varieties before the actual condition of disease and insect pest in Iran is made clear. Subsequently, however, we will advance some concrete proposals.

In addition, the transplantation of Japanese mulberry races is surely beneficial in the area under a similar climate. But Iran differs from Japan in the supply of water and has, in some areas, considerably wider ranges in temperature between day and night, which concern the fundamentals of plant physiology. In a long run, therefore, it may involve some danger to put stress only on the introduction of Japanese mulberry races. Since Iran has indigenous varieties, it would be necessary to bread those from them by selection which have desirable characters, if a stable and enduring sericulture is to be established in Iran.

Grafting and cutting are good methods to multiply mulberry saplings, and are being practiced in Iran. As there are many improved types in Japan, it is desirable to introduce some to raise efficiency.

5) Disease and Insect Damages of Mulberry

As it is difficult to conduct a survey on the disease and insect damages of mulberry in a period when the plant is not growing, we did not attempt it.

Among mulberry diseases, white and violet root rots and dwarf disease are most dreadful. As root rot attacks the root of many plants, it is necessary, when we have reclaimed a forest, to check its presence. It is reported that tea-trees suffer from root rot there. We may anticipate the presence of this disease.

Although many insect pests of mulberry are known, the detection of pests as well as the disease requires the skill of experts and is to be performed in a certain season. It is desirable therefore to let experts investigate the matter specially.

6) Training and Harvesting Methods of Mulberry

As far as we have surveyed, (high) medium cut is the base of mulberry training in Iran. Although low-cut is more frequently used in Japan, the advisability of its introduction might not be hastily concluded; the final decision will not come before the results of many experiments have been accumulated. The plant in the Iranian dry weather would need more stored nutrient and a deeper root system. This would be the reason why the higher-cut type has staid there in its sericultural history. When sufficient water is given by irrigation, however, the low-cut type may be adoptable.

In old sericultural regions in Iran, standing mulberry trees as they are frequently used instead of a mulberry field. Since old trees are low in productivity, it is desirable to replant trees of 20 years or older and shape them into a mulberry field.

7) Manuring

The application of manure to mulberry field does not seem a general practice in Iran.

The contents of main inorganic elements in various parts of the mulberry tree are shown in Table 3. The concentration of N and Ca is

especially high in the leaf. In addition, Fig. 1 depicts the absorption of the elements of manure year by year, broken lines delineating the exploitation by harvesting. Unless we supply these elements of corresponding amounts as manure, they will decrease gradually so that trees eventually become unable to produce a sufficient leaf crop.

In Japan, the standard level of fertilization is, in the case of low-cut, established as follows: N:300 kg per ha, P_2O_5:150 kg, K_2O:180 kg and some organic matter (for example, 750 kg of rice straw for a year). The organic matter is required to prevent the deteriolation of soil which repeated application of inorganic manure unavoidably brings about.

In the present survey, we saw 2 examples of manuring: (1) Mr. Roofoogaran's mulberry field was given 6 kg of stable manure per tree once every other year, and (2) Natanz Cocooner Company applied sheep's feces along with urea of 200 kg/6,000 m^2 (about 330 kg/ha).

As the amount of manuring varies with the kind of soil and the training method of mulberry, the standard level will not be established before the training method is set up.

Table 3. Content of main elements in Mulberry tree

(% in dry matter)

Section / Element	Root (Diameter m.m.)					Stem	Shoot	Leaf
	2	2~5	5~10	10~20	20			
N	1.92	2.27	2.66	1.44	0.55	0.79	1.24	4.29
P_2O_5	0.41	0.58	0.06	0.20	0.35	0.17	0.36	0.67
K_2O	1.84	1.63	0.80	1.09	0.92	0.58	0.73	2.44
CaO	0.82	1.36	0.86	0.95	0.81	0.97	0.97	4.76
MgO	0.37	0.39	0.15	0.23	0.24	0.15	0.15	0.66

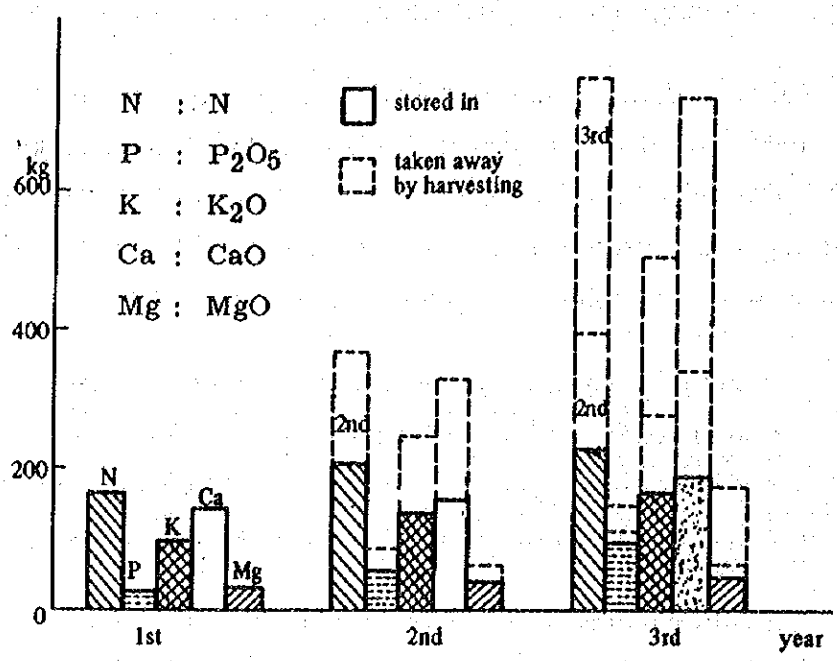


Fig. 1. Element absorption during the growth

8) Control of Silkworm Disease

In aconducting multiple rearing, what we must pay attention to is: silkworm disease. Viral disease of silkworm, in particular, spreads readily. In Japan, failure in cocoon crop was brought about, in former days, principally by pebrine, but this is now under control. At present, almost all failures are caused by viral disease, it is said.

In the current survey, we heard that some silkworms developed symptoms of diarrhea. It is highly probable that this is a viral disease. In a single rearing as it is, the pathogen will be naturally so diluted that the infective titer to the silkworms in the next rearing will fall. In actuality, therefore, there has happened no serious damage so far,

it seems. But this pathogen does not perish until it is exposed to direct sunshine or treated with chemicals.

What is to be feared next to this viral disease is the fungous disease of silkworm. As this disease is likely to break out when it is warm and humid, people in the lowlands along the Caspian Sea should be cautious enough.

In order to control the diseases of silkworm, we should clean and disinfect rearing room and tools thoroughly before and after their use. Against fungous disease, furthermore, we should carry on the disinfection of the body of silkworm and the rearing bed during rearing. In this connection, it is essential to disinfect the soil around the rearing house at the time of sterilizing rearing room and tools.

A solution of formalin mixed with some adjuvants is used to disinfect rearing room and tools as well as the ground around the rearing house. As for the sterilization of the body of silkworm and rearing beds, some chemicals for this purpose have been developed and are recommended. Concerning the concrete method of disinfection, refer to technical books, "Silkworm rearing technics in the tropics" and "Sericulture" attached to this report.

9) How to rear silkworm

As far as this survey is concerned, silkworm rearing in Iran may be called a laissez-faire rearing, in which the fate of silkworm is abandoned to the Providence, we presume. Rearing starts at sometime from late April to early May; during rearing they do not appear to resort to heating even when it becomes cold.

To build up sericulture as an industry, it is necessary to conduct rearing according to plan. In the present laissez-faire rearing, we cannot anticipate when silkworms are to be mounted, nor can we prearrange a drying schedule, not to speak of a plan of division of labor

with other farm works. In launching multiple rearing, we should, first of all, let the whole operation going on according to a schedule, which furthermore should be sufficiently scientific to agree with the physiology of silkworm.

(1) Installation of rearing room for 1st to 3rd instar:

Younger silkworms are more susceptible to pathogen, temperature and humidity. In order to conduct multiple rearing and harvest stable cocoon crops, it is necessary to build a rearing room which is agreeable to the physiology of silkworm. Although rearing area must be expanded rapidly as silkworms grow, a relatively small area is required in the 1st to 3rd stage. So, it is desirable to build a room where silkworms are readily isolated from pathogen and where temperature and humidity are easily controled. Since such an installation is uneconomical for an individual farmer, it is to be set up by a group, such as Cooperation or Cooperative Society. Incidentally, about 80% of the total silkworms in Japan are reared in such young silkworm cooperative rearing houses. Farmers who do not rely on these installations have their own facilities. There are various kinds of this installation: from a simple one which can be installed in an existing house for the rearing of about 10 cases of silkworm eggs to a big one which can take care of thousands of cases.

As to the rearing method to be conducted in this young silkworm rearing house, there are several types in Japan, such as rationalized type of the box rearing which is current in Iran, rearing machine (Fig. 2) which feeds mulberry automatically. The selection is to be made according to the amount of rearing and also the social condition.

Fig. 2. Example of automatic rearing machine in the 1st to 3rd stage

For reference, principal rearing technics of 1st - 3rd instar and the standard chart of young silkworm cooperative rearing are given in Table 4.

(2) Rearing environment of 4th and 5th instar

In the physiological phase, the character of 4th instar is nearer to that of 1st - 3rd rather than the 5th. If rearing temperature falls below 20°C, not only the rearing period extends but also cocoon crop decreases. In a region where temperature falls below 20°C during the 4th instar, therefore, a simple heating apparatus is needed.

Table 4. Principal Technics in Cooperative Rearing of 1st to 3rd Instar

Operation	Technics
Preparation for rearing	(1) Arrangement of rearing environment (2) Disinfection of rearing facilities and tools (3) Start of air-conditioning of rearing room
Rearing of 1st instar	(1) Rearing temperature and humidity: 28°C, 90%RH (2) Rearing density: 0.4 m^2/case, at the start, 1.6 m^2/case at the largest (3) No. of feeding: twice a day (4) Feeding dose: 1.3 kg/case (leafage) (5) Disinfection of newly hatched larval body
Rearing of 2nd instar	(1) Rearing temperature and humidity: same as 1st stage (2) Rearing density: 1.6 to 3.2 m^2/case (3) No. of feeding: twice a day (4) Feeding dose: 4.0 kg/case (leafage) (5) Disinfection of the body of silkworm immediately after ecdysis (6) Bed-cleaning, once during the stage
Rearing of 3rd instar	(1) Rearing temperature and humidity: 26°C, 85%RH (2) 3.2 m^2/case (3) No. of feeding: three times a day (4) Feeding dose: 15 kg/case (leafage) (5) Disinfection of the body of silkworm immediately after ecdysis (6) Bed-cleaning, twice during the stage
Distribution of silkworms	To farmers
After rearing	(1) Disinfection of rearing facilities and tools (2) Arrangement after the disinfection

The 5th instar has a higher adaptability to environmental conditions than other stages. Also, it requires a large rearing area. So, it is uneconomical to have a fine rearing house. It is enough to keep the temperature within 20 to 30°C, and prevent direct sunshine and rain, provided that the house is clean. If temporarily, exposure to below 20°C or above 30°C does not constitute a direct cause of crop failure.

Among rearing methods, branch shoot seems suitable. The standard area of rearing bed per case of silkworm egg will be: in the 4th stage, 5.0 m^2 immediately after ecdysis and 7.5 m^2 at the highest growth, while in the 5th stage, 7.5 and 14.0 m^2, respectively.

Rearing labor for the 5th instar accounts for about 30% of the total sericultural labor. A key point of the rationalization of sericultural labor lies in the harvesting and feeding of mulberry in the 5th stage.

In a large-scale rearing, mulberry harvesting is preferably to be mechanized, which has a close relation with the method of mulberry cultivation. The technics in low-cut have been almost established in Japan. It will be necessary, however, to improve them, if the (high) medium-cut training is to be continued.

For the rearing of 4th and 5th instar, an automatic feeding machine (Fig. 3) has been developed, but a simple, shoot rearing apparatus push-car (Fig. 4) may be preferred. This apparatus has a push-car moving on the rails. Mulberry shoots are put on the push-car, and the workers feed silkworms, pushing the car. Compared with shoot rearing by hand, this saves about 70% of feeding time and more than halves workers' fatigue.

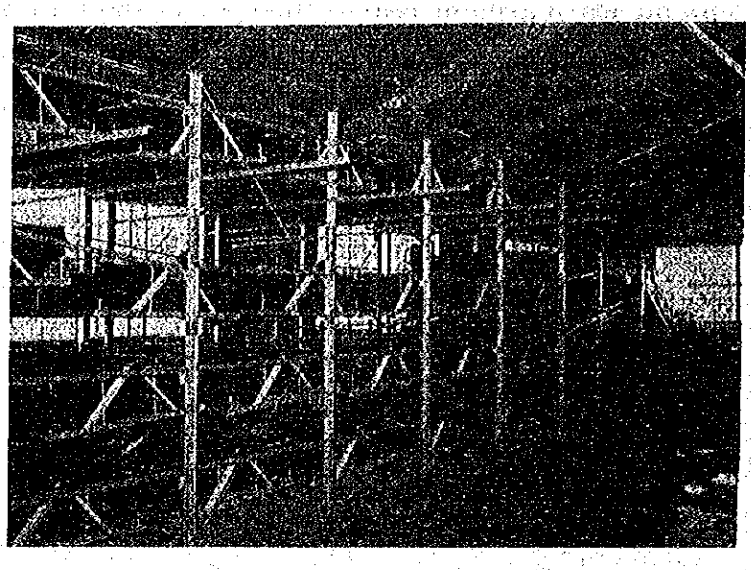


Fig. 3. Example of automatic rearing machine in the 4th and 5th stage

Fig. 4. Shoot rearing apparatus with push-car

In collecting mature silkworms, an apparatus for separating mature silkworms from shoots is efficient (Fig. 5). Especially, it becomes more efficient when combined with the rearing device shown in Fig. 4.

(3) Rearing tools

What is urgently needed in the rationalization of rearing tools is that of cocooning frame. In Iran currently they use branches of trees or grass, such as kher, khakeshir, for the purpose, which however causes most of double cocoons, cocoons with prints of cocooning frame and other bad cocoons, bringing about not a little

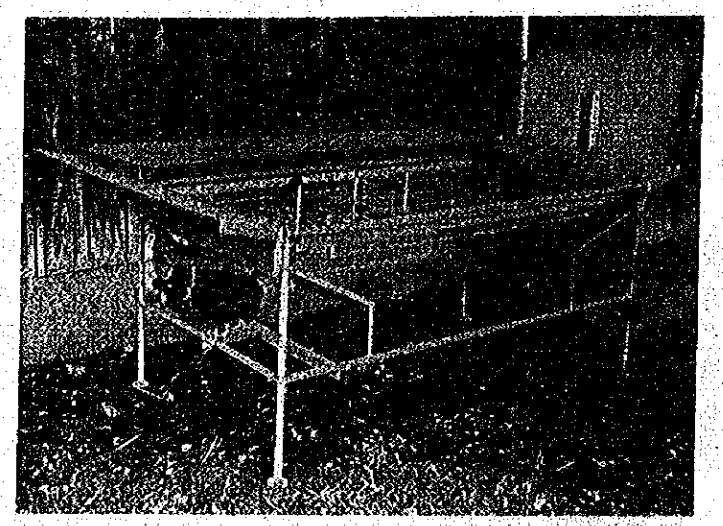


Fig. 5. Apparatus to separate mature silkworms from branches

loss of cocoon filament. These had cocoons, moreover, cannot be used on an automatic reeling machine. The rotatory cocooning frame which is widely used in Japan seems adequate for the purpose.

Other rearing tools will be determined according to the type of rearing method to be adopted. At any rate, they must stand the practice of disinfection.

10) Improvement of Silkworm Varieties and Production of Silkworm Eggs

In order to raise the quality of silk goods, it is necessary, first of all, to use a uniform, good silkworm race throughout the country. At

present, they rely mainly on imported silkworm eggs, while producing F_2 hybrid by crossing native races with imported F_1 hybrid. Our survey found the cocoons from native races and F_2 hybrid ununiform. These eggs are to be avoided. For the purpose, the training of breeding experts is an urgent business. Until some good races are bred, there will be no choice but to resort to imported F_1 hybrid.

In the production of silkworm eggs, it will be necessary to establish mass-production technics. At present, they produce eggs with separated batches of moths even for reeling purpose, which is inefficient. Instead, it would be better to make hundreds of moths lay eggs in a group, and as for pebrine inspection, adopt the sampling method based on the statistic principle.

In addition, in order to preserve original races, it is a matter of course that eggs are raised by separate batches of moths and the pebrine inspection of mother moths is conducted on the whole moths.

2. Drying and Storage of Cocoons

Cocoons in Iran are dried with Italian-type drying machines, or in the dry region, in the sunshine.

In the former method, the machine dries cocoons to some 70%, and thereafter the wind lowers the drying percentage to nearly 40%, it seems. During the exposure to wind, cocoons grow moldy when air humidity rises to 80% or above. Incidentally, cutting up dried cocoons of the Rasht Cocoon Company, we found mold on the pupae and the inner surface of cocoons. Moldy cocoons do not wind evenly, yielding less amount of raw silk which is poor in quality.

In the Esfahan and Khurasan Districts, cocoons are sundried, which is feasible only in the dry region where, like in these districts, humidity is 30 to 40%. But drying in the sun does not ensure a uniform result; besides the quality

of cocoon deteriolates on account of ultraviolet rays. Such cocoons are unsuitable for the automatic reeling machine.

For automatic reeling, a single-stage, band (conveyor) type drying machine appears adequate. In this machine, there are many sections which are arranged in the direction of the conveyor; each section is equipped with a fan, heater, hot blast duct, and other devices necessary for drying with forced current of hot air under a simultaneous, alternating air current system (See Fig. 6).

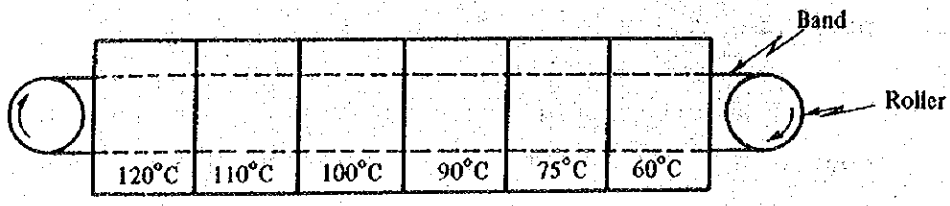


Fig. 6. Scheme of one-stage band type cocoon dryer

A layer of cocoon of 300 to 400 mm deep is put on the band, taking a drying time of 4 to 4.5 hours. A proper degree of drying is about 40% of the weight of fresh cocoon. For example, the measurement of a dryer with drying capacity of 8,000 kg of fresh cocoon per 24 hours is: 15.0 m long, 3.5 m wide and 3.9 m high.

When a single-stage, band-type dryer is introduced, its drying capacity can be designed for any weight between 500 and 40,000 kg. So, we can decide an adequate capacity which matches the cocoon production.

Compared with multi-stage types, the dryer of this mechanism is simple in structure and operation, with less troubles. In addition, this machine has 2 kinds: one uses steam, while the other not.

Dried cocoons are very moisture-absorbing; put at a humid place, they grow mold and decline in quality, as mentioned above. It is necessary to store cocoons at a humidity of 75% or below.

3. Reeling Equipment

As the current reeling equipment in Iran is old-fashioned, it would be a natural development that with increase in cocoon output, more and more automatic reeling machines are employed.

However, the use of automatic reeling machines cannot be regarded in the same light as that of the operation of tractors or flour mills. Because not only the operation of an automatic reeling machine requires high technics, but also good and uniform cocoons are needed. For the purpose, we must breed good silkworm varieties and modernize rearing methods, as previously stated. Also, sorting, drying, cooking, etc. of cocoons are to be conducted with high technics which match the automatic reeling machine.

Looking back over the history of the diffusion of automatic reeling machines in Japan, it took about 30 years from the establishment of principles to the introduction to filatures. The principal reason why such a long time was needed is that a series of related technics did not advance in parallel.

Although it is understandable that Iranian people want to introduce the automatic reeling machine as soon as possible, we cannot but say that as long as relative technics do not advance, imported machines will surely become idle. Therefore, its introduction should be done prudently and gradually. Since we had a strong request, however, for a suggestion as to a reeling equipment capable to produce 1,000 tons of raw silk, our suggestion is attached at the end of this report as an appendix.

II. ON-THE-SPOT SURVEY AND OBSERVATION

1. Mulberry Field and Silkworm Rearing

1) Farm Cooperation

(1) Rodpish and Fouman Farm Cooperation

A. Outline of survey

These two Cooperations are located at the suburbs of Racht City of Gilan Province in the lowlands along the Caspian Sea. Our survey was conducted mainly at mulberry field of 2 ha and projected site of mulberry field of 30 ha at Rodpish and projected site of mulberry field of 10 ha at Fouman.

First of all, we would outline these Farm Cooperations. The Cooperation at Rodpish was established 5 years ago, with a population of about 1,200, cultivating paddy field of some 500 ha of its own.

Land is flat, almost as high as the sea level, but the undergrounds water level was high: 20 - 50 cm.

As for climate, air temperature is 4 - 33.6°C: annual precipitation is 1,000 - 1,300 mm. But it rains mainly in winter, with little precipitation in July and August. Due to high underground water level, however, relative humidity is 70 percent or above throughout the year.

Soil survey is on a high level with soil maps prepared. Hydromorphic soil prevails all over the farm; pH is neutral; silty clay in soil texture.

Principal crop is waterfield rice, manured with urea of 100 kg/ha and super phosphate of 75 kg/ha. Water field is irrigated mainly from the dam at the rate of 900ℓ/sec.

Cultivating machines are mainly large tractors and about 40 tillers.

As regards Fouman, we had no time to hear its summary, but we presumed that the conditions of location there was almost the same as Rodpish.

Following is the outline of the results of our survey of mulberry field and projected sites of mulberry field:

The mulberry field of 2 ha set up 4 years ago at Rodpish displayed a very poor growth of mulberry trees: average three height of 130 cm and about 2 cm in stem diameter (20 cm above the ground). Mulberry leaves had never been harvested, we heard. The race was a native one, belonging to Morus alba, wearing small, lobed leaves. Although we heard that 6,230 trees had been planted in 2 ha, many of them died. The main cause of the poor growth was presumed to be the high undergrounds water level (the water level was 20 to 50 cm from the surface, with the lowest of 50 cm registered in summer).

From a simple analysis of soil, we ascertained that soil color is greyish tan, neutral in pH, rich in bases, but poor in phosphoric acid.

As for the projected sites of 30 ha at Rodpish and 10 ha at Fouman, the groundwater level was high, like in the established mulberry field. The officers concerned, however, assured us that this would cause no trouble in the future, since the drainage plan by canal was under way, and the water table would recede before long.

B. Direction of improvement in the future

As for the feasibility of developing sericulture in the sites of survey, the climate, labor and irrigation are satisfactory. But at least at present when the ground water level is high, they are inadequate to the mulberry plantation.

It is practically difficult to lower the ground water level of a part of the waterfield zone; its lowering from the whole zone would take a long time. The planting of mulberry trees should wait till the ground water level is surely lowered to 1 m or deeper from the surface. What is more desirable and advisable would be: we select the zone which is high in the sea level with groundwater level of 1 m or deeper to create mulberry field, leaving lowlands to be used as waterfield.

(2) Lashe Farm Cooperation

A. Outline of survey

This Cooperation is also in Giran Province.

It was set up just in 1972, with a membership of 181 farmers. A building for joint use was under construction. Its arable land is 550 ha, growing rice as main crop. Water for irrigation comes through a canal called the Sefid Rood (White River). Climate is almost the same as in Rodpish Farm Cooperation mentioned above.

As they intended to create mulberry field there, we examined its feasibility. Taking a sericultural house near the Cooperation as the subject of study, we conducted a survey by interview as to the conditions of location and sericultural technique.

The mulberry field was in a coppice, planted with a native mulberry race belonging to Morus alba. Although the groundwater level is rather high, 20 to 80 cm from the surface, subsoil is sandy, apparently with a good air permeability. Mulberry trees grew better than in Rodpish; the 2nd year trees were about 3 m high, while the 5th and 6th year ones measured about 8 cm in stem diameter. Branches of the latter were cut at the height of 3.5 m for feeding, we heard.

A simple soil analysis showed that soil is similar to that in Rodpish, but contains some deposits of chiefly $CaCO_3$; slightly alkaline in pH; low in phosphoric acid content.

Silkworms were reared in boxes of 70 x 50 x 50 (high) cm. With the growth of silkworm, boxes are increased so that in the 5th stage, 20 boxes are used per case of silkworm egg, they explained. The 1st to 3rd instars are reared in the main house, and the 4th and 5th instars in a separate, rearing shed, thatched with straw, but without walls. As they do not resort to heating in the whole duration, it takes about 40 days from the first feeding to mounting.

B. Direction of improvement in the future

In this region, the problem in the location of mulberry field is, like in Rodpish, too high groundwater level. On the side of silkworm rearing, the laissez-faire method extends the rearing duration, with less cocoon yield. It is necessary to rear the 1st to 3rd instar in a controlled environment as in the young silkworm cooperative rearing house mentioned in Chapter I and bring up sericulture as a paying industry.

(3) Sameskandeh Farm Cooperation

A. Outline of survey

This Cooperation lies in Mazandaran Province along the Caspian Sea, and has a population of about 1,700. Arable area of 1,258 ha is devoted chiefly to water-field rice, wheat, sunflower, soybean, and maize as feed.

They are reclaiming another 500 ha, and plan to set up mulberry field in part of the clearing, 10 ha this year, 30 ha next year, and eventually 250 ha.

There was a soil map of the place already cultivated, which showed that the water table lies 1 m or deeper from the surface. Soil fertility also was judged as suitable for mulberry field, except for poorness of available phosphoric acid. In addition, although part of this arable land is slope, the gradient is 5° or below. So, there is no need of concern about it in creating mulberry field.

In the tract of 500 ha under reclamation where they plan to set up mulberry field, the groundwater level is high--70 cm at the survey site. Furthermore, the soil layer of 35 cm or deeper from the surface is the Grey Horizon, undeveloped in structure and inferior in physical properties. This site is clearly unsuitable for mulberry cultivation at least at present.

B. Direction of improvement in the future

In the projected site of mulberry field, they were digging drainage. Like the case of Rodpish, however, mulberry trees should not be planted before the groundwater level is surely lowered to 1 m or deeper from the surface. It is, furthermore, desirable during the waiting time to grow soybean and other feed crops to mature the field.

What is the most desirable is that a cultivated land which suits mulberry trees be converted into mulberry field.

Finally, climate there favors sericulture, we presume.

(4) Golpaygan Cooperation

A. Outline of Survey

This Cooperation is in Esfahan Province, the central part of Iran. Reclaimed 5 years ago, it has a cultivated land of 2,000 ha and a population of 1,134. The total area, including uncultivated land, covers 5,400 ha, and cultivated land is expanding at a rate of 20% a year.

Principal crops are: barley, wheat, sunflower, beans, alfalfa, clover, opium poppy, etc. Including private property, furthermore, is holds 7,000 sheep, 80 beehives and 30 carpet looms. All the wheat is sold in the form of flour. Its flour mill has a capacity of 2t/hr.

There are 8 tractors for cultivation: 2 100-HP or above, 4 65-HP and 2 40-HP, besides 2 combines. In case of need, they can borrow bulldozers from the Head Office.

Climatic characteristic is little rain, annual precipitation averaging 246 mm over 6 years. Most precipitation comes in winter, with an average showfall of 40 cm deep a year. Monthly average of air temperature ranges between the maximum of 22.5 to 32.5°C and minimum of 6.2 to -6.2°C. In addition, the record of daily maximum air temperature and minimum are 38°C and -30°C, respectively.

Although the current irrigation relies on wells, they are planning to take water from rivers. They have 13 wells for irrigation; but only 10 wells are being used, half of which spouting 50 to 60 ℓ/sec, while the remainder 30 ℓ/sec; the quality of water is good. Incidentally, the irrigation for wheat was 10,000 m^3/ha per season.

As they wanted to create mulberry field of 10 ha in part of cultivated land, we selected a site as follows:

B. Feasibility of Developing Sericulture

The southern part of this tract which lies along the river contains much gravel; 70 cm beneath the surface, in particular, spreads a gravel layer; unsuitable for mulberry field. Apart from the standard in Japan for selecting land as stated above, the existence of unfavorable soil layer, such as gravelly one and Grey horizon, as near as 60 cm or less from the surface

or a soil layer, in general, containing 30% or more of gravel, is undesirable to mulberry field. The second site was a little northward, containing less gravel, apparently a sort of Brown Earth. The pH of soil was slightly alkaline; the layer of 30 cm or deeper held little phosphoric acid. Although it is susceptible to drought on account of little humus at present, this site seems about suitable for mulberry field, if the drought is taken care of. Needless to add, irrigation is an indispensable condition.

It is feasible to create a large-scale mulberry field here, but what is more desirable would be a step-by-step expansion in harmony with the level of technics and the installation of machinery.

2) Rural Cooperative Societies

We will treat here mulberry field and silkworm rearing, and items related to silk reeling will be discussed in the next section.

(1) Rural Cooperative Society of Chadicola

A. Outline of Survey

This Society is located in Giran Province on the Caspian Sea. Monthly average of air temperature ranges 7.6 to 30.7°C, and the annual precipitation is 670 to 953 mm, with little rain in summer. Relative humidity is high: generally, more than 70% throughout a year.

In this Society, we visited 2 sericultural farms, and observed their mulberry field and rearing sheds. At the first farm, we surveyed mulberry field. Red fruit mulberry, a native race, was planted. Mulberry field was divided into two. In one section, about 10-year old trees were trained in (high) medium cut (130 cm high), 4 cm in stem diameter, growing about 15 branches. This red fruit mulberry puts forth larger and thicker leaves than Morus alba, seems to be Morus latifolia.

The other section was planted in intervals of 60 to 70 cm, in the 3rd year after planting; trees were about 3 m high and 3 cm in stem diameter. They expected to harvest leafage from the next year, but growth was slightly poor. The ground-water level was 10 m; but available phosphoric acid seemed short, according to the result of our simple soil analysis. However, we found in the neighborhood some trees growing well. They were white fruit mulberry grafted in red fruit mulberry.

Silkworms are fed with whole leaves till the 4th stage. The 5th instar is shoot-reared; mature silkworms are mounted on branches of tree.

At the second farm, we observed some hand-reeling tools and rearing shed (reeling will be dealt with in Section 3). Silkworms here are reared in the main house, in similar boxes to those seen in Lashe, from the beginning of rearing to the 10th to 12th day, given chopped leaves. Later, they are transferred to rearing beds, 2 m x 1.5 m, resembling marsh-reed screen, to spend about 15 days. Subsequently, they are reared on straw spread over trees which are arranged on the ground for about 18 days, the total rearing days coming to more than 40 days, we heard. As seen in Lashe, rearing shed was thatched with straw, 4 m wide and 11 m deep, capable of rearing 3 cases of silkworm egg. Longer rearing duration was due to no wall which naturally does not keep the shed warm, we thought.

B. Direction of Improvement in the Future

Both climate and soil are mostly suitable for silkworm rearing. The first thing would be to modernize mulberry field. Next, it is desirable jointly to rear 1st - 3rd instar in order to stabilize cocoon crops. Rearing tools are to be modernized; for mounting, particularly, rotatory cocooning apparatus should be used.

(2) Rural Cooperative Society of Ramion

A. Outline of Survey

This Society is located in Golgan Province on the Caspian Sea.

As for climate, monthly average of air temperature ranges 3.3 to 30.0°C, the annual precipitation, 530 to 820 mm, little rain in summer. Humidity is slightly lower than in Giran or Mazandaran, but generally above 60% throughout a year.

This Society has a membership of 750 and cultivated land of 4,000 ha. It is capitalized at 500,000 rials in 1973. Main crops are: cotton, wheat, barley, water melon, Indian corn, sunflower, sugar cane, and beans. Silkworm rearing, though on a very tiny scale, is carried on, with silkworm eggs produced here.

Following are the findings of our survey of the actual condition of this Society's sericulture. Many of mulberry trees were old and standing; both white fruit mulberry and red fruit mulberry were found, but the latter put forth thicker branches and larger leaves. The largest tree was 60 cm in stem diameter and 10 m high.

As for rearing, silkworms for 3 days after hatching are reared only with mulberry shootlets, and given mulberry leaves later on. The rearing method of 2nd and 3rd instar were similar to that we observed at the Lashe Farm Cooperation mentioned above. In the old stage, they are transferred to rearing shed for shoot rearing. Unlike the shed we saw before, the roof is covered with galvanized iron sheets on marsh-reed painted with soil. Rearing rooms were enclosed with earthen walls of about 30 cm thick, as large as 8.9 m x 2.5 m. In the wall, there was a small doorway and a small window near the

roof for ventilation. In this shed, they rear silkworms of a case of eggs.

The soil of mulberry field is alluvial soil and good in physical property, with much humus content. Our simple soil analysis showed that a small amount of available phosphoric acid exists in the deposit consisting mainly of $CaCO_3$-the most fertile land of the sites we surveyed along the Caspian Sea.

B. Direction of Improvement in the Future

As many of mulberry trees are old and inferior in productivity, it is necessary to replant the trees of 20 years old or above. Also, as standing trees are inconvenient to harvest leaves, the training method is to be improved so that leaves can be reaped at 1 to 1.5 m high from the ground.

If irrigation is secured and manure is applied, this zone will become one of the most suitable zones for mulberry field.

Furthermore, the rearing of 1st to 3rd instar is to be conducted jointly, and rearing tools, cocooning apparatus in particular, are to be modernized.

3) Farm Production Cooperatives

Of Farm Production Cooperatives, we surveyed one — Esfahan Farm Production Cooperatives. This Cooperatives is located in Esfahan Province in the central part of Iran.

Following is the outline of survey and our view on the feasibility of development.

This Cooperatives is set up in 1972, having land of 1,082 ha and a population of 1,133. Main crops are: opium poppy, wheat, sugar beet, alfalfa, etc. grown on 700 ha.

Irrigation water is taken from the Zayandeh Rood River. Close to the river, the groundwater level here rises to 0.5 m from the surface in winter, but recedes to 4 to 5 m in summer. There are 54 wells of 4 to 5 m deep from the surface. Adding up this well water to the above river water, irrigation of 1,245 ℓ/sec is possible. In 2 years, they will be able to lead water from a dam, which is better in water quality.

As for climate, air temperature ranges -7 to 42°C; precipitation is 131 mm, making irrigation indispensable. In the central part of the farm, there is a marsh, around which stand mulberry trees of unpruned type, 15 to 50 cm in stem diameter and about 10 m in height. Trees of 50 cm in stem diameter are said to be about 100 years old.

In the southern part of the farm, they set aside 10 ha for mulberry field; we conducted survey of this site. In this zone, the groundwater level is low, and soil texture is loam. Our simple soil analysis endorsed the suitability of this zone for mulberry field. But humus is short, and the soil layer of 20 cm from the surface becomes, when dried, firm blocks This is almost common to all soils in the dry region. It is desirable to raise humus content and improve physical properties by applying stable manure, etc. In case chemical fertilizers are given, in particular, organic matter must be used jointly, as the former alone is apt to deteriorate the quality of soil.

4) Cocooner Company

This company was founded in 1945, and recently changed its name from the Rasht Norgan Factory to the present. This company is divided into material division and silk reeling division. The former division handles: (1) import or manufacture of silkworm eggs, (2) distribution of silkworm eggs to farmers, (3) purchase or cocoons from farmers and drying, and (4) transport of dried cocoons to reeling mills in Rasht. Branch offices are run in various parts of the country.

In this section, we will treat mulberry and silkworm relative to the production of silkworm eggs, with drying of cocoons and silk reeling carried over to the next sections.

A. Outline of Survey

We will describe it on one branch office after another.

(1) Rasht Cocooner Company

This company is in Giran Province.

In the silkworm egg division, they produce 35,000 cases of silkworm eggs besides imported ones. They let farmers rear native races along with imported F_1 hybrid. Most of fresh cocoon is dried for silk reeling, and the remainder is used to produce F_2 hybrid. Each moth is put in a paper bag to lay egg. Pebrine inspection was conducted on the whole moths, one by one.

(2) Langrud Drying Center

This Center is in Giran Province. We were explained that Ichinose, a Japanese mulberry race, was planted in an annex mulberry field, but could not confirm it, as leaves had all gone. The groundwater level in this zone was reported to be 10 m or less from the surface. We thought that this is a good place for mulberry cultivation.

(3) Rudsar Drying Center

This Center is located in Giran Province.

In the mulberry field adjacent to the cocoon collecting place, there was Kokuso No. 21, a Japanese mulberry race. This race had been grafted in 1-year old seedling stock of Morus alba. Some trees had been badly grafted so that the stocks themselves were sprouting.

(4) Shahi Drying Center

This Center is in Giran Province.

In 1972, they distributed 12,000 cases of silkworm egg to farmers, but only 2 tons of cocoons were collected, the great portion being diverted to the free market on account of soaring cocoon prices, we heard.

In this district, some silkworms suffer from diarrhea, which is due to much water content in mulberry leaves, we were explained. It is necessary to suspect the presence of infectious flacherie. In this connection, they conduct disinfection with formalin only in the stage of eggs, but not in the larval stage.

In the annex mulberry field, seedling was growing which sprouted from the seed imported from Japan; its name was not clear. In addition, since mulberry is high in hybridism, multiplication by seedling cannot produce trees of a fixed quality, its characters being readily diversified. Generally speaking, seedling should be used only for making stocks in grafting, but not for other purposes.

(5) Natanz Cocooner Company

This Company is in Esfahan Province.

It has a silkworm egg producing station, and distributes silkworm eggs. - Like the company in Rasht, it lets farmers rear imported hybrid eggs, and collects cocoons, most of which are used for silk reeling, and a part of cocoons which, according to explanation, do not fit reeling are used to produce eggs of F2 hybrid.

In the compounds, we saw mulberry field where trees of the 3rd year were planted, growing well, some being 4.5 cm in stem diameter and about 4 m high. What is worth mentioning here is that they use urea of 330 kg/ha together with sheep

droppings, and that cutting is used to multiply saplings. This was the only place in Iran where we observed the application of chemical fertilizer.

(6) Torbat Hydarieh Cocooner Company

This Company is located in Khurasan Province, in the northeastern part of Iran.

We surveyed its silkworm egg producing station and annex mulberry field. The climate in this district is: June to September is the dry season; rain falls in winter, centering around February to April, with the annual precipitation registering only 169 mm. In recent years, in particular, precipitation is little, and the groundwater level is receding to destroy some of mulberry trees. Silkworm rearing becomes more and more difficult, so that they gave up egg production last year.

Five years ago, they imported silkworm eggs from Bulgaria. A case of 25 g produced 62 to 35 kg of cocoons, averaging 50 kg, they explained.

The characteristic of sericulture in this district is the use of grass called khakeshir for cocooning.

Mulberry trees in the field are more than 30 years old, 9 cm in stem diameter, 130 to 160 cm high, trained in (high) medium cut. Planting space was 2 m x 2 m; the number of trees planted was thought to be slightly small. Young shoots did not grow so much; some of them were so thin and dry that they might readily break. There was a clear sign of moisture shortage.

Soil is loam and fertile according to our simple soil analysis. The most important problem would be how to secure irrigation water.

B. Direction of Improvement in the Future

Please refer to Chapter 1 where a general description of the subject is given. In addition, it is necessary to install a silkworm egg refrigerator and an egg incubation room in each Company. Much more so if the multiple rearing throughout seasons is to be introduced in the future.

5) Others

(1) Chamkhaleh Private Mulberry Plantation

A. Outline of Survey

This mulberry field is located in Giran Province.

Morus alba in the 4th year of planting measured 3 to 5 cm in stem diameter. The planting density was 0.7 x 0.5 m, about 28,000 trees per ha. Trained in (high) medium cut, trees pruned in spring before budding wore 3 to 4 young shoots each, growing about 1 m on an average.

B. Direction of Improvement in the Future

The site of survey seems suitable for mulberry cultivation.

Although such a dense planting does not fit a large scale management, it is an efficient method for a minute sericulture by hand. If manure is applied to compensate harvesting, twice-a-year rearing would be feasible, in spring and autumn, to raise efficiency further.

(2) Roofoogaran's Center of Silkworm Rearing Training

A. Outline of Survey

This is perhaps an only private enterprise in Iran which is engaged in sericulture.

Climate here is almost the same as in the Golpaygan Farm Cooperation mentioned above.

The soil of mulberry field is alluvial, containing slightly much gravel. Although soil texture is loam, humus is so short that it becomes firm block when dried up. Our simple soil analysis showed: pH is slightly alkaline; rich in bases; a small amount of available phosphoric acid is contained in the deposit of carbonates; considered to be a fertile soil.

They drew irrigation water from a well of 100 m deep; the groundwater level is 40 m deep. It yields 100 m^3/hr of water; driven 22 hours a day, it irrigates 2.5 ha of mulberry; a cycle of 8-day irrigation in rotation is repeated 40 times a year, we heard. From these figures, we may calculate a daily irrigation water at 11 mm, about double the irrigation water in Japan. This would be due to the fact that air in this region becomes extremely dry during the summer. The quality of water was unknown, but it tasted salty in mouth. Furthermore, we found dry, white salt in the upper part of the sides of irrigation canal.

Before planting, they apply stable manure of 6 kg per tree (for 2 years) and plant trees at intervals of 1.5 m x 1.5 m.

Saplings were being raised from grafts of Kokuso No. 21 inserted in the stock of native tree. Some other mulberry fields used Ichinose as scions.

The nursery bed was raising the saplings of Kokuso No. 21 planted in rows of 80 cm apart; after saplings are taken out from every other row, the nursery itself could be used as mulberry field, it was so designed.

Trees were trained in (high) medium cut of about 1 m tall; those of the 2nd year were 4 cm in stem diameter, and 2.5 m

high-growing well; young shoots after the (high) medium cut averaging 10. Those of 4th year were nearly 10 cm in stem diameter, about 4 m high, wearing 15 young shoots on an average.

In 1973, they tried, for the first time, the twice-a-year rearing in spring and autumn. In spring, they harvested shoots of about 2 m tall at the base of (high) medium cut, growing 3 young shoots each till they reached 1.5 m in late autumn, which were harvested, leaving 60 cm at the base, they told us. In the following spring, they expected to reap about 15 young shoots each put forth from the remaining shoots.

On the facet of silkworm rearing, they reared 40 cases of eggs by 1 ha of mulberry field in spring. On April 18th, eggs were transferred from 14 to 24°C; they hatched in 10 days' incubation. The 1st and 2nd instar was reared in shallow boxes, spending 9 days. In the 3rd stage on, whole leaves were given, passing the 3rd stage in 5 days and the 4th stage in 6 days. In the 5th stage, the shoots were given, leaning against a support. Feeding was done 3 times a day, yielding cocoons of 35 kg per case of eggs. For mounting mature silkworms, a kind of grass called kher was used.

Mulberry variety-wise, Kokuso No. 21 produced the largest amount of cocoon, followed by Ichinose and a native race. To harvest the same amount of cocoon, the native race required about 60% more leafage by weight than Kokuso No. 21.

Fifteen days before the start of rearing, the rearing room is disinfected by burning sulphur, which corresponds the disinfection with formalin of rearing room and tools in Japan. It is noteworthy that we can find the germination of rational control of sericultural diseases.

B. Direction of Improvement in the Future

Mr. Roofoogaran's sericultural technics here were developed in the Iranian environment, and considered very interesting as the foundation for the technical development in the future.

In the immediate problems, the planting space of 1.5 m x 1.5 m seems too coarse. That is to say, a denser planting would produce more leafage per ha, since the irrigation water in this dry region would be used more efficiently. As long as field maintenance is conducted by hand as at present, a planting distance of 1.5 m x 0.7 m would be sufficient.

Since tens of cases of eggs are reared at a time, it is desirable to install a simple constant-temperature room for the 1st to 3rd instar. It is enough that the room keeps the temperature between 25 to 28°C with a precision of $\pm$1.0°C. When it is cold, heat the room with oil or electricity, while when it is hot, the room is cooled with irrigation water. Then, its cost will not be so expensive.

Furthermore, we would recommend the modernization of rearing tools, above all cocooning apparatus. The primary cause of frequent occurrence of double cocoons and cocoons with prints of cocooning frame lies in the mounting of mature silkworms on grass or branches of tree.

Cocoon Drying Equipment

1) Outline of Survey

We visited the following 2 cocoon drying centers, both belonging to the Cocooner Company.

(1) Rasht Cocooner Company: established in 1945, with 2 Italian type drying machines.

(2) Shahy Drying Center: established in 1934, with 3 Italian type drying machines.

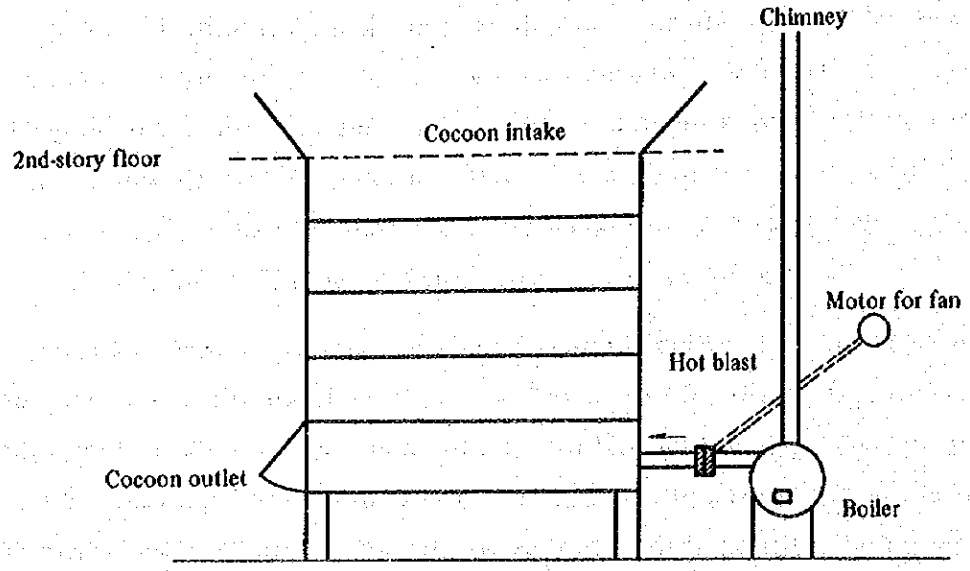


Fig. 7. Mechanism of Italian cocoon dryer

They dried cocoons with the Italian type drying machines as shown in Fig. 7. It has an intake of about 2 m x 1.5 m, holding 4 steps of cocoons: the uppermost step holds 200 kg, followed by 150 kg, 200 kg and 200 kg downward, totalling 750 kg to be dried at a time. Each step is made up of 5 vanes of about 30 cm wide; opening and closing them, cocoons are pilled up about 30 cm deep from the lowermost step. Its drying capacity is said to be 750 kg of fresh cocoons per machine for 1 1/4 hr: 90°C for 15 min. and 75°C for 1 hr. Cocoons which have passed through the dryer are transferred to 8-layer shelves in a separate building which has hardly any enclosure. Cocoons are put on the shelf about 40 cm deep for further air-drying, it was told.

In Esfahan and Mashhad areas in the dry region, cocoons are dried in the sun. According to Mr. Roofoogaran of Esfahan, on the 1st day, fresh cocoons are spread in the sun from 10 a. m. to 2 p. m. Cocoons are covered with a close cloth; in 4 hours hot cocoons are quickly put in plastic bags and sealed. On the 2nd day also, cocoons are exposed to the sun from 10 a. m. to 2 p. m., and thereafter they are air-dried in a room.

2) Direction of Improvement in the Future

The method of drying and storing cocoons affects greatly the efficiency of subsequent reeling, the quality of raw silk and the yield of silk. Notwithstanding its importance, the drying and handling of cocoons are extremely rough and rude. For the purpose of manufacturing good-quality raw silk by the automatic reeling machine, it is necessary to dry cocoons (to about 15% in the water content of cocoon) by a hand-type hot blast dryer. It is also necessary to store cocoons, immediately after being dried, in an adequately equipped warehouse in order to avoid their contact with moisture.

3. Silk Reeling Equipment

1) Rasht Cocooner Company

A. Outline of Survey

(1) Reeling equipment:

Italian-type reeling machines 120

In operation (on the day of survey) 70

(2) Reeling machines and personnel arrangement

Being Italian-type, the reeling machine is hand-driven; raw silk is directly wound onto a grand reel (106 cm in circumference). The machine has 8 ends, each equipped with a rotary end feeder. Each reeling machine is attached with a round cocoon cooking pan and an end groper. Cocoon cooking and end

groping are handled by a worker who sits vis-a-vis the reeler. The grand reel is at the back of the reeler; when raw silk breaks, one of a few other workers helps to piece it together.

(3) Objective size and reeling conditions

They manufacture coarse silk of 80 to 85 deniers and 120 to 140 d. in objective size. Doubled further, raw silk is used chiefly for the manufacture of carpet. In order to reel thick silk, 4 ends each out of 8 are put together before croisure, and oiled on the way .

The grand reel revolves at the rate of 80 rpm; or 85 m/min, the circumference being 160 cm.

The temperature of reeling water may be about 40°C. Cocoons were small in size and very uneven. On the figures given by the filature, the raw silk percentage of dried cocoon is:

$$\frac{1 \text{ (weight of raw silk)}}{2.7 \text{ (weight of dried cocoon)}} = 37\%$$

(4) Production of raw silk

As the filature is reported to consume 70 tons of fresh cocoon a year, or presumably about 28 tons of dried cocoon, we may calculate its annual production of raw silk roughly at 10 tons, on the raw silk percentage of dried cocoon estimated at 37%.

B. Direction of Improvement in the Future

Although raw silk is currently manufactured by very many workers, it is necessary to raise labor productivity and the quality of raw silk in the future. For the purpose, the introduction of the automatic reeling machine, as Iranian people desire, is beneficial.

So, we will discuss a few problems in its introduction. First of all, the automatic reeling machine which is widely used in Japan cannot produce thick silk, such as 100 to 150 deniers. So, in case automatics are used, it would be advisable to produce, at first, raw silk of around 42 deniers; then 3 to 4 threads are doubled together to gain the objective size.

As automatic reeling machines are greatly affected by the qualities of cocoons, particularly the length of cocoon filament and reelability percentage, it is necessary, above all things, to improve them in the sector of silkworm rearing.

As mentioned in the preceding Chapter, furthermore, the introduction of automatic reeling machines requires a careful examination beforehand.

At present, the filature consumes 70 tons of fresh cocoons a year. On this figure, we may provisionally calculate the requirement at about 10 sets (200 ends each) of automatic reeling machines. As previously stated, such automatics require a small-size automatic cocoon cooking machine, 25 rereeling machines (2.5 per set) and other auxilliary machines.

Next, the personnel requirement under this productive structure would tentatively be (with a margin):

Cocoon sorting	1
Cocoon cooking	1
Silk reeling	4
Rereeling and finishing	3
Boiler	1
Other	2
Total	12 persons

Currently, 70 Italian type reeling machines are operated by more than 100 workers, which could be replaced by some 12 persons.

2) Production of Raw Silk by Hand-reeling in Rural Cooperative Society

(1) Outline of Survey

A. Hand-reeling at a farm in Ghadicola

B. Hand-reeling at a farm in Ramian

By ahdn reeling, farmers reel raw silk from cocoons of their own raising. In Ghadicola, most of cocoon is sold and only a part is reeled. In Ramian, the Society holds 600 farms, which reel silk and further weave silk fabrics. Last year, raw silk prices boomed, while fabrics were in depression. So, all the raw silk was shipped. The raw silk they produce is very thick, about 200 deniers. Tools for hand reeling are very primitive. A worker cooks cocoons in a large iron pan (64 cm in diameter) and feeds ends of cocoon filament. Another worker turns the grand reel with hand, and the third does miscellaneous jobs — totalling 3 workers, they explained.

(2) Direction of Improvement in the Future

Needless to say, the manufacture of good, and uniform raw silk by all the members of the Society raises the price of silk and increases farmers' profit. In this sense, the current mode of production by which each farm reels silk separately is not desirable. However, the present practice may be rooted in the prevailing social situation; it would be difficult to revise it quickly.

In the direction of improvement in the future, therefore:

A. Most desirable is to abolish the current mode of production of reeling at each farm and set up a filature by each Society where farmers can work.

B. If the current system cannot be abolished, replace the machine with the hand- or treadle-driven type which can be handled by a single worker, as is used in a part of Japan. In this method, cocoons are cooked in a separate pan; the reeler, revolving the reel with her left hand or treadle, feeds the ends. The problems in this method are: raw silk reeled onto a reel must be rereeled to a grand reel; also to make especially thick silk, the fibers must be doubled.

3) Roofoogaran's Filature Factory

(1) Outline of Survey

This filature was established in 1969, and is operated by the same person as the Roofoogaran's Center of Silkworm Rearing Training as mention in the previous Section.

Installed with 4 Italian-type reeling machines, it produces raw silk of 100 to 150 deniers.

The machines were newly manufactured by the filature, all made of metal, but their mechanism is almost the same as those in the filature of Cocooner Company. Four ends of silk are put together, oiled and wound onto the grand reel; a reeler operating 2 grand reels. Although raw silk reeled from cocoons purchased from the Caspian Sea Coast is firm and dull, the fiber reeled from the cocoons reaped in this Esfahan area is soft and lustrous, they claimed. A kg of raw silk here is obtained from 6 kg of fresh cocoons, but 8 kg is required in the Cocooner Company in Rasht, they added.

When we visited the filature, it was closed; we could not inspect its operation. Thin silk layer in the dropped cocoon after reeling is separated by hand from pupae, we heard. Incidentally, this enterprise produces carpet too in sequence with silk reeling process. They handle both silk and woold carpets.

(2) Direction of Improvement in the Future

They produce relatively good raw silk for a small filature. With the increase in cocoon receipt in the filature, it is desirable to resort to small, automatic reeling machines as stated relative to the Cocooner Company.

III. IMMEDIATE MEASURES

Compared with other agricultural crops, sericulture involves much more technical fields. In order to promote sericulture, therefore, technics are to be organized. If 1,000 tons more of raw silk is to be produced, sericultural technics which are suitable for Iran are to be developed, without relying upon imported ones. At the same time, technicians are to be increased to extend modernized sericulture. For the purpose, our present survey is not enough; further studies by experts seem essential. For the immediate future, particularly, are desired the surbeys in the fields of breeding, pathology and mulberry cultivation.

It goes without saying that the first step in silkworm rearing lies in the creation of mulberry field. Aplan, however splendid it may be, will become useless at least in the subsequent procedure, if mulberry leaves are not harvested as scheduled. Also, the experiment on mulberry trees is to be launched quickly, as it takes at least 4 years before some conclusion is reached.

To create highly productive mulberry field, it is indeed a method to introduce good mulberry races from Japan. But environmental conditions here are different from those in Japan, so indiscriminate introduction is dangerous. This is typically exemplified by the fact that Kokuso No. 21 which is rather low in rating in Japan is highly appraised in Iran as stated above.

It is necessary in Iran to test the adaptation of mulberry in two zones: the humid zone on the Caspian Sea and the dry zone on the Iranian plateau. As the sites of experiment, we may tentatively suggest: Sameskandeh and Golpaygan Farm Cooperation (or Esfahan).

The procedure of experiment may be summarised as follows:

(1) The area of nursery is 10 ha each.

(2) Mulberry races to be introduced:

Kokuso No. 21, Oshimaso, Atsubamidori, Shin-ichinose, and Ichinose (5 races)

(3) Planting density is, as shown in Fig. 8, 2 m between rows and 0.7 m between trees, with 7,140 trees per ha. Then, 2 experimental sites require a total of about 40,000 samplings each race. In this connection, some samplings take more than a year from ordering to delivery, which must be taken into consideration in formulating a plan.

(4) The training method:

Compare low-cut and (high) medium-cut (Figs. 9 and 10). Harvesting is conducted twice: April in spring and September in autumn. To compensate nutrient taken away by harvesting, give 330 kg each of urea and super phosphate.

Half the amount of fertilizers is applied at the end of March, before budding, and the remainder at the end of spring rearing. In addition, 15,000 kg of stable manure is given during the winter.

(5) Based on these experiments, good mulberry races are multiplied in the 4th year on.

In carrying on this experiment, it would be beneficial for the officers in charge to acquaint themselves with Japanese technics beforehand.

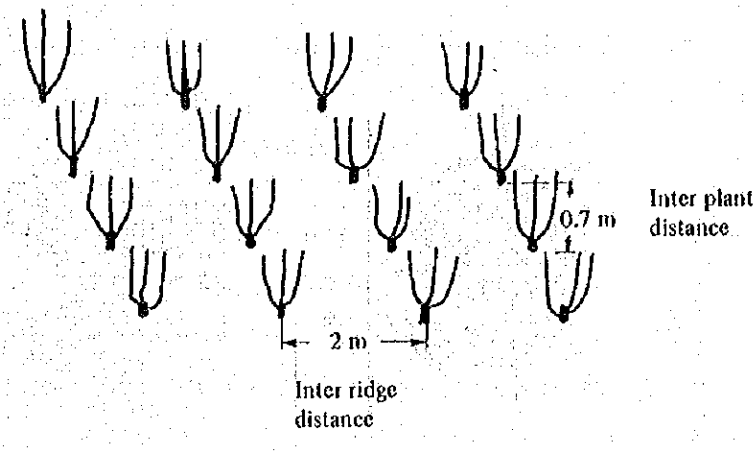


Fig. 8. Planting space

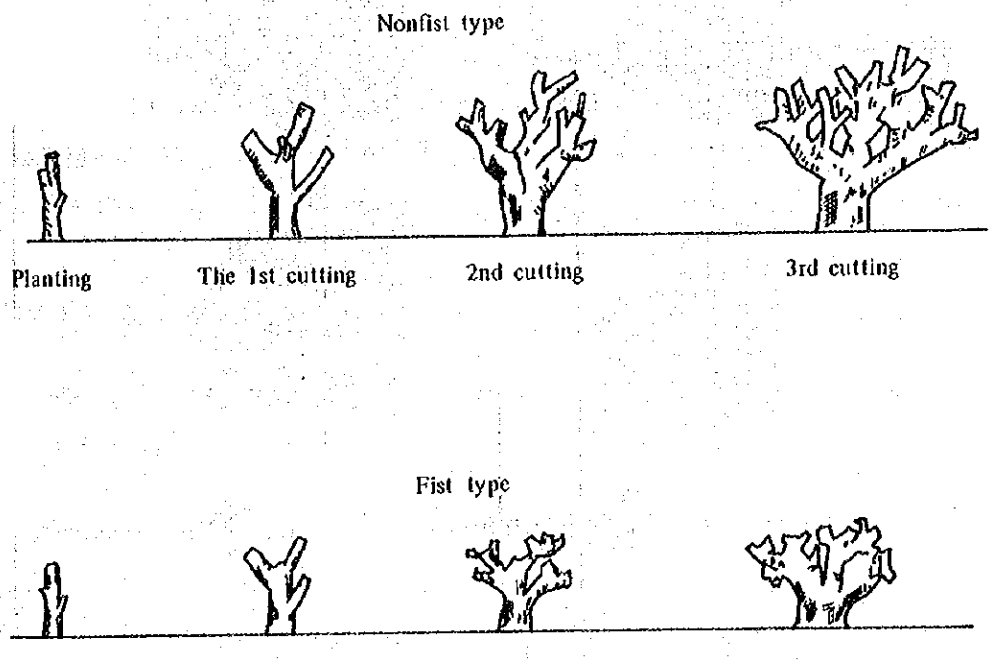


Fig. 9. Low-cut training

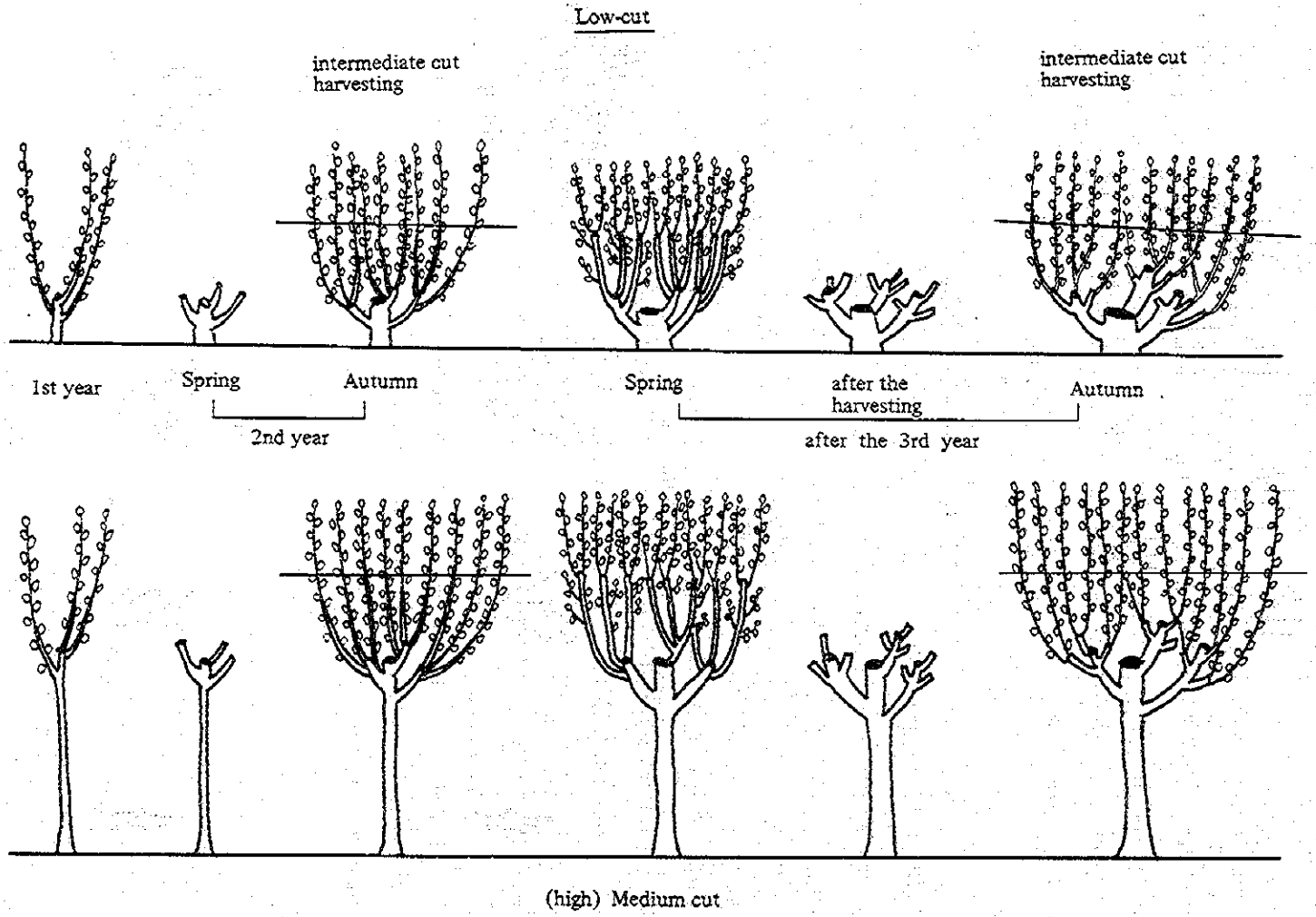


Fig. 10. Training and harvesting

POSTSCRIPT

Generally speaking, it is feasible to develop sericulture in Iran in the light of the conditions of location, such as climate, soil, provided that the problem of water is solved, we presume.

Heretofore, Iranian sericulture has been conducted on a small scale. Consequently, the level of technology is low. The project of 1,000-ton more production of raw silk which the Iranian Ministry of Agricultural Cooperation has formulated would require a fairly high level of technology. From the conditions of location, there is, in our opinion, room enough to introduce Japanese technics into Iran. A technic, however meaningful it may be, could not contribute to the productive activity in a foreign country, unless it is assimilated there. The introduction of technique, therefore, should be launched after the persons concerned of both countries have sufficiently examined the matter. The present survey is not enough. It would be worthwhile for Iranian experts to inspect Japanese sericulture on the spot.

At the request of Iranian side, we stated problems on the reeling equipment for 1,000 tons of raw silk as an appendix. But reeling equipment may be considered after cocoon output has acquired a definite outlook. We cannot stress too much that the first step should be the creation of mulberry field.

APPENDIX I

REELING EQUIPMENT REQUIRED TO PRODUCE 1,000 TONS OF RAW SILK

The Iranian plan aims at a production of 1,000 tons of raw silk as follows:

20 to 22 deniers	300 tons
100 to 150 deniers	700 tons

To produce such a large amount of raw silk, it would be proper to introduce automatic reeling machines. But the introduction should be carried out cautiously and slowly, as stated in the text.

1) Necessary conditions in building a filature equipped with automatic reeling machines.

(1) Security of cocoons required for annual operation.

(2) Cocoons of uniform qualities suitable for automatic reeling machine.

(3) Drying and cooking of cocoons that fit automatic reeling machines.

(4) Availability of a large quantity of water; the qualities of water are to be examined among other conditions of location, as they affect reeling efficiency, the quality of raw silk, and the raw silk percent-of cocoon.

(5) To control technics, skilled technicians are to be trained beforehand.

(6) To secure and train workers.

2) Trial calculation of automatic reeling machines required to produce 1,000 tons of raw silk.

Raw silk of 20 to 22 deniers can be reeled by an automatic reeling machine, but thick one of 100 to 150 deniers cannot be produced by the present machine. So, we will have to double so many silk threads of 40 to 44 deniers to match the objective size.

(1) Automatic reeling machines required to produce 300 tons a year of raw silk of 20 to 22 deniers.

* Annual raw silk production per machine

$$\frac{21^{(d.)} \times 0.05^{(g)} \times 130^{(m/sec)} \times 480^{(min)} \times 20^{(ends)} \times 300^{(days)}}{450^{(m)}} = 873.6 \text{ kg}$$

where

130 m/min is reeling velocity, which varies with the target quality of raw silk and the qualities of cocoons.

480 minutes are daily working hours.

20 ends make up a machine.

300 days are annual working days.

* Number of automatic reeling machines required

$$300^{(tons)} \div 873.6^{(kg)} = 343$$

(2) Automatic reeling machines required to produce 700 tons a year of raw silk of 40 to 44 deniers

* Annual raw silk production per machine

$$\frac{42^{(deniers)} \times 0.05^{(g)} \times 80^{(m/min)} \times 480^{(min)} \times 20^{(ends)} \times 300^{(days)}}{450^{(m)}} = 1,075.2 \text{ kg}$$

* Number of automatic reeling machines required

$$700^{(tons)} \div 1,075.2^{(kg)} = 651$$

3) Auxiliary machines

In building a filature equipped with automatic reeling machines, the following auxiliary machines are required, provided that the drying of cocoons is separately conducted:

(1) Automatic cocoon sorter:

In order to reject double cocoons and other waste cocoons from material cocoons, this machine arranges cocoons on a counter shone from beneath with artificial rays, and a worker sorts out bad cocoons.

(2) Automatic cocoon cooking machine:

This machine cooks cocoons uniformly and betters the reelability of cocoon filament, consisting of a wooden or stainless steel steam chamber, high and low temperature water tubs, steam pipes to heat them, and travelling cocoon containers, etc. Temperature and pressure at various parts are automatically regulated with a device, while the cooking hours are adjusted with a speed change gear.

(3) Automatic cocoon distributing apparatus:

Cooked cocoons are automatically carried to the end groping section of the automatic reeling machine in baskets or by water stream, compressed air, etc.

(4) Automatic reeling machine:

Equipped with a size detector which detects thinner size of raw silk while reeling, and an apparatus which sends out a cocoon and feeds its end at the sign of the detector. There are two kinds of cocoon supplier: one is the fixed type; the supplier is fixed in front of the feeder. The other is the circulating type; suppliers circulate around the reeling machine, and feed ends wherever the detector operates. To raise the efficiency of the automatic reeling machine, there are some attachments, such as end-groping machine, dropped cocoon collecting apparatus (transporting dropped cocoons and pupas), an apparatus which separates reelable cocoons from unreelable cocoons, etc.

Usually, 20 automatic reeling machines (400 ends) are combined into a set.

(5) Washing apparatus of size detector and cocoon supplier:

The size detector, etc. decrease their performance on a account of the deposit of sericin, etc. which resolve from cocoon shell. So, they are to be washed periodically.

(6) Rereeling machine:

Unlike the Italian type, which reels silk directly onto the grand reel, the automatic reeling machine reels silk onto the (smaller) reel, which is later rereeled onto the grand reel by means of this machine.

The grand reel is usually made of wood, hexagonal, 1.5 m in circumference. A grand reel winds up silk from 5 or 6 reels at the same time.

(7) Reel permeating apparatus:

In rereeling silk from reel to the grand reel, this apparatus softens raw silk sticking together and makes it readily reelable.

(8) Reeling water improving apparatus:

This apparatus makes water more suitable for reeling as to pH, hardness, alkalinity, etc.

(9) Bisu disposer:

Cocoons cannot be reeled entirely to the end of silk filament; part of inner silk layer remains over pupas, which is separate from pupas and used for some other purposes.

(10) By-product dryer:

This machine dries kibiso, bisu, pupas, etc.

(11) Steam supply installation:

Boiler and piping arrangement to supply steam to cocoon cooking machine, automatic reeling machine, rereeling machine, bisu disposer, by-product dryer etc.

(12) Water supply installation

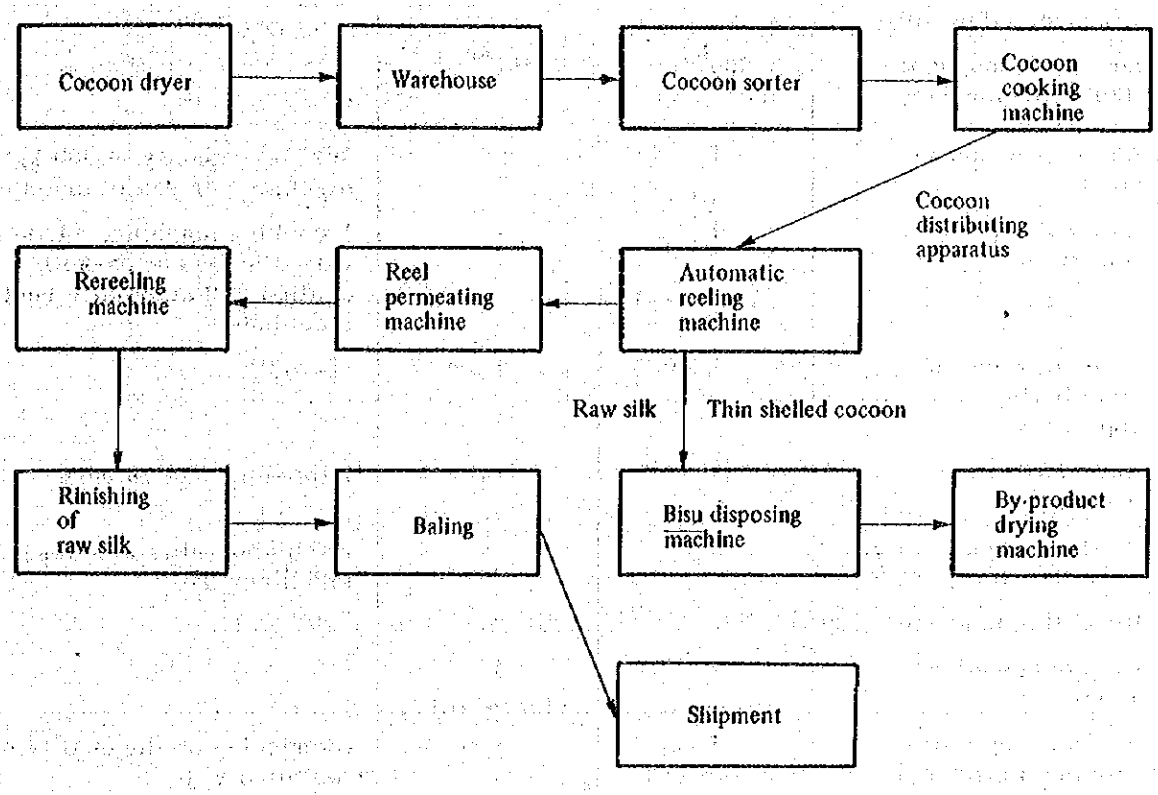
(13) Power installation

(14) Doubling machine:

Raw silk is doubled by this machine.

(15) Others:

Skein knotting machine, silk booking machine, large and small scales, counter (sizing) reel, skein balance, quadrant balance, etc.



Annexed Fig. 1. Scheme of silk reeling process

Silk reeling process is shown in Annexed Fig. 1, and machinery and apparatus are summarized in Annexed Table 1.

Annexed

Table 1. Summary of Machines and Installation

	To produce 300 tons of 20 to 22 d.	To produce 700 tons of 40 to 42 d.	
Consumption of cocoon			
Fresh cocoon, annual	2,400 tons	5,600 tons	
Dried cocoon, annual (converted by 40%)	960	2,240	
Dried cocoon, daily (300 working days)	3,200 kg	7,467 kg	
1. Automatic cocoon sorter	11	25	Sorting capacity of 300 kg per machine per day of dried cocoon
2. Automatic cocoon cooker	4	7	1 cooking machine, 14.85 m long with 3 series of baskets against 100 automatic reeling machines
3. Automatic cocoon distributing apparatus	1 set	1 set	
4. Automatic reeling machine	343	651	1 machine has 20 ends
5. Washing apparatus of size detectors, etc.	2	4	Each apparatus washing 170 machines daily
6. Rereeling machine	860	1,630	
7. Reel permeating apparatus	2	4	
8. Reeling water improving apparatus	1 set	1 set	(depending on the quality of original water)
9. Bisu disposing machine	2	4	
10. By-product drying machine	1	3	
11. Steam installation	2	5	1 installation generating 6 tons per hour of steam
12. Water installation	1 set 130 m^3/hr	1 set 300 m^3/hr	
13. Power installation (receiving)	1 set	1 set	
14. Silk doubling machine		1 set	
15. Others If necessary (é. g. apparatus to purify filature's drainage)	1 set	1 set	

4) Water for reeling

(1) Silk reeling consumes a lot of water. The amount of water used in a Japanese filature by process is shown in the following table:

Process	Amount of water
Cocoon cooking	62 to 95 m^3
Silk reeling	557 to 630
Rereeling	7 to 10
Boiler	76 to 95
Others	148 to 170
Total	850 to 1,000 m^3

Based on these figures, the annual water requirement would be: 270,000 m^3 at a filature producing 300 tons of raw silk, 20 to 22 deniers, a year; 630,000 m^3 at a filature producing 700 tons of raw silk, 40 to 44 deniers, a year.

(2) Quality of (original) reeling water

The quality of reeling water has a great effect on the reelability of cocoon, reeling efficiency, raw silk percentage of cocoon, the quality of raw silk, etc. Annexed Table 2 shows the standard of the quality of reeling water (original) from the viewpoint of these considerations.

Annexed

Table 2. Standard Quality of Reeling Water

Item	Standard concentration	Limit concentration
(1) Color and cloudiness	No color, clear	
(2) Odor	Odorless	
(3) Suspension, sediment	No	
(4) pH (original water)	7.0	6.8 to 7.4
(5) pH after boiling (original water)	8.6 to 9.0	8.4 to 9.4
(6) Specific conductance (micromho/cm)	100	30 to 300
(7) Hardness (°dH)	1.7 to 2.4	0.5 to 5.0
(8) M alkalinity ($CaCO_3$, ppm)	25 to 30	15 to 60
(9) Free carbon dioxide (CO_2, ppm)	6	0 to 20
(10) Heavy metal	As little as possible	
Iron (Fe_2O_3, ppm)	0.1 or below	0.3 or below
(11) Residue after evaporation (ppm)	85 to 90	30 to 300
(12) Consumption of $KMnO_4$ (ppm)	0 to 2	10 or below
(13) Others (ppm)		
Silicic acid (SiO_2)	10	10 to 50
Potassium (K_2O) and soda (Na_2O)	10	5 to 35
Calcium (CaO) and magnesium (MgO)		

5) Security of Cocoons

When we build a filature, what is the most important is how much cocoon we can secure. Increase in mills and automatic reeling machines installed should correspond with the expansion of cocoon output.

We may find a standard in the fact that an automatic reeling machine consumes about 7,000 kg of fresh cocoon to produce 20 to 22 denier raw silk a year, and about 8,600 kg in case of 40 to 44 deniers.

6) Quality of coccon

The quality of cocoon can be appraised according to the following items:

(1) Eliminated cocoon percentage:

This shows the ratio of unsuitable cocoon for reeling by weight which has been mixed in the lot. Double cocoons and perforated cocoons are all rejected; outside-stained and inside-stained (dead worm) cocoons, thin-end cocoons, thin shelled cocoons, cocoons with prints of cocooning frame, malformed cocoons, loose shell cocoons, moldy cocoons, etc. are eliminated according to a certain standard.

(2) Length of cocoon filament:

Reeling with 8 cocoons, the length of raw silk is measured with a meter installed on the reeling machine.

$$\text{Length of cocoon filament (m)} = \frac{\text{Length of silk} \times 8}{\text{No. of cocoons reeled}}$$

(3) Reelability:

Represents the number of breaks of cocoon filament during reeling. Ascertaining the number of feeding during reeling, we calculate it according to the following formula;

$$\text{Reelability (\%)} = \frac{\text{No. of cocoons reeled}}{\text{No. of feeding}} \times 100$$

(4) Size of cocoon filament:

Shows the average thickness of cocoon filament. It is calculated by the formula; size of cocoon filament

$$= \frac{\text{Conditioned weight of raw silk (g)}}{\text{Length of raw silk (m)} \times 8}$$

where, conditioned weight is the weight modified by 11% of moisture percentage.

(5) Neatness:

The number, size and distribution of neatness defects are rated in percentage. Winding raw silk on a seriplane board, we apprase it in comparison with the standard photograph.

(6) Raw silk percentage of cocoon:

The ratio of raw silk yield by weight against the whole cocoon. This has the closest relation with cocoon price.

$$\text{Raw silk percentage of cocoon (\%)} = \frac{\text{Weight of raw silk}}{\text{Weight of cocoon}} \times 100$$

The qualities of cocoon can be generally appraised by the above items. There may remain room for further study whether or not this testing be conducted in each producing center, for example in each Farm Cooperation; by sampling from a certain unit of lot of cocoon, etc.

For reference, the results (annual average) of cocoon testing in Japan in 1972 were as follows:

Percentage of eliminated cocoon	0.9 %
Length of cocoon filament	1,225 m
Reelability	73 %
Size of cocoon filament	2.63 deniers
Neatness	95.21 %
Raw silk percentage of cocoon	18.56 %

(7) Qualities of raw silk

The objects of raw silk testing are: a fair and smooth transaction of raw silk, and the setting up of targets for producers to improve silk qualities as well as the criteria for consumers in selecting silk lots. The testing consists of quality test and conditioned weight test, and is conducted mainly by sampling.

Principal items of quality test follow:

A. General finish:

The whole lot is checked as to the general condition of the uniformity, and the presence and degree of the defects on finish in a lot.

B. Breaks counting:

One item in the Winding Test, in which breaks during winding is counted.

C. Size test:

On the sizing skein of a certain length, the scattering of sizes, the state of the extreme values, and the grand average in conditioned weight are checked.

D. Evenness variation test:

Using a seriplane, coarse or fine passages in a certain length of silk thread are classified according to the degree and the numbers are checked, respectively.

E. Cleanness test:

Super major defects, major defects and minor defects in silk thread are checked by kind; each number is

penalized according to a certain criterion. Total penalties are deducted from 100 percent and the balance shows the result of this test.

F. Tenacity and elongation test:

Using a serigraph, resistance of raw silk to lengthwise stress and the degree of elongation at the time of tearing apart are checked.

(8) Reeling workers

Silk reeling requires relatively many female workers; it is an important matter whether the personnel can be secured.

Compared with Italian reeling machines, the automatic reeling machine is not only complex in mechanism, but also its introduction is to be accompanied by various auxiliary machines; reeling operation is to be divided into many sections. So, not only trained workers in cocoon cooking, silk reeling, rereeling, etc. are required, but also experts in the maintenance of machines, boiler, control of water quality and the like would be indispensable.

APPENDIX II. Reference Books

For reference to the modern sericulture, the following books are attached hereto:

1) "Sericulture" Overseas Technical Cooperation Agency (Tokyo), 1971.

2) "Silkworm Rearing Technics in the Tropics" ibid., 1973.

FEASIBILITY SURVEY REPORT

ON THE TEA INDUSTRY OF IRAN

January, 1974

CONTENT

1. Introduction

His Excellency, Mr. Valian, Minister of Cooperation and Rural Affairs of Iran and His party visited Japan in August, 1973 and requested Mr. Sakurauchi, the then Minister of Agriculture and Forestry for the technical cooperation in agricultural development of Iran. In compliance therewith Japan has decided to send a team of experts mainly for the purpose of grasping the state of tea industry of Iran.

Mr. T. Arai (Assistant Director of Upland Crops Development Division of the Agriculture, Sericulture and Horticulture Bureau, Ministry of Agriculture and Forestry) was sent to Iran to investigate Iran's tea industry in 1963, but since then there has been no negotiation that practically no information was available on Iran's tea industry. Accordingly we have departed for Iran to grasp the state of Iran's tea industry and to find out if there is any problem. By staying in Iran for about a month we were able to practically comprehend the state of Iranian tea industry and it can be safely assumed that we have established a clue for the future technical cooperation with Iran.

In our investigation we have been offered an undivided assistance and cooperation from the related agencies of the Government of Iran, particularly, from the staffs of the Ministry of Cooperation and Rural Affairs, for which we wish to present our deepest gratitude, for without their assistance and cooperation our investigation would not been possible.

1.1 Members of Investigation Team

Sogo KAWAI ..... Chief, Cultivation Dept., Tea Experiment Station of the Ministry of Agriculture and Forestry;

Yutaka SAKAMOTO .. Director, Makurazaki Branch of the above Station;

Isamu MATSUO ..... Director, Chiran Tea Stock Seed Farm of the same Ministry.

1. Object of Investigation

As the result of preliminaries with Mr. Mortaza Alahmad, Vice-Minister of Cooperation and Rural Affairs of Iran the following four points with respect to the Iran's tea industry have been decided by the same Ministry to have us studied.

1) Measures to promote the yield increase and quality improvement of Iranian tea.

2) Possibility of introducing the tea agricultural cooperative system of Japan into Iran.

3) Possibility of introducing the compensation against agricultural loss system of Japan into Iran.

4) Introduction into Iran the tea leaves storage technique under nitrogen gas.

Although all of them are difficult subjects but after discussing on-the-spot as much as possible we are confident that a considerable mutual understanding has been reached.

2. Investigation Itinerary

Nov. 17 AM Leave Haneda

" 17 PM Arrive Teheran

" 18 Courtesy visit to His Excellency Mr. Valian, Minister of Cooperation and Rural Affairs, and consultation with Vice-Minister Mortaza Alahmad and Mr. Ahmad Moradi Haghgoo, staff officer in charge of tea industry on the content and itinerary of investigation.

Nov.	19	Final consultation on the content and itinerary of the investigation and briefing on the Iranian tea industry's situations from Mr. Mohamad Ali Mobashery of the Organization of Cereals, Sugar and Tea. Courtesy call to the Japanese Embassy and received a briefing from Ambassador Arita on the matters to pay attention in the investigation.
"	20	Leave for the investigation of tea producing districts of the Caspian Sea coast. Teheran -- Qazvin -- Rasht -- Lahijan.
"	21	Inspection of the breeding of tea tree and experiment conditions related to seedling growth and tea manufacturing plant (government direct management, government supervision and private) under the guidance of Mr. Gh Reza Moezzi, Director of tea plantation area of the Lahijan Tea Headquarter.
"	22	Inspection of laboratory related to soil and fertilizer, biochemistry, cultivation and disease and insect control at the Tea Research Station of Lahijan, and consultation with respect to the content of research. Inspection of cultivating conditions of selected superior varieties, Assam varieties, Chinese varieties and Cambodian varieties. Inspection of cultivating conditions of Sabonchi tea garden which is a model irrigation-cultivation demonstration farm in Comlehe and the inspection of SaEE tea manufacturing plant (Government supervision) of Moraidan.
"	23	Inspection of Bibalan tea garden of Rudsar and tea manufacturing plant (direct government management) and Fahim tea manufacturing plant (Government supervision) of Divashal.

Nov.	24	Inspection of Kalarabad tea manufacturing plant (direct Government management) of Shassavar.
"	25	Visit to the Director of Agricultural Cooperative of Mazandaran of Sari and consultation on the content of Cooperative's business.
"	26	Gorga -- Sari -- Amal -- Ab-e-Ask -- Abali -- Teheran.
"	27	Report the investigation's findings in outline to Mr. Mortaza Alahmad, Vice-Minister of Cooperation and Rural Affairs and made arrangement on the content of investigation report.
"	28	Inspection of black tea refining plant of Lay under the direct Government management.
"	29	Compilation of preliminary report.
Dec.	2	Submitting of preliminary report and discussion.
"	3-11	Compilation of preliminary report No. 2.
"	12	Submitting of preliminary report No. 2. Courtesy visit to the Ministry of Cooperation and Rural Affairs and Japanese Embassy to say good-bye.
"	13	AM Leave Teheran
"	14	AM Arrive Tokyo Airport.

2. Trend of Tea Industry in Iran

1) Consumption of black tea

The black tea is consumed as a national beverage, consumption being at present, 38,000 tons per annum which is increasing 2-3% annually. Out of which about 24,000 tons are domestic production and the balance of about 14,000 tons are imported from Sri Lanka and India. The Government of Iran hopes to increase the domestic production of black tea and to minimize its import as much as possible,

thereby anticipates to approach the self-sufficiency in black tea consumption. And to ensure the same yield increase per unit acreage and the improvement of quality are deemed as important.

2) Tea garden acreage and cultivation method

Tea-cultivation-suitable-districts in Iran are a portion of Gilan and Mazandaran States facing the Caspian Sea. At present, about 36,000 ha of these districts are tea gardens. Out of which 4,000 ha are immature-tea gardens, 2,000 ha are devastated tea gardens, and so leaf plucking acreage is only about 30,000 ha. As far as the acreage is concerned it has been deemed as unnecessary to increase the present cultivating acreage.

Those tea gardens are distributed in the belt 0 m to 400 m, 25,500 ha thereof, accounting for 85%, are in sloping land of mountain-side and 4,500 ha, 15% in flat land. These belts are the most suitable tea cultivating lands, however, because the annual rainfall is around 500 mm during the growth period of tea from April to October, the tea tree is easily subject to growth disorder by drought. And because the cultivation method is bush training and in addition thereto, the width of tree is remarkably narrow. Accordingly, the yield is small with around 2,500 kg per hectare in green leaf. On the other hand, owing to cultivation under irrigation during summer season, the raising of tree height to 50-60 cm and by widening the tree width, the yield is raised 3-4 times more than the existing tea gardens. The Government of Iran takes as an important issue this problem of introducing irrigation to those tea gardens in summer season how much economically and how to extend the same.

As for the improvement of quality although a very fancy quality black tea could not be hoped due to climatic conditions, the quality improvement is anticipated by the extension of cross-breeds of Chinese varieties and Assam varieties.

3) Tea manufacturing plant

At present tea manufacturing plants of Iran are classified into 3 types; direct Government management (8 plants), Government supervision (65 plants) and private (54 plants), and the black tea production is 17,345 tons by Government-related plants and 6,655 tons by private plants. As for the manufacturing technique of black tea the Indian method has been introduced to all plants and there seems to be not much problem. A problem which seems to be the bottleneck is rather too many plants for the tea leaf production and major portion of private plants are in poor installation and others. It has been recognized as necessary to integrate and consolidate those plants but how to implement the same is said to be a future issue.

4) Farm management

Average holding of tea cultivating farmer is around a hectare or so, and because of extensive cultivation practically all labor is by family members with an annual income of 30,000 rials (¥120,000) at present. All those farmers sell their tea leaf either to government-related plants or private plants. That is, it is the management corresponding to green-leaf-marketing-farmer as seen in large number throughout Japan in the past. In order to ensure the income increase and the improvement of welfare of those farmers, ultimate answer can be said to be the establishment of agricultural cooperative. Furthermore, in Iran the tea cultivating farmers and tea manufacturing plants are entirely under separate management that in general, there is no connection between the two. With the systematization of farm management a problem is how to link the two into closer relation with each other.

Although tea manufacturing plants in general, operate about 200 days a year, it is anticipated to prolong this to a whole year, and to

do so it is necessary to store green leaf. And as a method therefor the possibility of green leaf storage under nitrogen gas is being studied.

In short, the Ministry of Cooperation and Rural Affairs sets target to achieve the self-sufficiency in black tea by studying the rational distribution of tea gardens and tea manufacturing plants in tea producting belts, by promoting the systematization of farm management and by establishing crop damage compensation system, thereby increasing and stabilizing the domestic black tea production of Iran, to ultimately improve the welfare and living standard of 30,000 tea cultivating farm households containing 300,000 family members.

3. State of Tea Industry in Iran

We wish to outline the state of Iran's tea industry based upon the briefing from the persons concerned in tea industry and by the knowledge we have obtained after inspecting tea producing districts during our stay in Iran.

3.1. Experiment and research

There is a Headquarter (Department of Cereals, Sugar and Tea) under the jurisdiction of the Ministry of Cooperation and Rural Affairs in Lahijan of Gilan State, which is the center of the tea producing districts. The Tea Research Institute has a laboratory for soil and fertilizer, cultivation, biochemistry and disease and insect and sub-station for variety breeding and propagation, and in the experiment farm near Fuman the experiment is being carried out on sprinkler's effectiveness, fertilizer, disease, insect and weed control. The scale of experiment and research on tea in Iran is not so large and the content of experiment are directed to problems directly connected to cultivation and tea manufacturing (particularly, chemical component closely connected to quality) that it could be said as giving priority to survey rather than research.

In order to improve the knowledge of tea cultivating farmer and to give the guidance on cultivating technique agricultural extension workers who have been trained at the Headquarter of Lahijan are being sent out to various places.

3. 2. Breeding work and nursery production

As for the breeding works we inspected the actual conditions at Lahijan's experiment and its sub-stations. In the tea producing districts of Iran the breeding works are being carried out upon the standpoint that cross-breeds of Chinese varieties and Assam varieties are suitable in the light of Iran's climatic conditions and because of the growth and quality of tea in accompaniment therewith. That is, suitable varieties are being selected from among the cross-breeds of Chinese varieties and Assam varieties. And the section method is the sowing of seed by natural crossing of Chinese varieties and Assam varieties. The first selection is made upon the observation of seedling's budding, drought resistance and disease resistance. The second selection is made by investigating the volume of tea leaf plucked, drought resistance and the recovery condition after collar pruning in June - July. And promising stocks are selected by investigating the conditions in budding, flowering and fruiting after the bush training. Those selected varieties are investigated on their tea quality after manufacturing. In such a way, at present 2,500 promising varieties are being cultivated. Although the propagation and extension of superior varieties have to be dependent on cutting propagation but the cutting-propagation is still at experimental stage in Iran. At the experiment station cutting bed of 1 m width and 10 - 15 cm height is filled by yellowish brown clayish soil and after the soil has been pressed hard the cutting is planted at the density of about 10 cm x 15 cm. The cutting is made by a sharp knife at the length of 3 - 4 cm with one leaf attached. After the planting the soil around the cutting is pressed hard again. The period for cutting

is June and after the planting the cutting is covered by jute fibre net and is watered every day for the duration of 3 months. The rooting is said to commence after 6 months. And the experiment is being carried out by using vinyl bag and it has been found that the result is very superior (3.6 times of ordinary method).

One remarkable thing in breeding and nursery production is the importance directed toward the character of drought resistance in selection, and even in the case of cutting a thoughtful consideration is rendered to drying by such measure as to make the moisture-maintenance of soil as good as possible.

3.3. Cultivation

Although the tea cultivating belts of Iran are distributed from Hashtpar to Chalus along the Caspian Sea coast we have inspected near Lahijan mainly the ordinary mountain-side sloping land tea gardens and flat land tea gardens as well as tea gardens under new irrigation-cultivation method of Sabonchi.

1) Atmospheric conditions

Although the atmospheric conditions are the controlling factors in tea tree growth, particularly, atmospheric temperature and rainfall are important. As to the study of atmospheric conditions of Iran's tea producing districts we have been informed that the temperature is maximum 30°C and minimum -4°C with relative humidity 75%, at times 95%. Accordingly, there is not so much problem in atmospheric temperature. The rainfall is 1,250 mm a year in general and 40% thereof, 500 mm is from April to October and 60%, 750 mm is from November to March. The rainfall investigated by Lahijan experiment station is as shown under the following table.

Year	Annual rainfall mm	Rainfall during growth period mm	Rainfall during production period mm
1958	1168	238	73
59	1368	312	69
60	1268	520	113
61	1178	270	71
62	1824	657	82
63	1394	526	109
64	1273	225	68
65	1272	349	180
66	1386	360	139
67	1347	370	34
68	1352	375	107
69	1645	576	151
70	1120	383	118
71	755	85	13

Remark: Growth period - Apr. - Oct.
Production period - June - July

30 - 40% of annual rainfall during growth period from April to October is assumed as good and if there is 60% it is excellent. As the Table above is self-explanatory, because there was only 85mm rainfall during 1971 growth period we have been informed that there was the outbreak of damage by withering. From these facts the drought damage is inevitable under the rainfall below 300mm during growth period. But if the ground water level is within 1.5m even if the rainfall is small the growth is good.

At any rate, it can be definitely stated that small rainfall during tea growth period from April to October is the greatest bottleneck in the tea cultivation of Iran.

2) Soil condition

The soils in Iran's tea cultivating districts are acidic (pH 4.5 & 5.5) loam or clay loam belonging mainly to brownish forest soil, so as far as the soil is concerned it is suited for tea cultivation. Because of a small rainfall in general there is a little aciditization of bases which leaches in soil as witnessed in Japan, rather the bases rise from lower layer and the trend of accumulation thereof seems to be strong.

3) Distribution condition of tea gardens

The total tea cultivating acreage of Iran is 36,000 ha at present and the distribution thereof is as shown hereunder, and the location of those districts is as shown in a simple map in last page.

Name of localities	Tea garden acreage
Rasht	4,000 ha
Lahijan	9,000 "
Langarud	7,000 "
Rudsar	13,000 "
Shabsavar	3,000 "

75% of those tea gardens are distributed in sloping land of mountain-side and the slope is said to be over 30°. The tea gardens of flat land accounts for 25%, less than 10,000 ha. Practically no land consolidation is enforced on the sloping-land tea gardens, similar to the conditions of mountain tea

gardens of Japan, such that it seems extensive cultivation management is inevitable from the condition of location.

4) Cultivation method

(1) Planting density and training method

The seed is sowed in nursery bed and after the rearing for a year the seedling is planted on tea garden. The ridge space is 1 m and the distance between plants 60 - 80 cm with 12,000 - 15,000 stocks per 1 ha. The stocks are planted and left as they are for the duration of a year and from the second year main trunk is pruned to the height of about 20 cm. Thereafter, the pruning is carried out each year after tea leaf plucking at 20 - 30 cm, and becomes a mature tea garden in 6 - 7 years. However, after that the pruning is carried out again by sickle to a condition practically near to the condition of collar pruning. Accordingly, the branches fasciculate from near the ground, thus tea stock becomes short in height with small width of tree. Because of such state of things it is only natural that tea leaf plucking surface is narrow, inviting a large naked ground. Major portion of existing tea gardens are characterized by such features. The tea gardens of sloping lands are all vertical planting (endwise planting) and because of such training the growth is poor and soil erosion is seen from naked ground.

In recent years those pruning practices have considerably been improved. That is on the 4th year the first pruning is made at the height of 40 cm and after the first crop of tea 5 - 10 cm is cut off and on the 5 - 6th year the pruning is carried out at the height of 10 - 20 cm above ground.

After that the tree height is maintained at 50 - 60 cm to ensure the leaf plucking surface a larger.

(2) Fertilizer application

In Iran main constituent of fertilizer for tea garden is ammonium sulphate. And the volume of fertilizer for tea garden is 11,000 tons per annum. 500 kg per ha is distributed by the Government but that distribution is implemented only in a small section of tea gardens. It seems there are many non-fertilized tea gardens in sloping land.

(3) Disease and insect control by agricultural chemical

Because of a dry climate in general there is a small outbreak of disease and insect that no agricultural chemical spraying is practiced at present.

(4) Irrigation

The tea garden irrigation has been launched in Iran about 5 - 6 years ago and we have been informed that sprinkler system has been introduced to about 200 ha. However, because the sprinkler system is cost high accompanying a problem of economic effect that a further study is now being made thereon.

(5) Tea leaf plucking and yield

The plucking is entirely by hand by two leaves and a bud (5% of the total) and by three leaves and a bud (95% of the total). The plucking period is 6 times as shown hereunder. However, the first crop of April - May is the largest, accounting for about 30% of annual yield.

The yield greatly varies --- 2,250 - 2,500 kg per ha in green leaf in sloping land of mountain-side and average of 3,500 kg in flat land tea garden. In the tea gardens under the Government aid and guidance 6,000 kg per ha is produced and in the tea garden under new training with irrigation (for example, Sabonchi tea garden) a very large yield of 12,000 kg per ha in green leaf is being produced.

Plucking period	Ratio of plucked vol.
Apr. - May	28.17 %
May - June	17.54 "
June - July	19.01 "
July - Aug.	15.75 "
Aug. - Oct.	12.81 "
Oct. - Nov.	6.64 "

The yield of tea garden in Iran was around 1,000 kg per ha 10 years ago, but now, under the Government guidance the cultivating management has greatly been improved, resulting in the yield increase in general. It is anticipated that a further increase will result to achieve higher yield level.

(6) Tea garden management

The number of tea cultivating farm households in Iran is about 30,000, and the holding of 85% of those farm households is one hectare or less. On the other hand, the purchasing price of green leaf by Government-related tea manufacturing plants is 25 rials (about ¥100) per kg for two leaves and a bud (1st grade) and 20 rials (about ¥80) for three leaves and a bud (2nd grade). However, 95% of

plucked leaves are said to be 2nd grade. The income of tea cultivating farm household operating about a hectare is 30,000 rials (about ¥120,000) per annum. In general, a full-time tea cultivating farmer is very few and major portion of farm household depends on income from the cultivation of jute, rice and other crops or engaged in sericulture besides the income from tea cultivation.

3.4 Tea manufacturing

As stated above the tea manufacturing plants of Iran are classified into 3 types: direct Government management, Government-supervision and private. At present, the number of Government-management plants is 8, Government-supervision plants, 65 and 54 private plants. Out of 54 private plants 28 plants are ill equipped with poor installation that they are deemed as poor plants. The distribution of plants is as follows:

District	Total No. of plant	Direct-gov't. management	Gov't supervision	Private	
				good	poor
Rasht	14	1	7	2	4
Lahijan	47	2	23	11	11
Langarud	29	1	12	4	12
Rudsar	24	1	18	5	
Shahsavar	13	3	5	4	1
Total	127	8	65	26	28

The machineries and tea manufacturing techniques of those plants have mostly been introduced from India and the capacity of each plant varies. In general, the plants can be classified into first and second class by tea manufacturing capacity. 1st-class plant can dispose over 8 tons of green leaves per day, equipped with more than

6 sets of tea roller and at least 2 sets of tea dryer. The disposal capacity of 2nd class plant is 4 - 6 tons of green leaves per day, equipped with 4 - 5 sets of tea roller and one set of tea dryer. Although the number of plants by each class is not known, the Government-management and Government-supervision plants are well equipped and tea manufacturing capacity is comparatively averaged. However, private plants are characterized by a great difference in superity and inferity. It has been said that tea manufacturing capacity of 73 plants under the Government management and supervision is 800 tons green leaves per day. Accordingly, the averaged tea manufacturing capacity per plant is 10 tons green leaves per day. The capacity of 54 private plants is said to be 200 tons of green leaves per day which means an average of 3 - 4 tons per day. From these facts it is reasonable to assume that the scale and equipment of Government-related plants are mostly superior and the same of private plants are comparatively a poor in most cases.

Generally, the plants operate about 180 - 200 days from April to October. And a study of the location of those plants reveals that either the plants are considerably far apart or comparatively aggregated in one area. In such a way the arrangement of plants greatly varies but there are many districts where the plants and tea gardens are separated by a long distance. Hand plucked green leaves are put into basket and transported to plant by mule or horse.

The black tea price manufactured at the Government-related plant is 123 - 126 rials per kg for 1st grade and 107 - 110 rials for 2nd grade. The black tea manufactured at the Government-related plants are transferred to refining plant of Government management in Rey south of Teheran where they are refined and marketed. As to the conditions concerning the refining and marketing of private plants are not clear.

3.5. Refining

There is a refining plant under the Government management in Rey, provided with 3 raw material warehouses, sieving plants, tea warehouse after the sieving and packing plant, employing 500 persons at all time. Although the sieving and mixing are all mechnized but the packing is by hand. About 100 dealers enter and exit this refining plant and are engaged in marketing. As a rule, against 1,500 kg of domestic Iranian black tea 1,000 kg of imported black tea is mixed. A dealer who does not wish the mixing must purchase 2,000 kg of domestic black tea for the purchase of 1,000 kg of imported black tea. The refined black tea of this refinery is marketed under three grades, 180 rials, 160 rials and 130 rials per kg.

4. Problems Confronting the Tea Industry of Iran

The writers wish to point out the problems which confront the tea industry of Iran in the light of the fact that the Government of Iran anticipates the development of her tea industry and the state of her tea industry by considering the technique of Japan's tea industry.

4.1. Breeding work and nursery production and the extension thereof

The Government of Iran does recognize the importance of breeding and an effort is going made to breed the superior varieties. The effort to select a suitable varieties from among the cross-breeds of Chinese varieties and Assam Varieties in tea producing district of Iran is, indeed in right direction in the light of tea growth and quality. At present, Japan is not positively carrying out the breeding of black tea-use variety, but in the past, suitable variety has been selected from among the cross-breeds of Chinese varieties and Assam varieties and has succeeded in breeding a very superior new variety, 'Beni-Hikari'. And in the selection of variety for black tea

use Snderson's chloroform test (1963) has widely been used as an early inspection method of quality.

Because already 2,500 stocks of superior strains have been selected in Iran, we believe that a further selection of suitable variety with superior quality and growth can be made from among those strains, and the wide extension of selected varieties is deemed as very important.

To ensure the construction of tea garden of uniform growth and quality is dependent on the cutting-propagation. Accordingly, it is necessary in future to propagate a suitable variety by cutting-propagation. As for cutting-propagation various experiments are being carried out in Iran, but the cutting technique should also be extended as quickly as possible. In Iran one-leaf-cutting of India is being experimented. In Japan, the cutting is made at about 10 cm, 2 leaves attached, 2 - 3 nodes and stalk length of about 3 cm from lower leaf, then thrust into cutting bed. Cutting density is distance-between-row of 10 - 15 cm with cutting's spacing of 1.5 - 3 cm and 20,000 plants per one hectare. After the cutting for about a month the watering is normally once a day. The cutting period is June, but about 45% light transmitting black cloth is used as cover up to about September. Then in March of the following year or in March of the year after that it is planted on field. Although a summer cutting in June is a normal practice but it is possible to carry out the cutting in September as fall cutting under vinyl-covering technique. Such a practice in cutting is widely used by private farmers but as for the State several Tea Stock Seed Farms are established throughout the country and the cutting seedlings are distributed to farmers in large volume (about a million seedlings per annum). Would it not be more effective in Iran to establish such a large propagation-distribution -- farm for suitable varieties for the extension to farmers?

4. 2. Cultivation

There are reasons to believe that problems in cultivation can be concentrated to 3 points, improvement of cultivation method of existing tea garden, irrigation and replanting.

1) Improvement of cultivation method of existing tea garden

As stated herein above Iran's existing tea gardens are characterized by bush training cultivation of low tree height to prevent the drying in summer season. However, to prevent the drying in summer season would it not be more proper to make the tree height a higher and widen the width of tree and to make the naked ground as small as possible to prevent the drying? Particularly, in the light of the fact in existing tea garden a severe method near to the collar pruning is being practiced in which the branches from ground level are practically pruned off every 1 - 1, 5 year. We believe that unless those methods are improved the expansion of plucking surface and yield increase of existing tea gardens can not be anticipated. It has already been confirmed how much this training method of 50 - 60 cm tree height will increase the yield in some tea gardens, so a problem now is how to extend it to farmer. And that we believe is a very pressing problem. In Japan such a training method has been found in many places in the past but now the row training method of arc-shape is practiced and the yield of 10 tons per ha or over is easily produced. Standard training method as used in Japan is as follows:

Standard training method

Years after planting	Pruning period	Pruned height	Shape
1st year	After planting	15cm above gr.	Horizontal
2nd "	" 1st crop	20cm "	"
3rd "	" "	20-25cm "	"
4th "	" "	30-35cm "	"
5th "	" "	40-45cm "	a little arc-shaped

After the 6th year the plucking or pruning is so carried out as to ensure the tree height 5 - 6 cm a higher each year and bring about the increase of branching and the expansion of tree width. The tree height is to be 60 - 90 cm in matured garden and when the tree height reaches over 90 cm the pruning is enforced. Such a practice as used in Iran of pruning at the ground level in matured garden each year is not practiced in Japan, even if used it is very rare.

In case the yield has been increased by the improvement of cultivation method then fertilizer application must be increased in proportion to yield increase. In Japan the fertilizer-application-component volume is computed from the volume of components and absorption rate of fertilizer per 100 kg of green leaf. That is, fertilizer-application-components volume is nitrogen 3 kg, phosphorus 1 kg and potash 1.5 kg per 100 kg green leaf. Based upon the ratio of those components fertilizer is applied in correspondence to the yield of respective tea garden. We believe that those fertilizer-components volume is applicable to the tea gardens of Iran.

2) Irrigation

As stated above, average rainfall from April to October in Iran's tea cultivating districts is around 500 mm which is about a half of Japan's tea cultivating districts. In Japan district with less than 1,000 mm rainfall during the same period is not deemed as suitable for tea cultivation. Accordingly, if the soil's moisture content is replenished during growth period in Iran's tea cultivating district, it would be natural to anticipate a vigorous growth and yield increase. This has been demonstrated by irrigation-demonstration tea garden of Saboncht which clarifies how a great result can be obtained by irrigation on tea tree growth.

Recently a sprinkler system is widely been introduced on tea garden even in Japan with a large rainfall. Because even in Japan comparatively a drying is witnessed in summer season, so the irrigation is being carried out positively to ensure a larger yield, at the same time an effort is being made to raise economic result by using sprinkler for the spraying of agricultural chemical and liquid fertilizer. But to introduce such irrigation facility it must be based on joint cooperative operation because it requires a large investment it is impossible to introduce the system by the burden of farmers alone. Accordingly, an effort is being made to complete the project under the financial aid from the State or prefecture.

As for the construction of irrigation facilities in Iran, a form of cooperative utilization system should be adopted by cultivating farmer, at the same time the State must render a considerable financial assistance. Otherwise the extension of irrigation facility would be difficult. In Japan sprinkler system is

being used for multi-purpose operations such as in spraying agricultural chemical and liquid fertilizer but for the purpose of irrigation at once the introduction of between-the-ridges irrigation system seems to be more rational rather than the introduction of sprinkler system. We wish to highly recommend that a further study be made on this problem.

3) Replanting

To ensure the yield increase and quality improvement in Iran existing tea gardens should be replanted by superior varieties. And in such a case a separate study should be made on mountain-side sloping land and flat land.

(1) Flat land tea garden

Regardless of sloping land or flat land the depth of soil suited for the growth and expansion of root for tea tree growth is over 60 cm and the soil must manifest an appropriate acidity reaction (around pH 5). The replanting should be advanced upon the premise of carrying out the ridging early. In flat land it is a rule to make the ridging from north to south to ensure the uniform growth. Although the planting density in Iran is ridge width 1 m, spacing 60 - 70 cm with 12,000 - 15,000 stocks per ha, but to make the ridging which will prevent the drying in early growth period, it is necessary to adopt a more dense planting by increasing the number of stock. In Japan ordinary planting is ridge width 1.8 m, spacing 30 cm with 18,500 stocks per ha, but in recent years many farmers adopt ridge width, 1.8 m, spacing 45 cm of double rows with 24,600 stocks per ha in order to obtain an early yield. And in order to prevent the drying

after the planting rice straw or wild grass is used to cover the tree root. Although such materials may not be easily available in Iran, but strong effort should be made to use the drying-prevention-material as much as possible.

(2) Sloping land of mountain-side

85% of Iran's tea garden are distributed in sloping land of mountain-side and the condition of location is poor in general as witnessed by many tea gardens with the slope of over 30° Accordingly, in such sloping land the plucking, in the first place and other farming operations are difficult, thus, it is only natural the cultivation becomes extensive. In Japan, although there are many sloping land tea gardens, the land infrastructure improvements are being carried out in those sloping lands to ensure the productivity increase. In the improvement of land infrastructure slope degree is reconstructed to a gentle slope to within 15° and farm road and water installation are constructed as to make the tea garden management easier for farmer.

How to improve those sloping land tea garden in Iran is perhaps a great problem. As a rule, it is necessary to make the sloping land to 15° slope and the land over that land topography should be reconstructed as in Japan. And in such sloping land counter ridge planting should be adopted and the planting should be dense in comparison to flat land. In Japan ridge width is made 1.5 m, with the spacing of 20 - 30 cm. And as the sloping lands are characterized by phenomenon of soil-erosion or easy drying,

in Japan the between-the-ridges is covered by rice straw and wild grass. In Iran a study should be made to obtain such material by constructing grass-collecting land, to obtain grass for such purpose.

Regardless of flat land or sloping land the replanting should be promoted giving a full consideration to the grouping of tea gardens, introduction of uniform superior variety and joint operation of farming works.

4. 3. Tea manufacturing

As to tea manufacturing no problem has been presented to us on-the-spot and within the sphere of our knowledge and inspection there is nothing in particular to point out.

Iran's tea manufacturing machines and techniques are superior. If anything, a study should be made to the lightening inside the plant from the standpoint of health of workers and the consistency in the operation of tea manufacturing machines should be studied to meet labor shortage in future.

One other problem which might be pointed out with respect to plant is how to give the guidance to poor private plants and to improve their facilities or improve them by unifying them. We believe that if the Government wishes to do so it is perfectly possible and the matter should be coped by the Government under the full study of the management of private plants.

4. 4. Relation between tea garden and tea manufacturing plant

In Iran the managements of tea cultivating farmer and tea manufacturing plant are entirely separate. At present, and there is no direct relation between the two. That is, Iran's system is entirely

different from the estate-form of India and Sri Lanka and from the case of Japan. In Japan, tea cultivating farmer also operates tea manufacturing plant. The state of Iran as it is now can be said as similar to the relation between the Government and rice cultivating farmer in Japan. How to improve the relation between farmers and plants is a difficult problem. However, because the Government-related plants comprise about 60% how the Government will guide tea cultivating farmers will give a clue to connect tea garden and tea manufacturing plant.

To repeat, in Iran tea cultivating farmers carry out the cultivation only, and tea manufacturing plants are entirely under different management, at the same time, 60% thereof are under the direct Government management of or Government supervision. Of course, there are some farmers in Japan who operate tea cultivation only but major portion of tea farmers participate in the management of tea manufacturing plant, and the State gives the guidance on the management of plant but does not participate in the management. It is only natural that each country adopts methods in conformity with respective stage of affairs of that country. So the writers do not say one system is better than the other but if Iran intends to introduce Japanese system in tea industry it is necessary to make a detailed study.

In the light of the state of Iran's tea industry it seems the best plan conceivable at the moment is the adoption of contract-cultivation formula between tea farmer and tea plant to ensure the supply of green leaf to fixed plant. In such a case some kind of special favor should be extended to contract-farmer and make him recognize the advantage of contract-cultivation. In the case of contract-cultivation in Japan the plant usually renders service to contract-farmer such as helping farmer to purchase production materials.

5. Japan's Tea Agricultural Cooperative System and the Possibility of Introducing the System into Iran

1) Management system

A study of Japan's tea industry management reveals practically all tea cultivations are under individual management but as for tea manufacturing sector it is classified into 3 types, individual management, cooperative management and company management.

In individual management there are several types: --- green-leaf-marketing farmer engaged in tea cultivation only --- self-tea-cultivation-and-self-tea-manufacturing but in this case there arises a surplus in plant facilities so a portion or major portion of green leaf is purchased, that is, green-leaf-purchasing at the same time operating plant --- self-cultivation-and-green-leaf-purchasing plant --- plant purchasing plant --- plant purchaising all green leaf.

In cooperative management tea manufacturing plant is operated by several farmers or by sub-community. In this cooperative plant there are two types: --- plant operated under voluntary agreement of farmers and plant operated by cooperative organization established under the agricultural cooperative juridical person system based on the Agricultural Cooperative Law. In general, the scale of the latter is larger than the former and is called tea agricultural cooperative.

Company management is operated by corporation system operating tea garden and tea manufacturing plant as well as refining plant.

The number of tea manufacturing plants by management types and volume of manufactured tea in representative tea producing prefecture, Shizuoka in Japan is as shown hereunder:

Individual management						Cooperative management	
Self-farming		Self-farm + purchase		Purchase of leaf			
No. of plant	Vol.	No. of plant	Vol.	No. of plant	Vol.	No. of plant	Vol.
5,101	7,280.6	740	8,334.3	271	8,029.6	521	9,968.3
74.3	15.6	10.8	17.9	3.9	17.3	7.6	21.4

Agr. coop. management				Company management		Total	
Gener.-purpose coop.		Tea agr. coop.					
No. of plant	Vol.	No. of plant	Vol.	No. of plant	Vol.	No. of plant	Vol.
22	1,458.8	178	9,729.2	35	1,733.5	6,868	46,534.3
0.3	3.1	2.6	20.9	0.5	3.8	100	100

Remark: Volume-unit-ton under number - %.

As the above tables are self-explanatory, the number of tea manufacturing plants by cooperative management and tea agricultural cooperative is yet small on the whole, but the volume of manufactured tea occupies about a half of the total. This indicates the fact that the scale of cooperative management and tea agricultural cooperative is large and their tea manufacturing capacity is also large.

2) Cooperative tea manufacturing plant

Among the joint farming operations in Japan's tea industry cooperative management there are fertilizer mixing and disease and insect control but such joint operation is comparatively few and the most cooperative operation is in tea manufacturing.

The commodity value of tea in Japan greatly differs by the way how the tea is produced, so the rational management in the course of production is regarded as very important. Recently in accompaniment with the progress in the increase of size and continuity of tea manufacturing machines their prices have hiked greatly, so to ensure the improvement and rationalization in tea manufacturing a large investment is required for the installation and the fixation thereof is required. Such a large investment is not possible by small-scaled tea farmers so there is a growing trend on the part of small-scaled farmers to get together to operate only the tea manufacturing installation jointly.

(1) Merits in joint operation in tea manufacturing

A. The plucking of tea leaf and tea manufacturing are carried out during the same period but the labor required in tea manufacturing can be supplied by cooperative members who have a surplus labor force which means that they can obtain wage income. Accordingly, member's individual management can produce an extra labor force in comparison to self-cultivating-and-self-tea-manufacturing and this saved labor force can be allocated to the expansion of his farm management.

B. The labor management of plant can be so enforced to allocate proper person to proper work which differs from hired labor in that his effort will directly be reflected on his own plant so he will be more enthusiastic in his work at the plant. And tea manufacturing technique which requires the delicacy needs not get into self-importance and the introduction of advanced technique becomes easy, and if one member acquires the technique it can be extended to others.

C. Because the labor efficiency in tea manufacturing can be greatly improved in comparison to self-cultivating-and-self-manufacturing's labor cost tea manufacturing production cost can be reduced.

D. Under the cooperative installation the cost of installation per member can be greatly reduced.

E. It is far more advantageous to purchase fuel and other raw materials jointly and the consumption volume thereof can be greatly reduced. And because the plucked volume of green leaf can be alloted to suit the plant capacity, ensuring a smooth bringing-in of green leaf into the plant, thus the installation will be fully utilized and because the plant uses fresh green leaf at all time good quality tea is insured.

(2) Conditions for the establishment of cooperative tea manufacturing plant

In the establishment of cooperative plant the following conditions must be met.

A. The members of cooperative plant shall be similar in their farm managements as a whole, particularly in various tea cultivating conditions.

B. Although the longer the plucking period of members' tea gardens the better, but there should have something in common. For instance, in case a new variety is to be introduced the variety should be unified.

C. The location of plant should be practically in the center of members' tea gardens, convenient in traffic and water use.

D. Management system and sectors of responsibility should be well defined, particularly, person-in-charge of management should be selected from among the well-qualified members.

E. Smooth plant operation must be ensured under the rational allotment of green leaf supply, and in order to ensure a good quality tea leaf the grading of green leaf brought to plant shall be enforced by all means.

F. Plant labor force shall be provided by members and labor efficiency can be improved by posting a right member at right place.

G. Various accounting book must be kept in order, always making the revenues and expenditures clear to save the expense as much as possible so that cooperative management can be absolutely trusted by members.

H. No unrest should be caused on the management infrastructure of plant by strictly carrying out the repayment of fixed asset.

I. Absolutely a safe transaction shall be the rule in marketing, and the accounting of payment for green leaf price should be made as quickly as possible and definitely.

(3) Capital for the establishment of cooperative tea manufacturing plant

As already been stated there are two types of tea manufacturing plant, comparatively a small-scaled plant with get-together of several tea farmers under voluntary agreement and tea agricultural cooperative's plant organized by many tea farmers in accordance with the rules and regulations provided for by the Agricultural Cooperative Law. Here, tea agricultural cooperative will be described.

The scale of tea manufacturing plant has usually one line of 60 kg tea manufacturing machine for 10 hectare of tea garden as standard. (one line is composed of one set of steamer, primary roller, 1 set of tea roller, 2 sets of medium roller, 2 sets of final tea roller and 1 set of tea dryer). Plant is to be equipped in accordance with the tea cultivating acreage of members.

The members are responsible for 20% of the installation cost (does not include the land). There are two ways of paying this installation cost --- equal burden by all members and the payment in accordance with tea production volume of members. 80% of capital is borrowed from the Government-connected financing institutions. At present the limit on such borrowing is ¥50 million. Those loans are of low interest (usually 5.6%) and after the non-redemption period of 2 years the loan is repaid in 5 years.

(4) Management of cooperative tea manufacturing plant

Cooperative plant manufactures tea using green leaf produced by members' tea gardens and markets the product. From this marketed money all necessary expenditures for plant operation are substracted and the balance is returned to members.

That is, in the return of net profit to members the distribution is made in accordance with the grade and production of green leaf of member. For a reference, various expenses and payment for finished tea and payment for green leaf per 10 kg of 5 plants operated by tea agricultural cooperatives in 1971 is as shown hereunder. The unit is yen/10 kg.

Fluctuating expense	Raw materials costs	5,251	Tea-manuf'g D=A+B	6,276
	Fuels	123	Net processing E=D-C	1,021
	Other materials	5	Tea price F	6,705
	Labor	363	Business profit G=F-D	429
	Wage	38	Against tea price green leaf reduction rate C/F %	78.3
	Sub-total	5,780		
	By-products	1	Against tea price net processing cost rate C/F %	15.2
	Total A	5,779		
Fixed expense	Welfare	34	Remark: Fluctuating expense is the expense which increases when the production increases. Fixed expense is the expense which does not increase even when the production increases.	
	Building	54		
	Processing mach. & equip.	193		
	Miscellaneous	20		
	Interest on capital	169		
	Land rent	16		
	Tax and impost	11		
	Total B	497		

The above is the outline of tea agricultural cooperative of Japan. And such cooperative movement in tea industry is being promoted by farmers' self-consciousness and under the policy of the State. Although, it is not conceivable that Iran can directly introduce such system of tea agricultural cooperative as practiced in Japan but we do believe that some form of agricultural cooperative can be introduced in Iran by the guidance of the Government.

6. Possibility of Introducing Japan's Agriculture Loss Compensation System into Iran

Agricultural loss compensation system of Japan can be summarized very briefly as follows: Disasters are frequent in Japan because of her geographical position and climate. As the agricultural production is controlled in large measure by natural conditions, farmers are constantly threatened by disaster damage. Salient feature of Japan's agriculture is its small-scaledness, each farmer's holding being around one hectare. Thus, financial status of farmer to resist against disaster is weak. How to prevent natural disaster damage and how to relieve farmers who sustained damage have always been one of the most important agricultural policies of the country.

Summary of Agricultural Loss Compensation System by Mr. T. Washida (Deputy Chief, Agricultural Insurance Division, Economic Affairs Bureau, Ministry of Agriculture and Forestry) is as follows.

Summary of Agricultural Loss Compensation System

T. Washida
Deputy Chief

Agricultural Insurance Division
Economic Affairs Bureau
Ministry of Agriculture and Forestry

October 30, 1970

In general, our daily lives and business are always threatened by risk. Above all, disaster in farm management is most prevalent, because agriculture is always under the influence of nature. Therefore, from the view point of the national economy, effective and reasonable policies should be taken for respective farm business to meet risks.

Many people who suffer from the same risks contribute funds in accordance with the probability of risk, and pooled financial resources are used to compensate loss suffered by people who have actually faced disaster.

This is insurance. The extension of this system to farm management is desirable. However, it is not easy to carry out due to the special nature of agricultural disasters. Therefore, the establishment of enterprises for insurance is difficult. Hereupon, it is essential for the government and public corporations to give financial assistance in order to operate this system.

From this view of point, "The Agricultural Loss Compensation Law" was established in 1947, and it referred to rice, wheat, barley, cocoons cattle, horses and hogs.

Before the Second World War, some insurance systems were in operation, but this new law was established by consolidating various insurance systems. Moreover, "The Fruit Insurance Temporary Measure Law" was promulgated in 1967 and for 5 years from 1968 (fiscal year) the "Loss Compensation Law" is being applied as a test case for mandarin oranges, summer oranges, apples, pears, grapes and peaches, the summary is as follows:

1. The Practical Organization of Business

The agricultural loss compensation system is carried out by dispersing the risk among many farmers through the application of their insurance system.

The dispersion of risk is carried out in three steps. Namely, it extends from small units, such as city, town, etc. to larger units, such as prefectures and the nation.

1) The first step of the dispersion of risk is carried out principally in city, town and village units. The operators of this business are the agricultural mutual relief associations.

Sometimes city, town and villages carry it out by themselves (the number of agricultural mutual relief association was 2,037, city, town and village 1,165 as of Apr., 1970). The sphere is the administration of the agricultural mutual relief association is principally the city, town and villages itself and it is organized by farmers living in each community who engage in the cultivation of rice, wheat and barley.

Farmers can be a member of these associations as long as their managing scale is above the under mentioned scale.

2) The second step of the dispersion of risk is carried out in the prefectural unit. One agricultural mutual relief association federation which is in charge of the dispersion of risk is established in each of the 46 prefectures, and all associations and city, town, and villages with operating mutual relief businesses become the members of this federation.

3) As the final step, the government establishes a special account to disperse risks on a nationwide scale and the insurance responsibility of the federation is insured again (voluntary mutual relief is not insured again).

2. Explanation of the Mutual Relief System

The agricultural loss compensation system has four kinds of mutual relief, namely, for crops, sericulture, livestock and voluntary insurance.

The former three are compulsory business for city, town, villages, associations and farmers, therefore, it is called "Necessary relief insurance which is carried out compulsorily". However, on the other hand, great financial support has been established for it.

The detailed explanation for each business are as follows:

1) Mutual relief for crops

(1) Object for relief

Rice, wheat and barley.

(2) Method of application

As a rule, the cultivators of paddy rice, wheat, barley, upland rice whose cultivating acreage of each

crop is over a certain standard (The prefectural governor decides on the scale of 10 to 30 ares, but the standdard for Hokkaido is bigger than for the main island) are compeled to insure, and cultivators under the standard are not compeled.

(3) Payment of mutual relief money

Compared with that of the normal year in case of decrease in production caused by natural damages or damages by disease, insects or birds which occurred during the time from planting to harvesting (estimated by cultivated land units) mutual relief money is paid for that part exceeding 30% of the damage 20% for 50 decrease, 70% for complete loss.

The harvesting conditions or degree of damage to the harvest is examined and the amount of relief money is decided on the bases of the above-mentioned three steps.

2) Mutual relief for cocoons and silkworms

(1) Object for relief

Cocoons

(2) The method of application to cocoons is divided into spring and summer and autumn cocoons.

As a rule, the sericultural farmers whose operation scale of one of these two is over a certain standard (The prefectural governor decides on the category of 10,000 - 40,000 silkworm eggs) are compeled to apply and the farmers under this standard are not compelled.

(3) Payment of mutual relief money

When the decrease in cocoon production is 30% or more caused by natural damages, disease or insects which occur during the time from the mulberry sprouting season to the cocoon gathering reason (estimated by farm management, compared with that of the normal year, that part exceeding 30% in damage is the object for payment. The degree of decrease in cocoon production is decided upon after examination on the bases of the above mentioned three steps.

3) Mutual relief for domestic animals

(1) Objects for relief

Cattle, horses and swine (the age of domestic animals for relief is decided respectively).

(2) Method of application

Contracts are established between farmers and associations or cities, towns and villages which carry out mutual relief work.

In many cases, farmers who raise cattle or horses are compelled to apply for contracts.

(3) Payment of mutual relief money

In case of death or condemnation of insured livestock, mutual relief money is paid in accordance with the cost of livestock and the rate of insurance.

In case of disease or injury to insured livestock, mutual relief money which is equal to medical expenses is paid up to a certain amount.

4) Voluntary mutual relief business

The number of object for voluntary relief is great and its system is various. In a business, which is being operated, the building is generally designated as the object for insurance, and this system is the same as with general fire insurance. Moreover, agricultural machinery implements and hogs are insured above a certain scale.

3. Method of National Subsidy

Various restrains are imposed upon the compulsory mutual relief out of the political necessity. On the other hand, the above mentioned various subsidy policies are established.

1) Delivery of financial funds

The delivery of financial funds is carried out in various ways and the main types are the following two.

(1) National liability for mutual relief premiums

The national treasury is liable for a part of the premiums which farmers should pay. According to recent actual results, the amount of the national liability for crops was 62.2% of the premiums and 26,080 million yen is included in the budget for the 1970 fiscal year.

(2) National liability for office operation expenses

The office operation expenses spent by association, city, town and village and federations on which operate mutual relief is liabled by the national treasury and 13,216 million yen is included in the budget for the 1970 fiscal year.

2) Special treatment accorded on taxation

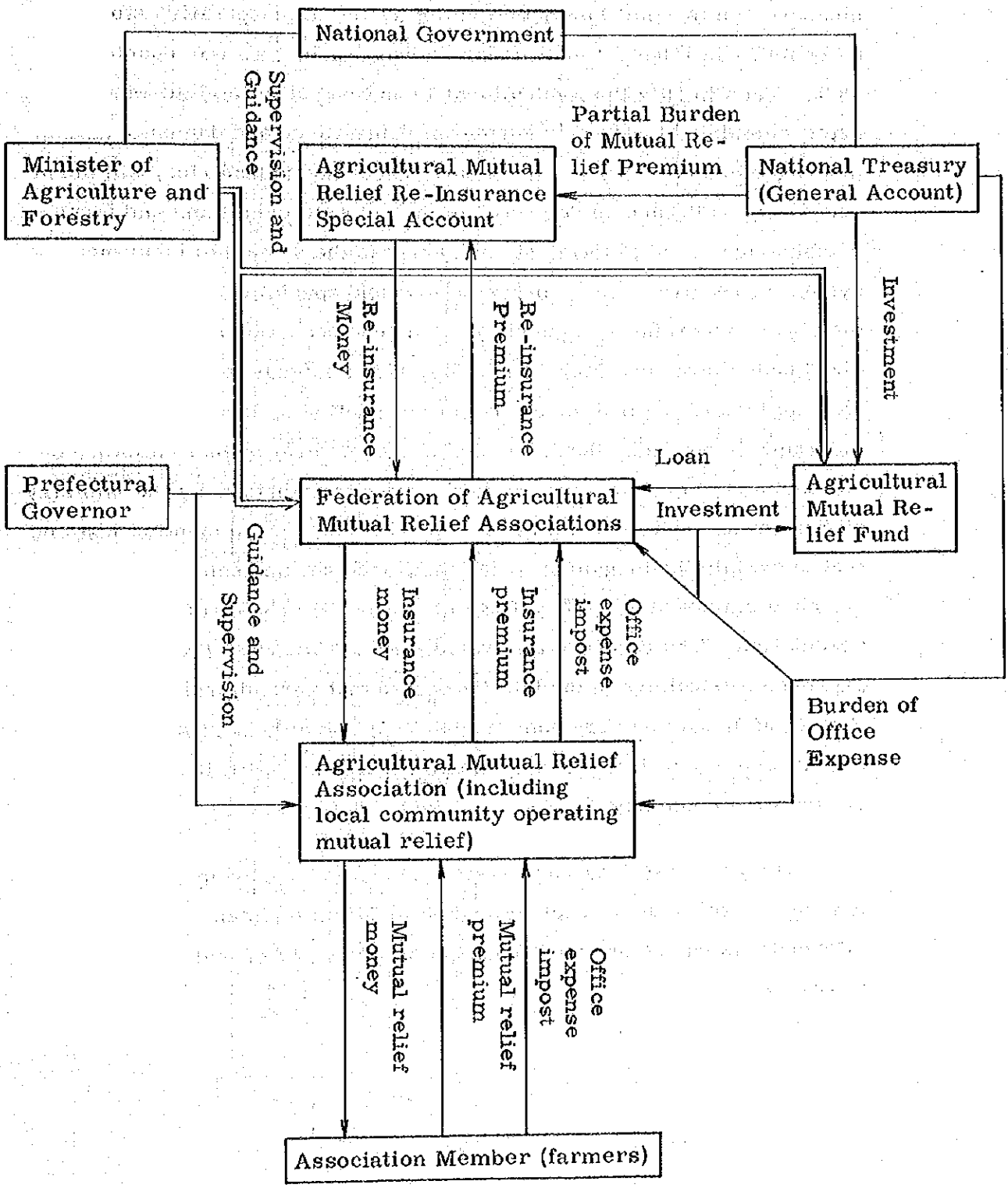
Special treatment for various taxation on stamps is accorded out of public interest.

3) Special financing system

The agricultural mutual relief fund was established by the federation in 1952 as a financing organ. The fund lends money to a federation which is a member of the fund when that federation suffers from a shortage of insurance money.

At present the government finances the fund to the amount of 1, 800 million yen which half of the total investment.

Organizations of the Agricultural Loss Compensation System



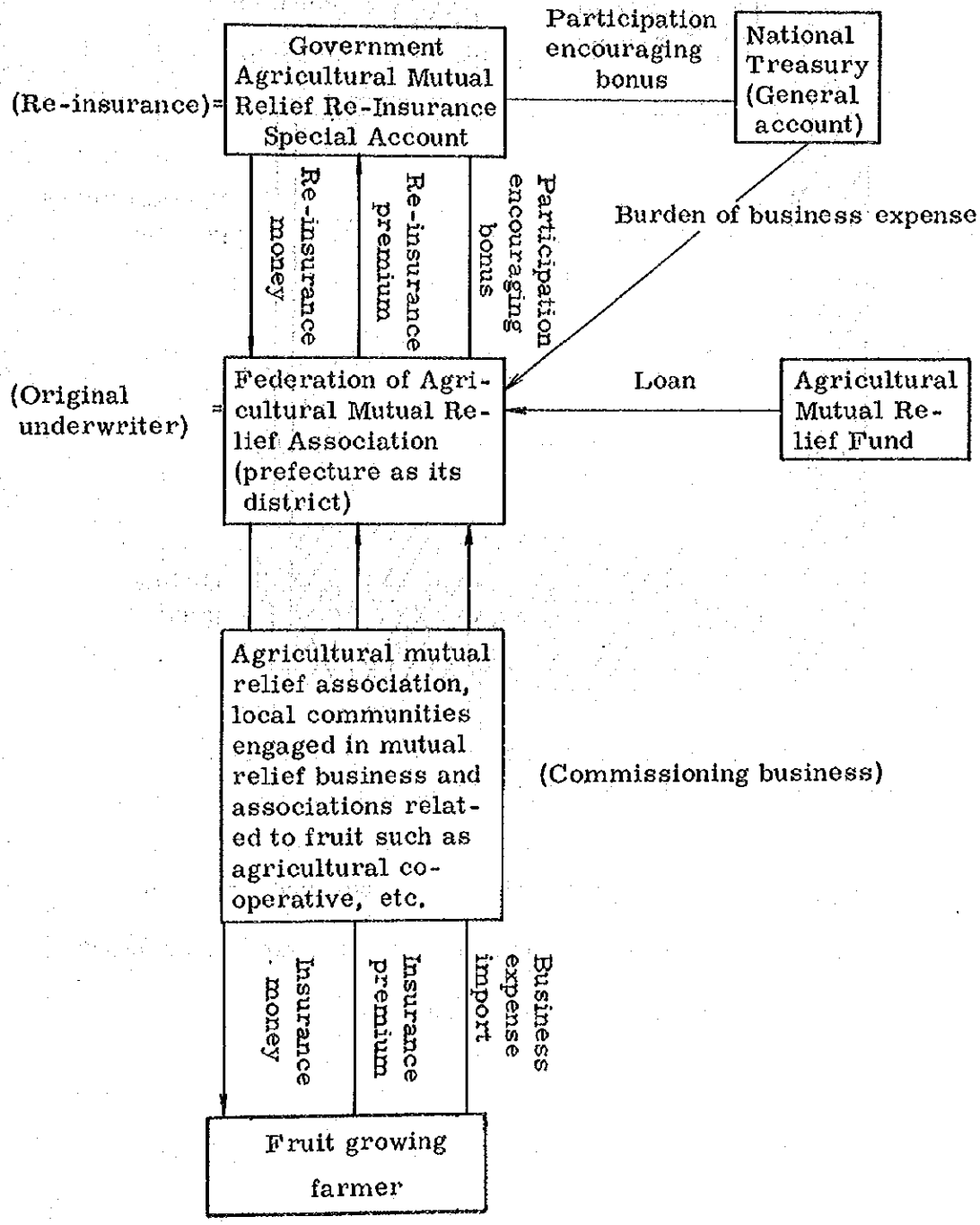
History of insurance system as agriculture damage counter-measure can be traced to mutual relief system of cooperative storage by farmers in 1900s. The Agricultural Insurance Law was enacted in 1939. Then in 1947 the Agricultural Loss Compensation Law was enacted combining the former agricultural insurance and domestic animal insurance and covering wheat, barley, paddy and upland rice, silkworm and cocoon, all kinds of domestic animal as well as building and farm machineries. And to formulate and harness the same into insurance system is requires a large organizations and special method to disperse the risk. Accordingly, agricultural loss compensation system is organized under three echelons: basically, it is a mutual relief business carried out by agricultural mutual relief association or local community then insurance business by the federation of agricultural mutual relief associations and the reinsurance by the Government, that is, by the Ministry of Agriculture and Forestry at the top echelon. Just to mention just one fact to explain the magnitude of the insurance set-up, some 22,000 persons are employed at 4,777 offices at the lowest echelon of mutual relief association. The report of the World Bank's Mission to Investigate Japanese Agriculture in the late '60 stated that agricultural insurance system of Japan is a very complicated one, and although its set-up and operation are well defined by laws and regulations, still it is a task to ensure its smooth functioning.

The fruit tree insurance system is stated here as an example but it is far, insufficient to explain a whole insurance system. Necessary informations can be obtained from the Ministry of Agriculture and Forestry.

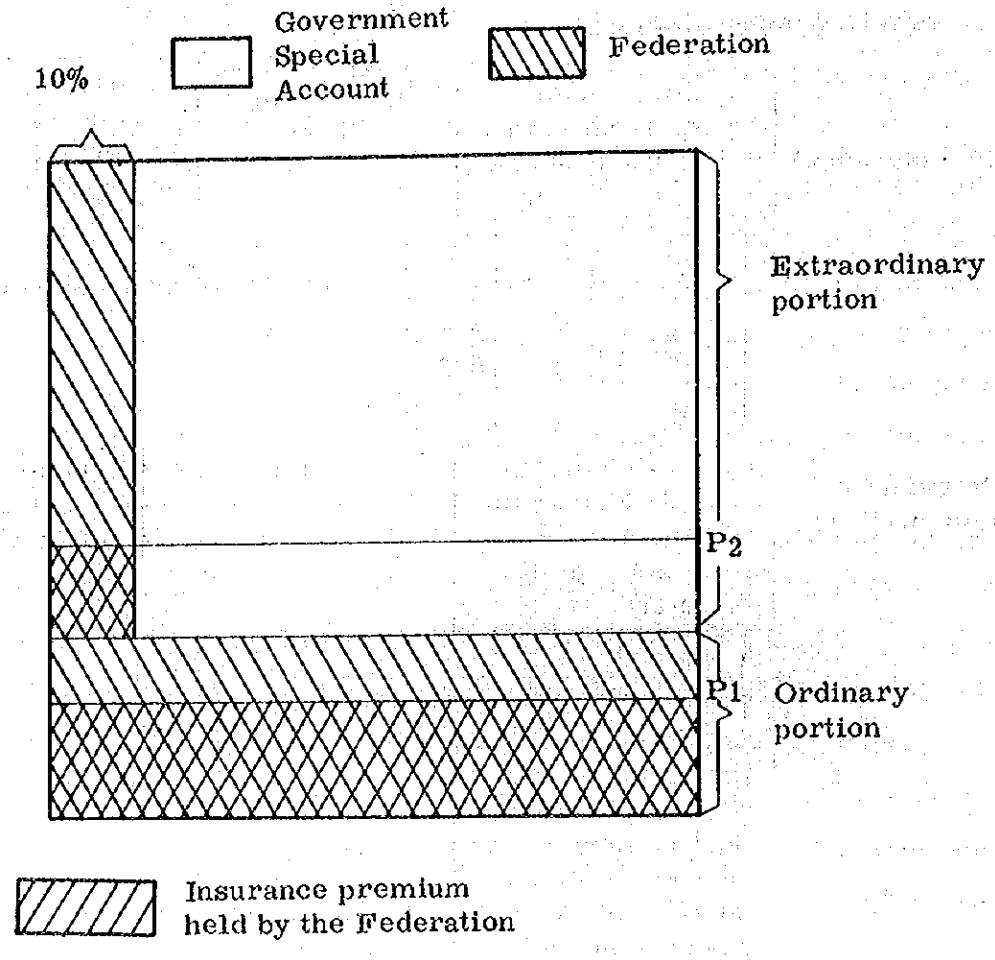
Outline of fruit and fruit-tree insurance

(Fruit and Fruit-Tree Insurance Temporary Law, enacted in 1967 for the purpose of experiment)

1. Operating mechanism



2. Sharing of responsibility



P_1 : Ordinary standard rate of insurance premium

P_2 : Extraordinary standard rate of insurance premium

q : Ordinary standard damage rate

3. Kinds of Fruit (the objects of insurance)

The objects in this insurance are fruit-bearing trees of Unshu Orange, Summer Orange, Apple, Grape, Pear and Peach.

4. Kinds of disaster (the objects of insurance)

Kinds of damage for which the insurance money is paid are as follows:

1) Damages from wind, flood, draught, cold, snow and other meteorological reasons (including earthquake and eruption).

2) Disease damage designated by the Ministry of Agriculture and Forestry.

3) Damage from wind birds and animals.

4) Fire

5. Kinds of insurance and the contents

The insurance is classified into 'Crop insurance' with damage to fruit as object and 'Tree insurance' with damage to tree as object. The formula and content thereof are as follows: and of which insurance to be underwritten is decided by the Federation.

Kinds of insurance		Content
Crop insurance	A - 1	Insurance in which insurance money is paid when the damage from decrease in fruit harvest is over 30%.
	A - 2	Insurance in which insurance money is paid when the damage from decrease in fruit harvest or decline in fruit quality is over 30%.

Kinds of insurance		Content
Crop insurance	B - 1	Insurance in which insurance money is paid when the damage from decrease in fruit harvest is over 50%.
		Insurance in which insurance money is paid when the damage from decrease or decline in fruit quality is over 50%.
Tree insurance		Insurance in which insurance money is paid when the damage occurs to tree by withering, washed out or partially lost.

The participation in three insurance is possible in case the participation in crop insurance is established.

6. Insurance period

1) Crop insurance ----- for about 1.5 year from bud-formation period (for Unshu orange and Summer orange, from the time when spring branch stop growing) to harvest time.

2) Tree insurance ----- One year from bud-formation period (for Mandarin orange and Summer orange, from the said time).

7. Formula for determining insurance benefit in this insurance shall be as follows:

1) In crop insurance, insurance benefit is computed based upon expected fruit harvest of participating farmer and upon the amount of 40 - 60% of recent average-on-the-field price of the district concerned.

2) In tree insurance, insurance benefit is for the time being determined within twice of the insurance benefit of crop insurance of participating farmer.

8. Insurance premium

Insurance premium is paid at the time of participation by 1/3 and the rest is to be paid at the time to be determined by the Federation.

As to the amount of premium, Insurance premium = Insurance benefit x premium rate.

9. Payment of insurance money

Insurance money is determined under the following formula:

1) Crop insurance

Insurance money = Insured benefit x insurance money payment rate (%)

Insurance money payment rate (in case the damage rate is more than 30% and less than 50%) = damage rate (%) x 1.4 - 40.

Following table shows the insurance money payment rate by damage rate by actual example.

Damage rate (%)	35	45	55	65	75	85	95	100
Insurance money payment rate (%)	15	25	37	51	65	79	93	100

2) Tree insurance

Insurance money = Insured benefit x damage rate (%)

To further elaborate fruit tree mutual relief insurance, one example of Shizuoka prefecture is as follows; Standard yield revenue money by each tree is computed and the amount obtained by multiplying 60% of that money by conversion coefficient concerned with tree age is set as mutual relief money. Conversion coefficient by tree age is as shown hereunder, but applicable only to 'Unshu orange'.

Tree age	Conversion coefficients	Tree age	Conversion coefficients
- 5 yrs.	2.9	36 - 40 yrs.	2.3
6 - 10 "	3.6	41 - 45 "	2.1
11 - 15 "	2.9	46 - 50 "	1.7
16 - 20 "	2.7	51 - 55 "	1.2
21 - 25 "	2.6	over 56 "	0.6
26 - 35 "	2.5		

The insurance premium paid by farmer is 5% of the mutual relief money per annum.

At present no insurance system is adopted on tea tree. However, in case of a great damage from natural calamity the provisions of the 'Law concerning the Loaning of Credit to Farmers, Fishermen and Forestry-men for the Damage caused by Natural Calamity' (so-called 'Natural Calamity Financing Law') applies to tea garden. For instance, in the case of a great damage to first tea crop by frost in 1972, the said Law was applied, and the total of ¥250 million have been loaned to tea farmers. The limit on credit was ¥44,000 at that time with repayment period of 3 - 6 years and the interest rate varying in accordance with the degree of damage, 3%, 5.5% and 6.5%.

7. Possibility of Storing Green Tea Leaf under Nitrogen Gas

Many researches have been made on the storage of green tea leaf. From the findings it has been clarified that in the storage of green leaf the temperature of green leaf must be reduced and the maintenance of high moisture are the most rational and economical. From these findings the improvement of green leaf storage house has been carried out at tea manufacturing plant, at the same time, a large volume storage installation based on air ventilation system has been developed (floor space of m^2 per 100 kg of green leaf) and is now being put into practical use.

There has also been a research on the storage of green leaf under nitrogen gas. That is, from the experimental result of controlled-atmosphere-storage-method, as shown in separate paper, in a plot of low oxygen with large nitrogen gas after one week of storage a great quality deterioration is witnessed already accompanied by a strong acidification odor and water-colored percolation turns red. Such a transmutation of green leaf is believed to have been produced by low-grade fatty acid and alcohol by non-respiration, and as the result thereof acidification odor is produced. Accordingly, it can be safely stated that the use of nitrogen gas in green leaf storage should be avoided.

However, after processing green leaf into green tea, then store it under nitrogen gas is effective, and the method is in practical use in Japan. As for the research finding on nitrogen-gas-storage of green tea is shown under separate paper. We do hope the same will be of some use.

In the case of black tea because maturing period is required after the manufacturing it is believed that a further study should be made on the storage by use-purpose, not by use-method as in green tea storage of Japan.

8. Conclusion

We have inspected the state of tea industry of Iran. After hearing various matters from persons in tea industry we were able to practically comprehend where are the problems, and we have compiled this report to the best of our ability within the limit of our knowledge. However, because our knowledge might have been insufficient our opinion might have been wrong and if there is any such a case we beg their pardon. With respect to the establishment of tea agricultural cooperative and agricultural loss compensation system our explanation is we believe, is far insufficient. We request that officials concerned in Iran will contact the specialists on those points.

At any rate we feel honored to have had the opportunity to talk intimately with many responsible persons concerned with tea industry in Iran and if our investigation contributes even in a very small measure to promote the technical cooperation between our two countries, not only in the field of tea industry but in all phases of agriculture as well as in many other sectors we feel we have accomplished our mission.

Again each of us wishes to thank all those persons we met in Iran for their kind assistance and cooperation. And we do sincerely hope that Iran's tea industry will develop more than ever.

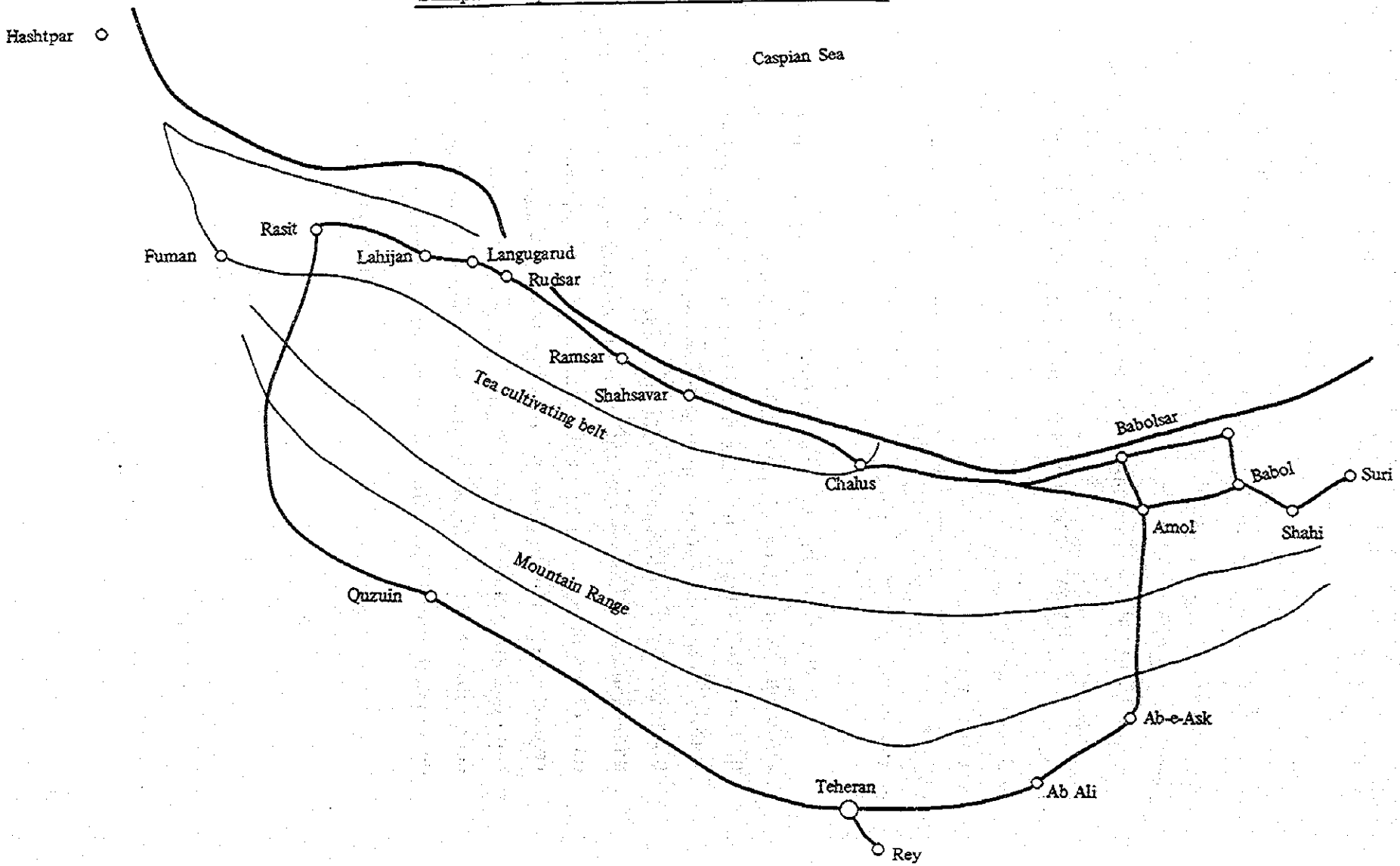
Controlled Atmosphere Storage of Plucked Tea Leaves

TADAKAZU TAKEO and YOSHITAKE KATO

Plucked tea leaves were stored for 15 - 21 days at 2 - 5°C in the atmosphere of nitrogen with combinations of 2, 5, 10 and 21% O_2, and 0, 5 and 10% CO_2. The tea leaves from 5 - 10% O_2 and 5% CO_2 levels retained the best overall quality throughout this CA storage test. From tea leaves stored in this CA condition for ten days, was observed. The decrease of oxygen concentration in the atmosphere depressed oxygen uptake of tea leaves and caused the increase of respiratory quotient (RQ) remarkably. The tea leaves from the 2% O_2 atmosphere developed the bad odor after the storage of 7 days. In an atmosphere of high CO_2 concentration (10%), no injury of the stored leaves was observed but the decomposition of ascorbic acid in the leaves was accelerated.

(Received July 6, 1970)

Simple map of IRAN's tea cultivating belt



Inert Gas Packaging of Tea

By KOZO FURUYA

Head, Tea Technology Division, Tea Research Station

As a method of keeping the quality of packed foods from changing, replacement of the head space gas in a package by an inert gas is widely utilized for dry foods. This method of packaging is very effective in case some oxidation-prone ingredients are contained in the foods, especially when the head space is large, or the bulk density is small.

Inert gas packaging is remarkably effective in case of tea for keeping the aroma, taste and color of liquor, and for preventing oxidation of ascorbic acid, because tea contains catechins, factors to produce aroma and astringent taste, and ascorbic acid, a hygienic factor, all of which are oxidation-prone ingredients greatly influencing its quality, and in addition, the head space is large. Therefore, inert gas packaging is now widely used for tea packaging, chiefly for green tea of high quality.

Materials for packaging

It is a matter, of course, that gas impermeability is the most important condition for the materials of inert gas packaging. In case of tea packaging, metallic cans are mainly used at present. Although the quality of cans is not the problem, they are too expensive and therefore plastic films have come to be used for packaging materials.

Some plastic films are excellent in gas impermeability, but none is found to have complete properties for a gas barrier when used alone. Some of the laminated films with aluminum foil, however, are nearly complete in gas impermeability, and this kind of materials will probably become the chief materials for packaging in future to replace metallic cans.

Table 1 shows the results[1] of a survey on the time variation of oxygen percentage of the head space gas in nitrogen gas packaging in case of flexible packaging. As indicated in this table, almost no changes are seen in the oxygen content in case of No. 3, the material using aluminum foil, in lamination. Therefore, it is considered to be sufficiently usable.

It must be noticed here that the aluminum foil of about 0.012 mm. thick has moisture permeability of 0.6~5.0 g/m²/24 hrs.,[2] and

Table 1. Oxygen per cent of head space gas

Film No.	Storage Time		
	1 week	2 weeks	3 weeks
	%	%	%
1	19.7	20.6	23.9
2	4.4	15.9	19.8
3	2.1	1.0	2.2

Score is average of three replications. Original Oxygen percentage is 2.5% (measured by gaschromatography)

Combination of films are as follows:

No. 1.... Paper (65 g/m²) · Polyvinylidene chloride coating (5 times 34 g/m²).

No. 2.... Cellophane (300 #) · Polyethylene (0.015 mm) · Paper (?) · Polyethylene (0.02 mm) · Polyvinylidene chloride coating (?)

No. 3.... Cellophane (0.022 mm) · Polyethylene (0.03 mm) · Aluminum foil (0.012 mm) · Polyethylene (0.045 mm).

there must be a considerable number of pinholes, so its gas impermeability is not so good when it is used alone.

In spite of that, aluminum foil can have a high gas impermeability when it is coated with laminated plastics. Plastic films alone have also little gas impermeability as clearly shown by Nos. 1 and 2 in Table 1.

In addition to the gas barrier properties mentioned above, film packagings have their respective properties such as heat sealability, printability, moisture permeability and physical strength. By combining these properties properly, we can obtain excellent materials for packaging.[3]

Among the laminated materials which are usable for inert gas packaging within the range of our experiments, a combination of polypropylene (or cellophane), polyethylene, aluminum foil and polyethylene are recognized to be the most simple combinated materials and to have properties almost satisfactory for various requirements. The aluminum foil in the above stated combination is 0.007 mm thick and has shown satisfactory gas impermeability.

Method of gas replacement

In the gas replacement of small-sized packages, a method of evacuating air with vacuum to be replaced by an inert gas is chiefly employed at present. In this method, the replacement percentage is naturally different according to the vacuum rate in evacuating air.

Even when nitrogen gas with a high purity of 99.9% is replaced by making the vacuum rate of the vacuum box about 10 mm Hg, oxygen is still detected to be about 2 per cent. In case a higher percentage of gas replacement is required, it is better to use a method of repeating the work of evacuation and gas replacement than to make vacuum rate higher.

In case of large-sized packages, the method of evacuating air with vacuum is inconvenient because a large vacuum box must be prepared. Consequently, a method of injecting an inert gas is being studied.[4] By making use of this method, an experiment was made on tea, and its results indicate that it is impossible to do gas replacement sufficiently in short hours, and an increase of oxygen is detected in the head space gas 2 to 3 days after the gas is replaced.

Such events are also seen in case of powder dry milk, and it is believed to be due to the gas contained in the granules which remains unreplaced and is gradually diffused.[4] It can be also considered in case of tea that some part of the space within the curled tea leaves is left without gas replacement. It is necessary, therefore, to repeat the work of gas replacement again several days after.

In addition to the methods described above, a method of filling up and packaging in a streaming of inert gas has been studied for flexible packaging.[3]

Effect of gas packaging

The quality of tea is decided by an organoleptic test on five items, color and style which can be visually felt with non-infused tea, and aroma, taste and liquor. Among these five items, all except style are usually changed in quality and deteriorated during storage.

The most important factor for changing the quality of tea is oxidation by the oxygen in the air during storage, and it is clear that the moisture content and the storing temperature have a great influence upon oxidation speed. The oxygen content in the head space gas also has a considerable effect on oxidation speed.

According to the result of an experiment on the effect of these storing conditions upon change of quality, which was carried out under

Table 2. Factors and levels

Factors	Levels			
	1	2	3	4
Moisture content (W) %	3.2	6.7		
Storing temp. (T) °C	5	25		
Residual Oxygen (O) %	1.3	5.2	9.4	21.0
Storing time (M) month	2	4		
Blocks (B)	1	2	3	4

Table 3. Table of L_{32} Orthogonal arrays

Array No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Array label	a	b	a b	c	a c	b c	a b c e	d	a d	b d	a b d	c d	a c d	b c d	a b c d	e
Factors	B^1	B^2	B^3	T	O^1 W	O^2 M	e	O^3	T W	e	e	T O^1	W	O^3 M	e	O^2

Array No.	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Array label	a e	b e	a b e	c e	a c e	b c e	a b c	d e	a d e	b d e	a b d e	c d e	a c d e	b c d e	a b c d
Factors	W T O^1	T M	e	T O^2	O^3 W	M	e	O^1	W T O^2	e	W M	O^3 T	W O^2	O^1 M	e

Table 4. Scale categories assigned in this test

Score	Item
7	Moderately well
6	Slightly well
5	Same with standard
4	Slightly poor
3	Poor
2	Very poor
1	Extremely poor

Standard Samples are stored at temp. of --20°C and packaged in nitrogen atmosphere with 1.3% oxygen during the experiment period.

the program shown in Tables 2, 3, and 4,[5] the effect of temperature and moisture content covers all the items, color, aroma, liquor, taste and ascorbic acid content, and the effect of oxygen content is seen on the items except color, as shown by the analysis of variance in Table 5.

When an analysis is made on the above result from the viewpoint of the effect of oxygen content in the head space gas, an interaction is recognized between storing temperature and oxygen content regarding the liquor. When a study is further made on the changes of reductive ascorbic acid which shows oxidation phenomena most clearly, there is seen an interaction between two factors, the storing temperature and moisture content, and the oxygen content, and at the same time an interaction between the three factors mentioned above is also recognized.

A further study on the above result indicates, as given in Fig. 1, that there is no difference in effect of the storing temperature level and degree of the moisture content within the ranges of 5°C~25°C in storing temperature and 3.2%~6.7% in moisture content when the oxygen content in the head space gas is about 1%, and when oxygen content has become about 5%, a large effect of the moisture and the temperature can be detected. It is also recognized that complete preservation of quality is difficult when the oxygen content grows more than 10% even in low temperature and low moisture.

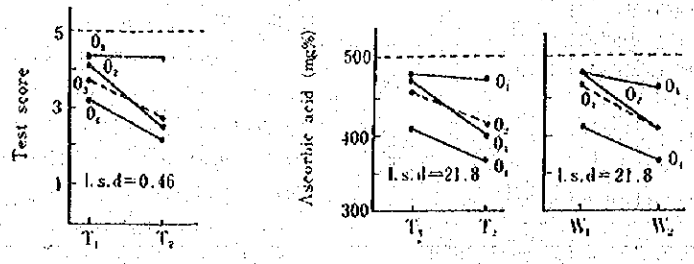
As already described, it is clear that a high efficiency in keeping the quality of tea can be obtained by replacing the oxygen in the head space gas with an inert gas as one of the storing conditions of tea, and that the differences of oxygen content after the gas replacement have influence on the effectiveness of other storing conditions. As for the aroma of tea, even 1% of oxygen is recognized to have some influence on it.

Accordingly further study is required on this matter in the case of still lower oxygen

Table 5. Analysis of variance among storing conditions of tea

Source of variation	Degree of freedom	Mean sum of squares				
		Color	Aroma	Liquor	Taste	Ascorbic acid content
Block (B)	3	1.375	0.458	5.031	1.708	788
Temp. (T)	1	630.125**	378.125**	175.781**	153.125**	16,069**
Moisture Content (W)	1	544.500**	392.000**	810.031**	242.000**	18,590**
Oxygen Content in Packed Atmosphere (O)	3	1.125	40.375**	88.031**	130.208**	10,672**
Stored time (M)	1	6.125	21.125	3.781	60.500	2,334**
First Order Interaction						
T × W	1	40.500**	32.000*	—	—	1,724*
T × O	3	—	—	20.948**	—	2,860**
W × O	3	—	—	—	—	1,095*
Second order Interaction						
T × W × O	2	—	—	—	—	1,122*
Error	8	2.156	5.297	1.969	6.141	179

** Significance at 1% level
* " " 5% "



Notice; $O_{1,2,3,4}$ $T_{1,2}$; $W_{1,2}$……Described in Table 2

Fig. 1. Interaction of oxygen content and other storing conditions.

content. In order to keep the aroma of tea to perfection it is necessary to make 100% removal of oxygen, or to perfectly carry out the storing conditions in low temperature and low moisture.

From the results of another experiment on the changes of aromatic ingredients of black tea,[6] it is also shown that the nitrogen gas packaging makes it possible to prevent the ingredients of tea from oxidation completely. These results are given in Table 6.

Head space within the package

When the quality of tea is changed owing to the oxygen contained in the head space gas in a package, its influence varies according to the amounts of the head space. In case of liquid foods, the head space can be made as small as possible in filling up the package, but for solid foods, there is some space left between grains even if the package is completely filled up and the amount of space is different according to the shape and bulk of respective granule, or it is generally dominated by the

Table 6. Relation between storing conditions and flavor of black tea (Peak area of gaschomatogram)

	Storing conditions							
Temperature	5°C				25°C			
Atmosphere	nitrogen		air		nitrogen		air	
Moisture content	4%	8	4	8	4	8	4	8
Acet-aldehyde								
Unknown	−	−	−	−			−−	−−
Propion aldehyde			+	+			+	+
Aceton or Iso-butyl-aldehyde								
Unknown								+
n-Valerialdehyde or n-Propanol							++	
n-Capronaldehyde			++	+++			+++	+++
Unknown							+	+
trans-2-hexenal							−−	−−

+···S×1.5 −···$\times\frac{1}{1.5}$

++···S×1.5~2.0 −−···$\times\frac{1}{1.5}\sim\frac{1}{2.0}$

+++···S×2.0

S···Standard sample stored at −20°C in nitrogen atmosphere with 4% moisture content.

bulk density.

The bulk density of tea is 0.37~0.40 g/cc in higher quality and about 0.29~0.32 g/cc in inferior quality. It is very small compared with the bulk density 0.60 g/cc of powder milk, and accordingly the head space amount is that much larger.

Since the specific gravity of tea is unknown, it is difficult to estimate a precise amount of the head space, but it is believed to be more than 50% at least.

In inert gas packaging, the effectiveness is, however, influenced by the amount of the residual oxygen in the package, and so the influence of residual oxygen must be considered from the quantitative ratio of gas and the packed foods, not from the percentage of oxygen in gas components only. These are the problems still left to be solved.

Nutritional Disorder and Feeding Standard in Cows

By TOSHIO YONEMURA

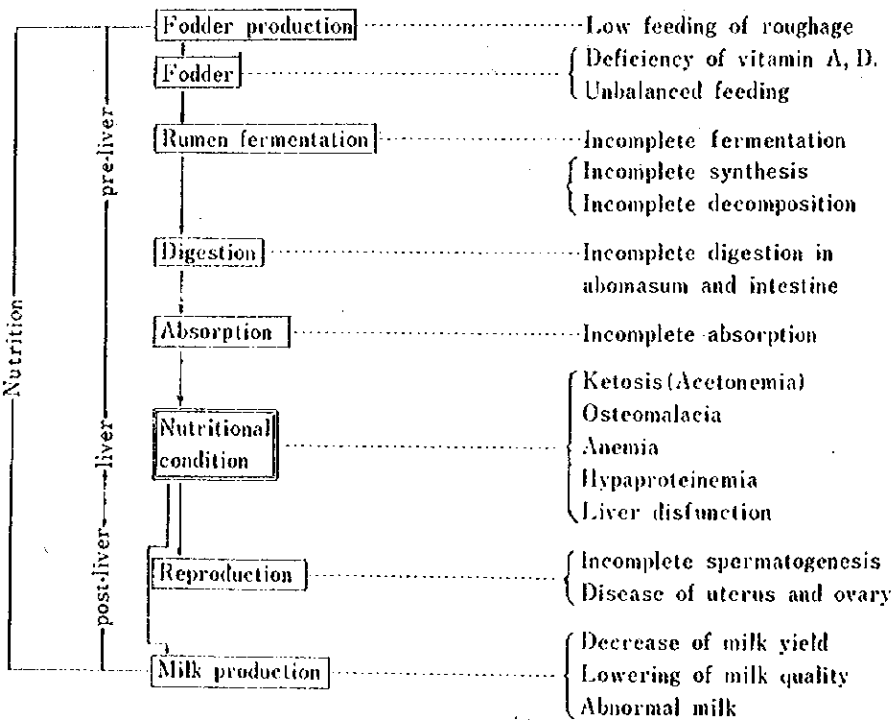
Chief, 4th Research Division, National Institute of Animal Health

The problem of nutritional disorders in cows has two sides of feeding and animal as seen in Table 1 and the various causes of the disorders are complicated. In this paper, the problem will be limited in considering feeding, especially feeding based on its standard in describing the relation existing between feeding and the nutritional disorder in cows.

As to the feeding standard in cows, those of NRC, Morrison, Kellner, Woodman and Hansson are cited as representative ones. However, there is practically no report on the problem of what are the changes or disorders induced in cows fed on a diet superfluous or deficient in the amount of DCP and TDN as compared with those standards.

It is said that the nutritional condition of cows is related to their useful life, reproduction and milk yield. However, the excess of

Table 1. Points problems of nutritional disorder in cows



Report of the Survey on the Feasibility of Establishment

of

Fish Production Industry

in Agricultural Cooperatives

in Iran

January, 1974

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Mr. Takeichiro KAFUKU, Dr.
Mr. Kunisuke MUTA

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1. December 11 1973, Rudpish Farm Corporation (F. C.)
2. December 11 1973, Fuman F. C.
3. December 12 1973, Sefid Rud Agro-Industry Station, Ministry of Defense
4. December 12 1973, Northern Fisheries Cooperation
5. December 12 1973, Biological Research Laboratory, Northern Fisheries Cooperation
6. December 12 1973, Ab Kenar Rural Cooperatives (R. C.)
7. December 13 1973, Lashe Rural Production Cooperatives (R. P. C.)
8. December 13 1973, Sefid Rud Carp Research Laboratory, Northern Fisheries Cooperation
9. December 14 1973, Semeskandeh F. C.
10. December 14 1973, Panbe Chule R. C.
11. December 14 1973, Akand R. C.
12. December 16 1973, Garmsar F. C.
13. December 16 1973, Adl abad R. C.
14. December 18 1973, Karzin F. C.
15. December 18 1973, Ghir F. C.
16. December 18 1973, Afzar F. C.
17. December 20 1973, Fahlian R. P. C.
18. December 20 1973, Deh No R. P. C.
19. December 21 1973, Dariush Kabir F. C.
20. December 21 1973, Band amir R. C.

21. December 23 1973, Esfahanak R. P. C.
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24. December 26 1973, Dez F. C.
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26. December 26 1973, Shams Abad F. C.
27. December 26 1973, Shoosh F. C.
28. December 26 1973, Dezful F. C.
29. December 30 1973, Reza Pahlavi F. C.
30. December 30 1973, Zahab F. C.
31. December 31 1973, Ravansar F. C.

III. OUTLINE OF THE SURVEY

Several localities visited during the tour were chosen by Iranian Government in accordance with the conditions, i. e. (i) considerable supply of irrigation water, (ii) considerable development of general agriculture and (iii) existence of leading regime in agricultural activity by either of Rural Cooperative, Farm Corporation or Rural Production Cooperative. The survey was carried out on such a base that is considering (i) conditions of water, weather and topography, (ii) availability of suitable fish feeds from agricultural by-products or wastes, and (iii) how to get seed fish. So that the kind of fish to be cultured or released into natural water body ("fish propagation") and the type of fish culture could be studied.

Followings are outline of the survey:-

1. Topography of area in connection with water supply:
2. Quantity of available water and its seasonal change:
3. Quality of water, i. e. temperature, pH, density, transparency, colour and others:

Some of other important items, i. e. oxygen content and salinity could not be examined. Maximum summer water temperature which sometimes affects the conditions of fish could only be estimated from summer air temperature except for some localities where the summer data were available.

4. Availability of fish culture feeds:

Cyprinid fish (carp family, warm water fish) is omnivorous. Local availabilities of some of suitable feeds were studied. Output of silkworm pupa, one of best feeds for the carp in Japan, was also studied. Sometimes, cyprinid fish can be cultured only by considerable amount of plankton in pond without feeding. In this case, manure is one of the useful fertilizers to increase the quantity of plankton ("fertilized fish farming"). In this connection, availability of animal or chicken manure was inquired.

5. Conditions of agricultural insecticide:

This is sometimes fatal for fish culture. Therefore, the names of chemicals and doses were recorded especially for the areas of sugar beet. It seems that the existing effect of insecticide is not so serious. Further investigations, however, are required. The use of herbicide was not found.

6. Conditions of water pollution:

No specific evidence was found in this problem. Further investigations, however, are also required especially for the areas near to factory of beet sugar or inorganic fertilizer.

7. Wild fish fauna:

Sometimes, suitable fish species to be cultured or propagated are found among wild fishes in the country. The frequent interviewings with local residents were made in order to collect the concerning informations.

IV. RESULTS OBTAINED

1. Type of applicable fish culture

1) Paddy-cum-fish culture

Applicable area

Caspian Sea region where there are large areas of paddy:

Kind of fish to be cultured

Japanese common carp (Cyprinus carpio)

Iranian common carp (" ")

German mirror carp (" ")

Outline of paddy-cum-fish culture

This is to culture fish, especially carp together with paddy, extended in many countries including Japan, China and several South East Asian countries since some hundreds years ago. Its most of necessary techniques have been exploited. Accordingly in each region each own system of procedures which is most suitable for environmental conditions in the region has been established. The conditions in the Caspian Sea region are quite similar to those in Japan. The Japanese system, therefore, should be introduced into the region.

In Japan, this type of carp culture was destroyed since few decades ago by the remarkable development of agro-chemicals, insecti- and herbicide, which caused pollution of water. Under the circumstances, anti-agrochemical campaign took place sinc few years ago. A movement of reestablishment of paddy-cum-fish culture which is a part of the campaign is going to be launched. It is noticed that the carp in paddy basin plays the role

of agro-chemicals to some extent. The carp eats some of harmful insects and weeds, grubs the paddy basin bottom, agitates the water and excretes one of best fertilizers. Accordingly, the crop of rice never be lessened by the carp without much dose of chemicals; sometimes, it is increased.

The Japanese system is to keep the carp in paddy basin during the period when there is a water in basin, i. e. from early summer to autumn, which is the growing season of carp, warm water species. The rest, the cold season, is empty which is the resting season of carp. Accordingly, the carp is kept in deep wintering pond during the season when there is no water in paddy basin.

The followings are the growth data of the carp born in April or May and reared in paddy basin:-

Year or growth season	Age of carp	Carp size at the end of growth season	Amount of yield at the end of growth season*
first	0+	20-100 gr	200-800 kg/ha
second	I+	100-220 gr	800-1,100 kg/ha
third	II+	375-750 gr	1,100-1,800 kg/ha

(* The amount of yield which includes the initial amount of carp stocked at the beginning of rearing season, increases in accorddance with the increment of the carp size. On the other hand, the productivity, net increment of total fish weight per unit area, is constant regardless of the size or number of the carp in basin, if the carp is reared with same treatments.)

It is understandable from the data, that it takes 3 or 4 years to get marketable size of carp which is 700-1,000 gr. The rearing of large sized carp, II+ or more age carp, is too troublesome to farmers who are busy with their main business of agriculture. The large carp rearing requires some additional procedures, i.e. making the dike higher and stronger, deepening the water, and supplying considerably large amount of feed. Therefore, most of Japanese farmers try to sell out their yield of small carp at the end of the first season to the specialists in large carp rearing for seed carp. Some of paddy farmers who have no wintering pond or who do not like to meet with high mortality of carp in wintering pond must sell out all of their yield of 0+ age carp. The specialists who bought the seed carp from paddy farmers grow up the seed into the marketable size during the following season in ponds with much feeding.

As mentioned above, the paddy-cum-carp culture is a side business of paddy farmer, as there is a large demand of seed carp. At the same time, it is also true that some of small sized carp are consumed by farmers themselves for food. And also some farmers prepare some parts of their paddy field ready and rear the large carp for their own food. Then, in the South East Asian countries, there is not such a large demand of seed fish. And the people do not rear such large fish in paddy basin. They consume their yield of small fish for their food. In China, 10% of vast area of paddy field is exploited for this type of fish culture.

In Japan, carp culturists are specialized in some of different fields, i.e. fry making, seed carp making and food carp making. In this sense, the Caspian Sea region may be specialized in seed carp rearing. It is perhaps possible, however, that the total supply from the region exceeds the total demand of seed carp in

the country sometime in future. In this case, what which is the best is encouraging the people to consume small carp more for their food. At the same time, the small carp may be made into fish meal for feed of valuable fish or domestic fowls. Accordingly, it seems that this type of carp culture industry is worth to be established in the region in time before the water might be polluted.

2) Man-made pond carp culture

Applicable area

As far as the areas visited are concerned, the particular areas where this type of carp culture is definitely impossible to do have not been found, except Dariush Kabir area where the water temperature is too low to carp. For the Caspian Sea region which is the area of seed carp rearing in paddy field, this type of carp culture in pond also should be introduced. Accordingly, the distribution of the carp culture industry in future is concentrated densely in the Caspian Sea region and scattered in several places in the central and southern parts, which is nearly a copy of water distribution map.

Kind of carp to be cultured

Japanese common carp

Iranian common carp

German mirror carp

Outline of man-made pond carp culture

Any kind of irrigation water, i. e. river, spring, well or qanat is used. Drain water from arable, which is worse in quality and quantity than irrigation water is not used. Optimum

water temperature is 15 - 30°C for the appetite of Japanese carp. The area of a carp pond is from 6 to 30 ares. The water conditions in smaller pond are easier to be controled. If the water in larger pond is kept once in good conditions, it is more stable than that in smaller pond. The pond shape is oblong, long octagon or long oval, about 1.2 m water depth. Several ponds compose a carp farm in each spot. For easy management, ponds are close together as far as topography allows. Each pond receives new headwater but not used water from other pond. Sometimes, if it is necessary, reservoir is installed between headwater and ponds in order to meet drought and quick refilling the the ponds in routine maintenance. Drain water from fish pond is used for irrigation.

Fundamentally, the pond water is stagnant, as the stagnant water pond is constructed quite easier than that of running water. Topography or quantity of available water does not allow to construct latter in many cases. For the former, on the other hand, it is always possible to make if there is some of water.

The principal problem in this type of culture is the supply of feed. Total area of ponds is quite narrower than that of paddy fields. Therefore, unless the carp is stocked much more densely than that in paddy field, it is not profitable. If the pond is dense with carp, unless the carp is fed enough it can not grow. How to enable carp eat and digest more feed is the key of this type of culture. (This is a "intensive fish culture", and paddy-cum-fish culture is a "extensive fish culture".) In order to enable carp has a good appetite the quality and temperature of water must be kept in good conditions. The supply of little quantity of new water is one of the effective means to control the water.

The productivity of the carp in this system in Japan is about 40 - 100 kg per are.

If it is possible to supply considerable amount of water for a round of clock, then the productivity of the carp reaches 20 or 30 times more than that shown above. However, the construction of running water pond is difficult with rare exceptions, as mentioned. Furthermore, accidental failure of constant water supply kills easily most of fish in pond. Finally, the total yield of carp is decided by the total amount of the feed consumed by carp, not by the density of carp in pond. The type of water for pond carp culture, therefore, must be stagnant or semi-running but must not be full-running. In other words, the running water pond is recommended only under the exceptional conditions that enlarging of total area of ponds is limited, but there is no limitation in feed supply, and physical conditions allow.

3) Man-made pond trout culture

Applicable area

Along Dariush Kabir River, downstream of Dariush Kabir Dam:

Among the areas visited, this is only the place where the breeding and rearing of trout are made.

Kind of trout to be cultured

Rainbow trout (Salmo gairdnerii iridius)

Outline of man-made pond trout culture

This trout culture requires (i) cold water (ii) in large quantity and (iii) a good deal of animal protein for feed. The conditions of water in the area fulfill the conditions (i) and

(ii) above. The water temperature in the area, 9°C in December, is cold enough to enable the trout breed not only grow. For the spawning, 4 - 12°C of cold water is required, for the growing, 18 - 19°C of water temperature is the optimum. The condition (iii) above is helped by by-products or wastes from a large meat complex factory which is under construction in the area by Ministry of Agriculture and Natural Resources.

The size of growing pond is 1 - 2 ares, 60 - 90 cm water depth, and oblong, long octagon or long oval shape is recommended. In connection with pond layout, there is not significant difference from that for carp pond mentioned before. The principal difference is the type of water, which is running. The productivity depends on the quantity of water supply. In Japan, the total yield per year per unit of water supply, 28 ℓ/sec, ranges from 0.7 - 24 tons, 5 - 7 tons in average. The rough average of that per are is 1.5 - 2.5 tons, though the yield is not decided by the area of pond. The essence of new water is the quantity of oxygen dissolved. The oxygen content in water and managing techniques vary the productivity very much..

The growth of trout at 9.5°C water temperature is:-

$$\log(\text{body weight in gr}) = 4.104\,(\text{months lapsed after hatching}) + 1.8885.$$

The marketable size of the trout in Japan is 70 - 100 gr which is of 12 - 18 months grown in 9.5°C water. If the water temperature is high during the summer, disposition of trout becomes earlier. The marketable size in foreign countries is about 200 gr.

4) Farm pond carp culture

Farm pond is also man-made pond purposefully constructed to keep water for irrigation not to keep the fish. (The man-made fish pond mentioned above is constructed purposefully to keep the fish.) A farm pond is quite larger than the man-made fish pond above. The statistics of Japanese farm ponds are as follows:-

Total number	157,000
Total area	68,000 ha
Size range	0.03 - 100 ha
Average size	0.4 ha

Little more than half of them have been exploited for carp culture.

There was not such a farm pond in the areas visited during the tour. If any of them are available in any other area or in future following carp cultures are applicable.

(1) Farm pond carp culture with feeding

Applicable pond

Not found in this tour:

Kind of fish to be cultured

Japanese common carp
Iranian common carp
German mirror carp

A domesticated form of Japanese common carp (Yamato-Goi) is so tamed that all of carp are lured in dense to the feeding point with tapping noise. This reaction is quite beneficial in two points below. (i) No loss of feed occurs. If

there is not such a behavior for any fish, feeding culture becomes impossible, sometimes, especially in large pond. (ii) No difficulty is found in catching fish by lift net or trap cage. Otherwise, unless the pond is drained, that is not always possible, efficient harvest of fish is not made. Drag net fishing is usually difficult in such a reservoir (farm pond), as reservoir is not constructed for fish culture, so many obstacles are left on the bottom of basin. Therefore, if such a tameness is not found in Iranian common carp, Japanese one is recommended to be cultured. This conclusion is also applicable for the man-made pond carp culture mentioned previously.

Outline of farm pond carp culture with feeding

The procedures are not much differed from those mentioned in Section 2) above. The productivity is 40 - 80 kg per are which is somewhat less than that of man-made pond carp culture.

Outline of net cage carp culture

If a pond (or lake) is so large and some number of organizations (or persons) wish to administer the carp culture independently of each other in a same pond, the net cage culture is applied. This is to set a large number of net cages in a large pond. Each group of cages is managed by each organization. Size of cage net is about 100 m^2, total depth is 2 m (1.5 m draft). The net cage fills the role of running water pond constructed on land. Therefore, there is not much difference in both of productivity and feed consumption between this and running water pond culture.

(2) Farm pond carp culture with fertilizing

Applicable pond

Not found in this tour.

Kind of carp to be cultured

Japanese common carp

German mirror carp
Any other plankton feeder fish

Outline of farm pond carp culture with fertilizer

This system, one of "extensive fish cultures", is to culture the fish without feeding but with plankton which is purposefully propagated in farm pond by organic and inorganic fertilizers. Accordingly, the cost of production and productivity also are considerably low. The size of pond is the key to increasing the amount of yield. The productivity of this system in Japan is 1.5 - 10 kg per are for fishes including common carp and others. In Japan the common carp is kept in the pond of this system always together with other kind of fish (Gengoro-Buna, a form of crucian carp, Carasius carasius, less than 35 cm in length) which depends on plankton more than common carp which likes benthic animal more than plankton.

German mirror carp, one of Chinese carps or tolstolobik (Hypothalmichtys moritrix, as large as common carp) and Gengoro-Buna are the most popular species which are cultured by this system. For the Iranian common carp, its feeding habit has to be studied before it is cultured by this system.

It is noticed that if this system is combined with feeding system, (1), above, a better result (less consumption of feed or more yield) is expected. This system, however, can-not be combined with map-made pond or net cage culture.

2. Kind of fish to be cultured in Iran

1) Japanese common carp, a domesticated form, Yamato-Goi

It is believed in Japan that this is the best fish to be cultured among warm water fishes. It has many merits to be cultured, i. e. high reproductivity, quick growth, omnivoruosness, tameness and some others. Culturing history is so long that most of necessary investigations have been completed and many systems of techniques also have been exploited. It seems that environmental conditions examined so far must accept this fish in Iran all over the country. No evidence which gives harmfull effects on nature of the country has been found so far. Under the circumstances, if quick results are required, the importation of some spawners of Yamato-Goi is recommended.

2) Iranian common carp

This is a wild local one in the country. So, its merit is that the fish is already adapted to the local conditions. In Japan there is also a wild form of common carp, which is worse than Yamato-Goi in connection with tameness and corpulence. Accordingly, before the Iranian wild common carp is spreaded in the country for culturing, some of biological investigations on it are required, comparing with Yamato-Goi.

3) German mirror carp

This is more herbivorous, more adapted to cold water and more corpulent than Yamato-Goi. Accordingly, it is worth to

study its environmental adaptability especially to Caspian Sea region, if its peculiar scalelessness is overlooked. As mentioned in the preceding section, this is also suitable for fertilized fish farm if applicable.

4) Tilapia nilotica

This is so spreaded in the world being cultured especially in tropical region. Its essential merits are adaptability to warm and saline water, and easiness in culturing. Though T. nilotica is the most suitable species to be cultured among other many species of tilapias, there are some demerits as follows. (i) The size is not large, less than 40 cm in length. (ii) The reproductivity is too high and reproduces by itself in pond, so that the pond is easily in dense with stunted hungry tilapia. Therefore, thinning the population density in pond, which is sometimes difficult is the essential technique. (iii) Sometimes, high reproductivity is harmful for other useful fish.

In spite of demerits above perhaps there are some waters which accept T. nilotica in the country.

5) Some of local fishes

The principle of fish culture is to culture some of local fishes which are favourites with the local people and adapted to the local environmental conditions. In order to find some suitable local fishes, frequent interviewings with local residents were made. Not many useful informations, however, were collected. The investigations on ecology of wild fishes, i. e. spawning and feeding behaviors and growing conditions are required.

6) Rainbow trout

Needless to say, this is the best fish to be cultured from many points of view among all of cold water fishes. Most of necessary knowledges and techniques have been found from long history of culture as same as for the common carp.

3. Supply of fish feed

The two important conditions in the feasibility of fish culture industry are water (or fish) and feed. In the preceeding sections, the problem of water which is that of fish, i. e. what kinds of fish or fish culture are accepted in Iranian water has been discussed. And no negative situation has been reported. Then, the next important problem is the feed which is discussed in this section.

The amount of fish production is determined from that of feed consumed by fish. Any technique which improves the conditions of water or pond is to keep the fish active and to get a strong appetite. For each kind of feed, the conversion ratio which is (weight of feed consumed) / (weight of fish increased), has been studied and found as shown below. Accordingly, if the total amount of feed available is given, the possible amount of fish production is estimated, and vice versa. Kinds of materials shown below are some of common ones used in Japan. All of them are from agricultural industry. Any new material of feed can be exploited in the country in addition to some below.

Kind of feed	Conversion ratio (feed consumed/fish produced) for carp
soybean cake	5.1
barley	2.6
corn	4.65 - 5.00
wheat flour	7.2

rice bran	8.76
wheat bran	6.13 - 7.32
dry pupa	1.25 - 2.1
raw pupa	3.2 - 5.0
fish meal	1.43
meat powder	1.99 - 2.02
blood powder	1.51 - 1.68

Under the circumstances, the important pre-investment survey is the estimation of total quantity of feed material available in each year in the country for the time being and in future. So that the total amount of fish yield expected in each year can be estimated from such kind of data shown above. Cost of fish yield also is estimated. Accordingly, the final conclusion, whether the establishment of fish culture industry is worthy or not, then the construction of pilot fish farm is useful or not is obtained.

The serious problem is fish meal which is the most basic material of fish feed in Japan. Animal protein feed is essential for the carnivorous fish, such as trout, but not for the omnivorous fish, the carp. However, Japanese carp farmers feed plenty of animal protein to their carp in order to get quick growth. The material of animal protein is pupa or fish meal. The supply of pupa is not as large as fish meal. Therefore, the fish meal in pellet feed is the most important carp feed in Japan, in spite of that the condition of fish meal supply in the world shall never be improved, but it is getting worse.

In the meanwhile, the fish meal is not a basic feed material of carp in both of South East Asia and China, where the carp culture is also thriving. In South East Asia, the basic material is vegetable protein. Feed efficiency of vegetable is quite lower than that of animal protein. However, because of tropical warm water, fish can be fed throughout the year and grows without resting during the winter time,

which covers low efficiency of vegetable feed. In China, the principal fish culture is fertilized fish farming or combination of fertilizing and feeding in both of warm and temperate areas in the country, as there are large areas of irrigation waters for fish rearing.

On the other hand, the conditions in Japan are worse than those of above two regions as follows:- (i) There is no tropical warm water, (ii) There is no large water for fertilized fish farming. (iii) The cost of land is very high; no land is available to increase the area of fish pond: At the same time, there were other special conditions:- (i) There was a strong demand for fresh fish by the people in the area far away from the sea. (ii) There was a large amount of supply of pupa at low price in the area: Those two positive conditions enabled the people to exploit a unique system of carp culture with pupa, animal protein, which enabled to grow food carp within only two years rearing, in spite of that there was a long resting period of winter. After that, what happened were decreased supply of pupa in accordance with deterioration of sericulture, which compeled the carp rearers to substitute pupa by fish meal for which there was no difficulty in supply. Then, what is happening, recently, is the shortage in supply of fish meal and serious rise of its price. Under the circumstances, what Japanese feed chemists are investigating is to exploit new materials for animal protein fish feed, i. e. single cell proteins which are from many kinds of yeasts or bacteria. It is regretful, however, decisive materials or techniques have not been found yet.

Finally, what are the negative conditions in Iran are:- (i) no tropical warm water, (ii) no large inland water area for fertilized fish farming, and (iii) less amount of pupa and fish meal: The positive conditions are:- There are some of (i) wastes from meat processing industry, (ii) vegetable protein feed materials from developing agriculture, and (iii) unused lands around irrigation headwaters: It is regretfu

that the total amount of available feed materials especially for meat wastes could not be estimated in this tour. Therefore, at this moment, no decisive information is available in connection with quantity and quality of fish feed in the country.

The longer rearing period is required for harvesting for the carp fed by vegetable protein than that fed by animal protein. No concrete conclusion has been obtained from scientific investigations more than above words. For a tentative instance, if it requires 2 - 3 times period by vegetable protein feed, 2 - 3 times of pond area and maintenance cost are required in order to get a certain amount of yield. The problem is the estimation of the quantity and quality of the feed available in the country as mentioned in the beginning part of this section.

Feed pelleting plant

Recently, most of fish feeds are made into pellet for each kind and size of fish to be fed. The pelleting is tosave compounding and handling labor and loss into water. The materials which cannot be pelleted is raw pupa, raw fish, boiled barley, any feed for young fish and some others. Pellet plant is beneficial to the industrialization of fish culture.

4. Kind of fish to be released into natural water body

1) Grass eater carp or white amur (Ctenopharhyngodon idellus)

This large fish, 1 - 1.5 m length, is one of Chinese carps depended on aquatic weeds. So, when extermination of weed in lake or pond is required this is released. This is not able to propagate itself unless it lives in large long river. If this is in a confined water, unless its maturity is induced artificially by hormon injection, it does not spawn.

2) Rainbow trout

This can be released in Dariush Kabir Reservoir. The spawning ground of it is in river. Therefore, the reproductivity of the trout released in the reservoir depends on the conditions of the river flowing into the reservoir. The wild rainbow trout is active carnivorous fish, eating fry or young fish and insect. Therefore, if the trout is propagated successfully in the reservoir, original fish fauna including shemaia, Chalcalburnus sp. (C. mossulensis ?), which depends on amphipod and chironomid is sometimes affected. The problem is that of preference. Perhaps the trout is more valuable than original habitants in the reservoir. Sometimes, valueless small fish is released to provide the trout with the pray.

3) Other fishes

Refer to the following part.

5. Others

1) Wild fish fishing activity

Fish culture has been originated from the intention of fish-eater country's farmers who are interested so much by wild fish, and have much knowledge about it. Sometimes, in meat-eater country, the lack of interest of people in fish, causes a obstacle to the development of fish culture industry. Therefore, encouraging the farmers in their activities of fishing is recommended in order to increase their interest and knowledge.

2) Research on wild fish

The wild fish is a resource for food and pleasure of game fishing. In addition to those above, wild fish fills a important

role, i. e. it is an indicator of water pollution. From those points of view, investigation on its ecology is important. In this tour, it was found that there are some good amount of fishes in some rivers, but not in all. What which is the best is that there are plenty of useful fishes in most of rivers and lakes in the country. Therefore, after ecological investigations on wild fishes, some of suitable ones are chosen and released into any other rivers. This is more efficient to do in time before the water pollution problem become serious.

3) Ornamental fish

This is a pet fish being kept around the people for pleasure. The most popular ones in Japan are coloured carp, a form of common carp, for garden pool, and gold fish, a form of crucian carp, for basin in house room. Both of them are beautifully spotted with red, white, black and sometimes yellow. Japanese garden pool is made purposefully to keep such fish but Iranian one so far observed is not. Under the circumstances, pet fish culture industry in Japan is also thriving for fish farmers. A piece of pet fish sold for thousands of dollar is not rare. It is wise, therefore, for fish farmers to culture this type of fish beside food fish, and spread this fish in garden pools and house rooms all over the country, so that the people's interest in fish is also increased.

There is no difference in the procedures to culture between food carp and pet carp. Only the point of pet carp culture is the sorting. The sorting is to discard the valueless worse fry and to culture only valuable better fish.

V. PRACTICAL PLAN OF THE PILOT FISH FARM

1. Practical plan of the pilot farm of the carp

The plan concerns Japanese common carp with feed enriched by animal protein. This is not significantly differed from that German mirror carp. Many parts of procedures are perhaps applied to Iranian common carp.

1) Hatchery

The scale of the hatchery is tentatively adjusted in order to produce half million of seed carp.

Importing the spawners

The followings are spawners to be imported;-

	fish size	average size of fish	number of fish	total weight
female	2-8 kg	5 kg	30	150 kg
male	1-4 kg	2.5 kg	60	150 kg
total			90	300 kg

The biological fecundity of a grown female is 100,000 - 600,000 eggs. In view of carp culture, the available number of healthy eggs per single female is 100,000 in average. That of seed fish in the following autumn from single female is 20,000 - 30,000 in average.

Spawners' stocking pond

120 m^2 x 2 m x 2 pieces (for femal and male)

Every depth shown here is that of water not pond wall.

Spawning pond

30 m^2 x 60 cm x 1

Hatching pond

30 m^2 x 30 cm x 1

Immediately after the spawning the eggs are transfered to the hatching pond together with spawning bed which is a bunch of some kinds of weed. It takes 5 or 6 days to hatch. Live water-flea is fed 2 or 3 days after hatching when yolk sac of fry is absorbed, and transfered to the nursery pond 5 or 6 days after hatching. The Japanese name of the fry until this stage is Mizuko.

Nursery pond

1,000 m^2 x 30 cm (or 120 cm) x 5 - 10

Stocking density of Mizuko is 200,000 - 300,000 per 1,000 m^2. The feed of Mizuko is live water-flea. Therefore, a quantity of water-flea must be propagated in the nursery pond in advance before the Mizuko is transfered in it. After the consumption of water-flea, artificial initial feed is given. Mizuko is reared in the nursery for 1 or 2 months. Then it grows to about 3 cm in length which is Aoko. In good conditions 100,000 Aoko per 1,000 m^2 is expected. Aoko is strong enough to be transported for a long way. Rearing of Aoko requires a series of particular techniques. The point is how to accustom fry to artificial feed. If it is failed proper growth in future is affected. Some carp culturists are specialized only in this Aoko rearing. They sell Aoko to seed carp rearers. The seed carp rearer continues to grow Aoko until the following autumn in pond or paddy basin with rather

simple procedures. Grown Aoko in the following autumn is Shinko, 20 - 150 gr body weight. If Aoko is not dispatched but continued to grow until the autumn in this nursery pond, the depth of pond must be 1.2 m.

2) Seed carp (Shinko) rearing

(1) Shinko rearing in paddy field

Arrangement of paddy basin

The dike is heightened and strengthened to 40 cm height, 30 cm width. Install the fish screens at inlet and outlet of water. Dig the fish pool in paddy basin near to inlet, 6 m^2 per 10 ares paddy basin, 30 cm deeper than paddy basin bottom, and some of radial ditches from fish pool in order to guide the carp to fish pool. Fish pool or ditch is a place of refuge. If it is too large or deep, carp trys to stay always in it so that carp does not grow.

Shinko rearing

Immediately after the paddy transplanting, Aoko is released into paddy basin. The followings are rough estimation of Shinko yield in the following autumn and required area of paddy field per 500,000 of Aoko. The figure in blackets is tentative average.

Aoko			
Initial number	500,000 fish		
Stocking density	5,000 (without feeding)	- 30,000/ha (with feeding)	(15,000/ha)
Required area of paddy field	17 (with feeding)	- 100 ha (without feeding)	(33 ha)

Shinko in the following autumn

Expected yield per ha	200 (without feeding)	- 800 kg/ha (with feeding)	(400 kg/ha)
Total expected yield	13,600 (with feeding)	- 20,000 kg (without feeding)	(17,000 kg)
Body weight	20 (without feeding)	- 100 gr (with feeding)	(60 gr)
Total number			(280,000 fish)

Hanko rearing

Some Shinko of 17 tons, @ 60 gr, has been obtained from the first year's paddy field rearing. This is to sent to pond carp rearer for the following season. This size of Shinko is too small to get marketable size of food carp at the end of following autumn. Therefore, sometimes, paddy farmers rear Shinko again in the following season in paddy field. So that Shinko grows to 100 - 220 gr in average, which is called as Hanko. Hanko is accepted by food carp rearer with good price. Wintering pond is only additional requirement to rear Hanko.

(2) Shinko rearing in man-made pond

This is also rough estimation to rear 500,000 of Aoko into Shinko in man-made pond. The feeding is essential in this case.

Aoko	
Initial number	500,000 fish
Stocking density	20-25 fish/m^2
Nursery pond size	@ 600-2,000 m^2 x 1.2 m
Required total area of pond	2-2.5 ha
Shinko in the following autumn	
Expected yield per ha	4,000-8,000 kg/ha

Total expected yield	8,000-20,000 kg	(14,000 kg)
Body weight	50-150 gr	(100 gr)
Total number	80,000-200,000 fish	(140,000 fish)

3) Food carp rearing

This business is to rear Shinko or Hanko into marketable size of food carp larger than 700 gr which is Kiri-Goi. The rearer buys seed carp at the end of autumn and rears it in pond from the following spring. In this business in view of technique, there is not foundermental difference from that in seed carp rearing in pond. The only difference is that of scale. The Kiri-Goi rearer has to prepare quite larger area of pond and also very larger amount of feed than Shinko rearer.

The Kiri-Goi rearer (and also Hanko rearer) has to make seed carp pass a winter in pond. The stocking capacity of wintering pond is 4.6 - 6 tons of carp per 100 m^2 x 2 m of pond, at the water temperature lower than 7°C with little quantity of new water supply. It seems that the ordinary growing pond with 1.2 m depth is substituted for the wintering pond in most parts of Iran as in Japan.

As mentioned in the previous section, 17 tons, @ 60 gr, or 14 tons, @ 100 gr, of Shinko has been obtained either from paddy basin or pond from identical 500,000 of Aoko. Then, they have to meet with some mortality during the winter. The mortality rate ranges from few % to nearly 50%. In view of roughness of the estimation, it is not unreasonable supposition that for both of two groups the same quantity of seed carp, 10 tons (@ 60 gr or @ 100 gr), is survived in the following spring. The followings, accordingly, are estimated in connection with Kiri-Goi rearing.

Spring		
Quantity of initial stocking	10,000 kg (@ 60 gr of 167,000 fish or @ 100 gr of 100,000 fish)	
Stocking density	500-1,000 kg/ha	(750 kg/ha)
Required area of pond	10-20 ha	(13 ha)
Autumn		
Expected yield per ha	4,000-10,000 kg/ha	(7,000 kg/ha)
Expected total yield	80,000-100,000 kg	(90,000 kg)

As shown above the quantity obtained in the following autumn is 90 tons for both of two groups. However, the average body weight of the group grown from the paddy basin Shinko, @ 60 gr, is quite smaller which theoretical size is 480 - 600 gr, 540 gr in average, than the other group grown from pond Shinko, which average is 900 gr as far as the above figures are concerned, as a matter of fact, if loss in fish number is disregarded. The smaller sized group, @540 gr, called as Chuppa, can not be marketed at the end of this season. It must be reared again in the following third season. Some of Chuppa are also rejected from the larger sized group as marketing size.

The rearing of Chuppa in the following third season is very beneficial in view of following two points. (i) It enables the marketing period of Kiri-Goi to be from the summer not only concentrated in the end of year. (ii) It desterilizes the idle capacity of water or pond. The amount of initial stock in the pond shown above in quite smaller than the capacity of the pond. Therefore, sometimes, if there are several growing ponds, a certain quantity of seed carp is kept more densely than one shown above table in less number of ponds. And in the remaining ponds Chuppa is reared. In accordance with the growth of both groups of carp; Chuppa is marketed some by

some, so that the number of Chuppa ponds become less; some of Shinko is transfered to the empty ponds which were being occupied by Chuppa, so that the numerical stocking density of Shinko is thinned out. For the other case, for a farm pond, a large quantity of Chuppa is added to the certain quantity of Shinko at the beginning of rearing season. The total amount of both groups of carp must be less than the productive capacity (not stocking capacity) of the pond. (If the amount of fish is more than the productive capacity which is quite smaller than the stocking capacity, no growth of fish is expected.) All of grown Chuppa is marketed some by some in time before the final disposition of grown Shinko. By either of two procedures above, it is true theoretically that the double of original productivity is expected. This compound rearing is applied also for Hanko. It is understandable that the retarded growth of paddy basin Shinko is not the unpleasant occurence.

4) Supply of feed

As mentioned so far above, 90 tons of large carp has been obtained in the end of second year. If Shinko is produced for successive years 14 tons of Shinko is produced in each year in pond. Then, total production in each year is 104 tons. The production of 17 tons of the paddy field Shinko is disregarded in view of feed supply, as this includes the fish grown without feeding. The feed conversion rate of Japanese pellet feed is 1.3-1.7 for commercial carp farmer. For the Iranian pilot carp farm, the rate of 2.0 may not be far from the actual result. Then, 208 tons of feed is required for single rearing. If the compound rearing that is mix rearing of Shinko and Chuppa or Hanko, is carried on, theoretically, another 90 tons of Kiri-Goi is produced, so that another 180 tons of feed is required.

In other words, in each year there are rearings of three groups of carp, i. e. Shinko, 0+ age, Chuppa, I+ age and Kiri-Goi, II+ age, with full productive capacity of pond. Then, the total amount of feed required is 388 tons at most for carp culture made from 500,000 of Aoko per year, provided that the total area of pond is not increased.

The typical ingredients of pellet feed of carp are as follows:-

fish meal	40 - 60 %	fish oil	0 - 5 %
wheat flour	0 - 50 %	vitamins	+
soybean cake	0 - 30 %	minerals	+

Because of expensiveness of the pellet, ¥200 (RLs50) per kg in average, carp farmers use many other available cheaper materials, i. e. pupa, raw fish, boiled barley, etc. As mentioned in the foregoing section, the quality of feed available in the country is the principal problem. All of estimations discussed here, i. e. growth rate, rearing period and amount of feed, are based on the feed enriched with animal protein. It has been tentatively supposed in the discussion, that the yield conversion ratio of the feed for the pilot farm would be 2.0 as only the loss of feed into water was regarded. However, if Iranian feed is based on vegetable protein, the value can be 5.0 - 6.0 or more. In this case, all of estimations given above must be entirely changed.

5) Locality of carp pilot farm

Carp culture industry is categorized as follows:-

Hatchery (including Aoko rearing)
Shinko rearing in paddy field

Hanko rearing in paddy field (if applicable)
Shinko rearing in man-made pond
Kiri-Goi rearing in man-made pond (including Chuppa rearing)

The Rasht area where there is more rain fall than Sari is recommended for the pilot farm of Shinko rearing in paddy field. Then, the hatchery also constructed in the vicinity of above pilot farm. Shinko rearing industry in pond also must be established in the country so that the small Shinko together with large one enables to get considerably high productivity in Kiri-Goi rearing. The Caspian Sea region is capable of the center of carp culture. Therefore, the both pilot farms of Shinko and Kiri-Goi rearing in pond also established in Rasht area.

Meanwhile, there is another idea in connection with the locality of hatchery, that is, Aoko must be ready to be released in paddy basin as soon as paddy transplantation is finished in May so that the rearing period can be longer. The early spawning in warm water guarantees early supply of Aoko in time in May more than late spawning in cold water. Therefore, some spot in south region where there is warm water may be preferable for hatchery more than north. However, because of a large demand of Aoko in the Caspian Sea region in future, the hatchery, Aoko rearing, must be established successfully in the region by all means, even if the water is little colder than some of southern spots.

For the final decision of actual sites of the pilot farms, further scrutiny is required taking many local conditions into consideration.

6) Scale of pilot farm

All of necessary informations concerning to the determination of the scale of pilot farm have been given above, on the way from 500,000 of Aoko to 90 tons of large carp. It seems that this scale is perhaps for the final stage of pilot farm. For the initial stage, 100,000 of Aoko, respectively for paddy field and man-made pond, 200,000 in total, and 36 tons of large carp may be the suitable scale. Further scrutiny is also required for this problem.

2. Practical plan of the pilot farm of the trout

Principle of estimation

For the carp pilot farm, many relevant data are unknown. Therefore, Japanese data with wide latitude have been applied. So that the final figures estimated perhaps differ some much from the actual results. However, it must be appreciated because the purpose of pilot farm is to know the actual data for industrialization. At the same time, in the case of trout, it is more difficult than that for carp. Because the productivity is decided by the quantity of supply of water that is oxygen, which varys very much by hydrologic conditions. Therefore, sometimes, a tentative assumption of amount of water supply in estimation of trout yield gives nonsense results.

Followings are the standard stocking rate of the rainbow trout based on oxygen consumption. The conditions of the estimation are:- (i) The oxygen saturation rate in the inlet water is 85%. (ii) The oxygen content in the drain water is 3.5 cc/l which is a allowance which has not been necessarily consumed by the trout. It means that the trout is kept in pond very safely, and more trout is able to be kept. The other name of the rate is safety stocking rate. But the larger stocking amount than the safety rate never be dangerous, therefore, the name of standard stocking rate has been prefered.

The standard stocking rate in kg fish per 1 1/sec water supply at 0 m altitude:

Water temperature, °C \ Trout size in gr.	1	2	5	10	50	100	200
5	72 kg	78 kg	88 kg	98 kg	130 kg	151 kg	181 kg
10	31	34	39	43	58	69	83
15	17	19	21	23	31	35	42
20	10	11	13	14	18	21	25

Correction coefficient of the standard stocking rate by altitude:

Altitude in m \ Water temperature, °C	5	10	15	20
0	100 %	100 %	100 %	100 %
200	95.6	95.6	94.5	93.4
400	91.0	90.0	88.6	86.7
600	86.6	84.8	82.7	80.1
800	82.5	82.2	77.5	73.5
1,000	78.5	75.6	72.0	67.3

The actual stocking rate of trout farmer is 2 or 3 times of the standard rate above. In other words, the initial stocking amount is less than 2 times of standard amount. In accordance with the growth of trout, when the stocking amount has become more than 3 times of standard amount. The farmer disposes the all or 1 time of standard amount of trout.

The yearly actual yield is 2 or 3 times of the actual stocking amount by the same principle mentioned for carp. The spawning

period of trout is so long. Furthermore, there is a technique which enables the spawning period to advance four months by short day treatment. So that the varied sized group of seed fish are available during the long period. The marketable size in Japan is 70 - 100 gr which is about half of that in foreign countries. In Japan, therefore, the trout is disposed 10 - 16 months after hatching, which is quite earlier than carp. (The average water temperature of trout farms in Japan is higher than 9.5°C.) Therefore, the production efficiency of trout can be higher than carp in case of compound rearing.

Practical rough estimation of the yield

As mentioned, theoretical estimation of the scale of the pilot farm is difficult unless the conditions of water supply and oxygen are decided. Under the circumstances, it is estimated from the practical data which are based on farmers' experiences. The average of yearly yields of many trout farms under the varied conditions is 5 - 7 tons, 6 tons in rough average, per 28 l/sec of water supply. Then, for 10 tons of yield, 47 l/sec of water is required by compound rearing. For single group of rearing for the first step (X2.5), 118 l/sec of water is necessary.

There is no theoretcial relationship between trout yield and pond area. Practical data based on the results of many trout farm with varied amounts of water supply is 1.5 - 2.5 tons, 2.0 tons in average, per are per year. Then, for 10 tons of yield by compound rearing, 5 ares is required. By the single group rearing (X2.5) 12.5 ares is necessary.

Rough estimation of the quantity of eyed egg required and the scale of the pilot hatchery

The observed survival rate of eyed egg for the first one year is 40 - 50%, 45% in average. The average body weight at that time

is 60 gr at 9.5°C water temperature. Then, the number of required eyed eggs is estimated as follows:-

quantity of trout after one year		10,000 kg
number of trout	(÷@ 60 gr)	167,000
number of eyed eggs required	(÷0.45)	371,000

Capacity of a Atkins incubator is 120,000 eggs. Atkins incubator is wooden tank, 33 cm x 180 cm x 33 cm depth, with 40 pieces of hatching trays. Neither large area nor large cost is required for incubation.

Supply of feed

For the early stage of the pilot farm, the feed conversion rate may be 2.0, though standard value of it is 1.4 - 1.6. Then, for 10 tons of trout yield, the required feed is 20 tons. If the compound rearing is carried on in future in the pilot farm which is designed in order to get 10 tons of trout by single rearing, 40 - 60 tons of feed is required. The composition of trout feed is not so differed from that of carp. Only difference is that 10 or 20% of more fish meal is included in trout pellet. The price is as high as that of carp. Trout farmers try to substitute by any other cheaper materials. The followings are some of examples of trout feed before the pellet feed is exploited.

	A	B	C
dried pupa	49.0 %	52.0 %	40.2 %
dried opossum shrimp	7.5	11.2	5.5
dried marine amphipod		2.2	8.3
fish gut		6.0	3.9
total of animal materials	56.5	71.4	57.9
barley	24.5	18.7	39.2

potato	11.3	1.9	
radish		2.2	
green rape	7.6	5.6	2.8
total of vegetable materials	43.5	28.6	42.1

The trout is carnivorous fish. The animal protein in the trout feed can-not be substituted by vegetable protein. Therefore, the total amount of animal protein materials available in the country for the trout feed definitely decides the scale of trout culture industry.

Scale and site of the pilot farm

Most of necessary informations to decide the scale have been given so far. The scale and the site are decided after scrutinizing taking local conditions of Dariush Kabir river and supply of animal protein feed into consideration.

3. Term of the pilot farms and number of the experts required

It seems that it takes 1 or 2, perhaps 2, years period before the first fry of carp or trout is produced in new hatchery, after the start of designing of the pilot farms. Because the spawning of carp is not always done in the year, but only in April or May. It requires at least 3 seasons' experiences of operation to get necessary data which are required for the industrialization of carp or trout culture. Therefore, 4 or 5, perhaps 5, years total period is expected for this project.

The number of necessary experts for each subject is as follows:-

chief	1
carp culture in paddy field	1
carp culture in man-made pond	1
trout culture	1
feed nutritionist	1
total	5

VI. RESUME

1. The feasibility of establishment of fish culture industry was surveyed in December, 1973. Several agricultural cooperatives were visited all over the country and necessary informations were collected.

2. As far as the quantity and quality of water are concerned, the following fish culture industries are possibly established.

1) Paddy-cum-carp culture

This is a seed carp rearing in the Caspian Sea region.

2) Man-made pond carp culture

This is a food carp rearing in man-made fish pond in the Caspian Sea region and many other areas in central and southern regions where irrigation water is available.

3) Man-made pond trout culture

This is done along Dariush Kabir river where a good deal of cold water is available.

3. The estimation of the total amount of fish feed materials available in the country, especially for the animal protein materials could not be worked out. The productivity of the carp rearing is decided by the total amount of animal proteins in the feed, i. e. wastes of meat processing industry, pupa, fish meal or others. The trout rearing is impossible without animal protein materials for feed. Therefore, the further investigation on the supply of fish feed materials before the construction of the pilot fish farms has been recommended.

4. All of necessary informations for the construction of the pilot farms of carp and trout have been given on the basis of the feed enriched by animal protein.

5. Some other relevant informations, i. e. farm pond fish culture, fish propagation, pet fish culture and others have been mentioned.