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Report of a visit to Japan from April 8 until May 21 (1975). A study of the possibilities of mutual exchange of scientists in the field of fundamental agricultural research and closely related problems

by

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Contents

Introduction

In recent years Wageningen, the main centre of agricultural research and education in the Netherlands, was visited by a number of Japanese scientists for periods between six months and over a year. These visits were the result of increasing contacts between our two countries during the past ten years. In the field of crop physiology this intensification was for a considerable part due to the stimulation of co-ordinated research by the International Biological Program (IBP). Several international meetings led to an intensive exchange of scientific results and ideas and a large number of publications within the themes of IBP-research were written. It were especially the fruitful visits of two young scientists viz. Dr. T. Takakura and Mr. T. Horie which promoted the wish for further intensification of scientific contacts, also by means of reciprocal visits of Dutch scientists to Japan.

The visit to the CABO of Mr. Ryozo Sunobe, at that time ambassador of Japan in the Netherlands, brought the wish for mutual exchange of scientists into more official channels. Both he and Dr. Takakura in Japan and Dr. G. de Bakker, General Director of Agricultural Research in the Netherlands, very much promoted an officially regulated exchange. This ultimately led to a formal agreement between the Japanese Society for the Promotion of Science (JSPS) on the Japanese side and the Netherlands Organization for Applied Scientific Research (TNO) on the Dutch side. The main features on the agreement are 1) the possibility for junior scientists to carry out research supervised by the institute visited for periods between six months and a year at a frequency of one person per year in both directions and 2) the possibility for senior scientists to lecture and co-ordinate research on specific topics for periods up to three months at a frequency of two scientists per year in both directions. The sending country will pay the travelling expenses, the receiving country the cost of housing and living up to a certain amount.

Already before the agreement was signed the author got an invitation from the JSPS to visit Japan for a period up to two months to study the exchange possibilities between the two countries in the field of more fundamental agricultural

research, more specifically but not exclusively, in the range of primary productivity.

The author wishes to express his sincere thanks to the JSPS for this invitation, to Prof. Kanda, Dr. Takakura and Mr. Horie for the excellent way in which the whole visit was organized and for all the background information that made it possible to understand at least a bit of Japanese thinking and way of living and to all the scientists named in this report who besides the scientific discussions showed such generous kindness and hospitality.

Visits to scientific institutions in chronological order

I. Faculty of Horticulture, Chiba University, Matsudo

75-04-14+15

The Faculty has four departments, viz. of Horticultural Science, Agricultural Chemistry, Landscape Architecture and Agricultural Production and Management. Consequently, the Faculty does not confine itself strictly to horticultural problems so that other crops are included in the research programme, although a very restricted area is available to carry out agricultural field experiments.

Considerable attention is paid to the more basic problems of regrowth of fodder crops after cutting, especially on the effect of temperature pretreatment. It was found that e.g. Dactylis glomerata can adept itself to higher temperatures in the sense that photosynthesis shows a far broader optimum temperature range with plants pretreated at higher temperatures than with plants pretreated at lower temperature. As to the influence on regrowth, the higher the temperature in the period before and after cutting, the slower the rate of regrowth and also here some adaptation phenomena can be observed. Besides the influence of the carbohydrate reserve level on regrowth phenomena also a distinct hormonal influence could be demonstrated; usually both are negatively correlated. Plants with a lower reserve level show a higher rate of leaf elongation directly after cutting, due to a higher content of IAA. Where high amounts of fertilizer are applied (500 kg N per ha) the total dry matter production is comparable to that in the Netherlands; the mean annual production is lower (4.5 to 6 tons dry herbage per ha).

Horticultural research centres around greenhouse climatic control and optimalization of conditions. For the latter a device is available in which the conditions with regard to temperature, relative humidity and carbon dioxide concentration can be optimalized by means of measuring the photosynthetic performance of the plant. By using computer regulation optimum climatic conditions are chosen for maximum photosynthesis, following the light intensity trend in the greenhouse Plant performance here is compared with the production in a normal type of greenhouse.

Besides this rather sophisticated set up there are many experimental greenhouses, ranging from very large glasshouses to a simple plastic cover of a row of e.g. strawberry plants in which it is even possible to create a temperature gradient simply by placing a fan at one end. Plastic greenhouses are used very much in Japan, mainly due to the high cost of glass. Usually they last for two seasons; they are of a very simple and very practical design.

Carbon dioxide enrichment is studied intensively. It was found that in normal commercial greenhouses during the morning hours, when the vents are still closed, the CO_2 concentration can drop to very low values. During this time CO_2 enrichment can be applied with much success. Concentrations around 1000 to 1500 ppm are considered to be an optimum.

II. Agricultural Laboratory of the Central Research Institute of Electrical Power Industry (CRIEPI) 75-04-15

The Institute was founded in 1951 as a non-profit corporation, receiving money from the nine electric power companies of Japan and the Power Development Company. It is engaged in research on the technological and economic aspects of the electric power industry. The Agricultural Laboratory studies a.o. the environmental conditions for plants in glasshouses and plastic houses, both with natural light and artificial illumination and also the utilization of by-products emitted from thermal power stations as hot water, carbon dioxide and fly-ash. The laboratory has excellent facilities for studying the influence of different spectral regions on plant growth and development. This in relation to the use of plastic films of different colour to be used in greenhouses to shift the radiation somewhat in the direction of the more photosynthetically active wave-lengths. The same holds for the controlled facilities for examining the effects of air pollutants on plants. Of the three main gaseous pollutants SO_2, NO_x and O_3, the latter seems to cause the largest damage. Devices are constructed to economize on energy consumption in greenhouses and to this purpose several experimental houses are available. Worth mentioning are the devices to trap the incoming energy during the day to prevent too much cooling causing low temper-

ature damage during the night. One solution is a double walled glasshouse; during the night hours foam plastic pellets are blown inbetween the two walls, giving a very effecient insulation. The other is a system in which the air in the greenhouse is led through pipes in the soil of the cultivation benches. During the day the soil is heated and during the night this heat load prevents excessive cooling.

Close to the power stations - not visited - are experiments on using the hot drainage water and carbon dioxide for glasshouse air-conditioning and fish farming.

III. National Institute of Agricultural Sciences (NIAS)

Tokyo	75-04-16
Konosu	75-04-17
Kitamoto	75-04-18

This Institute consists of several scientific departments. Each department is subdivided into divisions which, in turn, are again subdivided into laboratories. Some departments are situated outside - but not far from - Tokyo. Visited were the Departments of Physics and Statistics, Soils and Fertilizers and Plant Physiology and Genetics at Nishihagara, Tokyo and divisions of the latter at Konosu and Kitamoto.

At Nishihagara a general survey was presented of the research going on in the Department of Physics and Statistics with emphasis on the Division of Meteorology. An important part of the research is devoted to carbon dioxide fluxes into crop canopies and concentrations inside the canopy. Furthermore crop structures are defined and micrometeorological observations are carried out and related to the influence of separate climatic factors. Also climatic studies in greenhouses are performed.

At the Department of Physiology and Genetics haploid rice plants have been obtained from immature pollen grains by culturing anthers on agar medium. In addition (also) diploid, triploid, tetraploid or trisomic plants were found. The same technique has also given positive results with tobacco and it is said that in China haploid wheat plants have been raised in this way, but up to now other plants failed. Furthermore, irradiation with ^{60}Co has given some successful mutants as

shorter rice plants and earlier ripening soybeans and wheat. In the Laboratory of Physiology research has been started on the possibility of biological weed control in paddy fields by the activity of the tadpole shrimp. Also physiological work on the mode of action of different kinds of herbicide is carried out.

At the department of Soils and Fertilizers an original method of measuring light penetration into a crop was demonstrated. Small containers with a test crop on small vials with nutrient solution are suspended at different heights in the canopy. The growth of the test crop is a measure of the light intensity at that particular site. By means of very uniform standard swards it was also possible to measure the relation between light intensity and growth rate during very short growth periods. Furthermore, very useful devices to measure ion uptake by plant roots were shown.

At the branch station at Konosu rather fundamental work on different subjects is carried out, e.g. differences between C_4 and C_3 plants in their reaction of photosynthesis and transpiration to different concentrations of CO_2 and O_2. Growth simulation programmes based on their different chemical pathways are developed. Furthermore the influence of different gaseous substances on a large number of test plants is studied. This comprises C_2H_4 and substances that are supposed to set free this substance, like ethrel and methionine and also the adverse effects of air pollutants. A rather peculiar observation in this respect is that many plants can be hampered in their elongation by brushing the leaves gently and regularly. When brushing is stopped the elongation rate increases above that of control plants. This brushing is already used in practice in shortening lilies.

At the Kitamoto branch much research is carried out on comparing wheat varieties from different climatic areas of the world under optimum soil conditions. This is directly comparable to similar research carried out at CABO and at other institutes in Europe. Close co-operation on this subject is simply necessary and already organized in so far as exchange of seeds and results are concerned.

Simulation models on plant growth and on competition have been worked out, related to those of C.T. de Wit. Fundamental re-

search on crop growth is carried out and good facilities are available to measure leaf and plant photosynthesis.

IV. Kyoto University 75-04-21

This faculty studies rice production and the introduction and comparison of new varieties as well as more physiological research. An example of the latter is the effects of the temperature of the root medium and the shoot base on growth rate and transport of assimilates. This in relation to the use of rather cold irrigation water in many rice growing areas of Japan.

Next to this research is carried out on adaptations to different ecological conditions as for instance the different light conditions of forest floor plants during their growth period. For such aspects of environmental physiology a new building with very advanced climate rooms is under construction and nearly finished. In some rooms it is possible to work under sterile conditions.

V. Excursion to the Tea Experiment Station 75-04-22

Tea production in Japan amounts to 100,000 tons per annum, sufficient for inland use. Around Kyoto very good, but also very expensive tea is produced. This tea is only harvested once per year after the young shoots have been shadowed for three weeks prior to picking; the shading intensity increasing from 60 to 95%. The nitrogen fertilization is very high: 1500 kg N per ha for a yield of 12,000 kg per ha dry tea. Part of the research centres around the question whether this amount of fertilizer can be reduced without influencing yield and quality.

VI. Osaka University, Faculty of Agriculture 75-04-24+25

The work at this Faculty is mainly concentrated on the fundamental aspects of crop growth and photosynthesis. Besides calculations of crop photosynthesis from carbon dioxide fluxes into the crop, the influence of various factors on photosynthesis and plant performance are studied, as e.g. wind speed research in a specially constructed tunnel, relative

humidity, spectral composition, light intensity, CO_2 concentration. With all this work attention is focussed on short time effects and periodicities. It has e.g. been demonstrated that there is a certain lag time in the reaction of photosynthesis to changes in light intensity. This lag time is different for the upper and the lower side of a leaf. Also sudden changes can trigger a periodicity in photosynthesis; not only changes in light intensity, but also in relative humidity and temperature.
The influence of carbon dioxide enrichment is studied in much detail in the sense that also the effects of adaptation and ageing are taken into consideration. Good and original facilities for measuring photosynthesis are available. Next to this work there is also a device to optimalize photosynthesis comparable to that at Chiba University. A difference is that here only artificial light can be used so that daylight greenhouse conditions can not be simulated.

With a large industrial area close to Osaka it is obvious that air pollution is studied. Mainly the effect of car exhaust gases on plants is taken into consideration, but also the effect of other air pollutants is studied. It seems that all hydrocarbons, except methane, can evoke or catalize adverse reactions in plants.

VII. Kyushu University, Faculty of Agriculture, Department of Agronomy, Crop Husbandry 75-04-28+30

This Department is also very much involved in the measurement of photosynthesis and respiration, in particular photorespiration.
In large growth rooms the net photosynthesis rate of rice plants is measured growth rate is distinctly higher than that calculated from photosynthesis. Possible causes for this discrepancy have been extensively discussed. The photosynthesis measurements during the day show a kind of hysteresis curve, a feature that also frequently occurs in our own experiments. Usually with a given light intensity the morning photosynthesis is higher than that in the afternoon and the difference cannot be explained by differences in respiration on account of a higher afternoon temperature.

A very interesting feature is that the respiration during the night is very much dependent on the rate of photosynthesis during the preceding day, suggesting a distinct relation between the quantity of photosynthates produced and growth. Another observation, comparable to what has been found by other workers, is that the growth rate in the heading stage is distinctly higher than that in e.g. the booting stage, although a difference in light energy in these two periods cannot be ruled out.

In so far as photorespiration is concerned, growth at low oxygen concentrations produces shorter plants with smaller leaves, so that a decrease in photorespiration is counteracted by a smaller leaf area. The net effect on the growth rate then depends on the duration of the experiment.

The influence of climatic factors on photosynthesis and crop growth rate has been extensively studied with several grass and clover species and this has led to a quantitative formulation of expected growth rates under the various climatic conditions in Japan. Maximum annual production values are calculated from these and amount to 14 to 15 tons of total dry matter for the southern part of the country and to 11 tons for the northern part. These values are rather low when compared with 17 to 18 tons of dry herbage obtained in the Netherlands. The difference is likely to be due to differences in nitrogen fertilizer level, amounting to 500 kg per ha per year in the Netherlands and to 200 kg in Japan.

VIII. Kyushu University, Biotron 75-05-01

The Biotron of the University is constructed as a research centre for biological processes under controlled conditions. It comprises two phytotron units, a zootron, an entomotron and many specialized facilities besides a well equipped laboratory with modern analytical apparatus.

Unfortunately, there was a general overhaul during the visit so that nothing was in operation. Such an overhaul occurs twice a year during one month, so that the biotron only operates during 10 months a year. The mean occupation of the phytotron was estimated at 80% of the available space. No doubt this biotron is very modern and it is possible to control separate external factors within narrow limits.

Up to now there have been no special difficulties in the functioning as a centre, in the sense that there are not more applicants to work in the biotron than there is space available. The scientific staff discusses the results of their work at staff meetings. Those that are permanently attached to the biotron (16 staff members) have special facilities at their disposal.
Worth mentioning in this respect are facilities to study plant growth at rather narrow spectral regions at intensities of 0.12 J cm^{-2} min^{-1} and a set up in which the spectral composition can be changed from one end of the visible spectrum to the other by varying the intensity of fluorescent tubes with coatings of different colour. Besides the permanent staff there are usually some 20 guest workers. The running costs of the whole biotron were estimated at *f* 2000.- per day.

IX. Excursion to some co-operative grassland farms on Kyushu, SW of Fukuoka 75-05-02

In the southern part of Japan herbage crops are often grown during the winter period, alternating with rice; permanent pasture is only found in the hills, often consisting of cocksfoot and white clover grazed by heifers during summer. In the paddy fields mostly italian ryegrass is grown during winter and spring; the fields are then used for rice that is transplanted in June and harvested in October. As Japan is now exporting rice in substantial amounts animal husbandry is propagated by the government and for this reason the change from paddy field to fodder crops in summer is subsidized. In these cases mainly sorghum is grown. The main yield over the year of such a field is about 80 tons of fresh grass per ha and a similar amount of sorghum, amounting to a total of 25 to 30 tons of dry fodder.

The government also helps in the foundation of co-operative farms of which two were visited, both looking modern and well organized. These farms serve two purposes. Not only do they work more economically than the old fashioned individual small farms, but they also take farming away from the village centres and in this way reduce waste disposal problems there.

X. University of Tokyo, Faculty of Agriculture 75-05-06

This Faculty is well equipped with facilities to measure photosynthesis of whole plants and plant parts and to study related enzymatic reactions. Especially for the comparison of the dark reactions of C_3 and C_4 plants very useful experimental facilities have been constructed and a lot of interesting results have been obtained e.g. in measuring the influence of pretreatment on photosynthesis of both kinds of plant. It could be demonstrated that the temperature has a marked influence on the rate of protein and chlorophyll formation and with it on the relative activity of RuDP oxygenase and carboxylase of etiolated leaves of rice. In comparing rice (C_3) and maize (C_4) it was found that the optimum temperature for photosynthesis was 25° and 35°, respectively, but that the RuDP carboxylase activity increased progressively with temperature up to 40° for both species.

Field photosynthesis measurements in wheat showed hysteresis curves when the relation with light intensity was plotted during the day (see also Kyushu University, page 8). However, contrary to Takeda's and our own observations the highest photosynthesis with a given light intensity was not always found in the morning. The cause of this hysteresis effect is not clear. In relation to this the influence of air and soil temperature on the photosynthesis - light intensity relation and on transpiration is studied and the diffusion resistances calculated. The results show that an adverse effect of low temperature is largest at low light intensities.

Another study concerns the photosynthesis and dry matter distribution of rape with emphasis on the changes of photosynthesis and respiration of the seeds during development and a comparison between calculated and measured dry weight increase.

In so far as radioactive studies with ^{14}C are concerned there is a close co-operation with the Centre for Isotope Research, a centre both for service facilities to other institutes and for own subjects of study, mainly in the field of plant physiology and biochemistry. With ^{14}C the photosynthesis pathway is studied in algae and leaf segments. This pathway seems to be influenced by the wave-length of the incident light. In blue light ^{14}C is especially incorporated in aspartate and

malate and in red light in sucrose. In blue light also the PEP carboxylase concentration increases. Blue light is supposed to inhibit the C_3 pathway.

XI. Obihiro University of Agriculture and Veterinary Medicin
75-05-11+12

Obihiro is a town on Hokkaido, the northernmost island of Japan. At this time of the year even the lower mountains are still covered in snow and in the plains the snow had only just melted so that the deciduous trees were still leafless and the grasslands still covered with dead leaves under which the young shoots just started to grow. The soil is black and consists of very acid volcanic ash. Arable crops in this area are mainly potatoes and sugar beet, but also rice can be grown. Around Obihiro horticultural crops are grown; onions in the open and strawberries under plastic cover. The main grasses in this area are cocksfoot and timothy; in the more elevated parts especially the latter grass, because it is less sensitive to winter killing. Great efforts are made to improve animal husbandry. By increasing the nitrogen fertilization to about 100 kg per ha some 2.5 heads, mainly heifers, can be kept; in an experiment station in the hills north of Obihiro the effect of fertilization on production is studied. Also more eastwards a large farming area was visited. Of a total area of 130,000 ha about 120,000 is under grassland. Farm units of 50 ha each have been established with 68 heads of cattle of which 50 are milking cows. Grass production is about 8,000 kg dry matter per ha in 2 cuts. At an experimental branch station cold resistance of timothy varieties and the interaction of K and Mg are the main objects of study.

XII. Hokkaido National Agricultural Experiment Station, Sapporo
75-05-13

The western part of Hokkaido where Sapporo is situated has a higher temperature than Obihiro at this time of the year. Important crops are onions, rice and also soybean. At the Station much work is done on the effect of low temperature on the growth of these crops. With rice also cold spells during flowering can adversely affect the ultimate yield.

There are excellent facilities for more fundamental research in a rather new phytotron, equipped with controlled glasshouses and climatic rooms and facilities for studying growth and development at different wave-length bands.

This Station also has much contacts with Dutch seed firms, especially on testing the cold tolerance of their grass varieties.

XIII. Towada Experiment Station, Towada 75-05-15

This station situated in Tohoku, the northern part of Honshu, has been especially founded for breeding and testing cold resistant rice varieties. A spring with an abundant supply of rather cold irrigation water is situated near-by and can be used for irrigation with and without heating. The most sensitive development phase for cold damage is 2 weeks before flowering, which is the time of pollen differentiation. This phase is still the main point of research. With regards to the overall cold resistance, the critical temperature has been brought down from 17° to 10°C in 20 years of research. In the mean time the yield of unhusked rice increased from 3,000 kg per ha in the thirties to 6,000 kg in the seventies. A sharp increase in yield occurred after 1950, when the transplanting time could be advanced by two to three weeks by covering the nursery beds with plastic sheet.

The station is located in a very large rice growing area. Everywhere now the nurseries are under plastic cover. Puddling is done by machine, transplanting both by hand and by machine. The fields are usually fertilized with circa 100 kg N per ha and herbicides are used to remove weeds. Sometimes a grain crop is sown after harvest, which crop is used as green manure in the following spring.

In addition to the field work, the Station has a set of some 16 small transportable greenhouses in which the air temperature and humidity can be controlled and in some of them also the temperature of the root medium. Such a set of greenhouses seems to be very valuable when a number of conditions with approximately natural light have to be compared during the experimental period.

XIV. Faculty of Agriculture, Tohoku University, Sendai
75-05-16

A number of different subjects is studied at the Department of Agronomy of this Faculty. Of these the following can be mentioned:

- The study of incident solar radiation on reflection and transmission of photosynthetic active radiation in a rice crop.
- The seasonal changes in production rate of a natural Zoysia vegetation and other grasslands, with emphasis on the occurrence of a midsummer depression which seems to occur especially with C_3 species.
- The influence of daylength and wave-length on growth and development of a number of plant species, including some Basidiomycetes. Again a set up is available to obtain light of rather narrow wave-length bands, using a xenon 2 kW lamp as a light source and both filters and a grid.
- The influence of leaf position and leaf thickness as well as the nitrogen content of the leaves on the rate of crop photosynthesis and dry matter production, using calculation models similar to that of De Wit for comparison.
- The influence of external conditions on dry matter production and chemical composition of a number of crops as grasses, lucerne and rice.

Unfortunately time was rather short for this visit, so that no intensive discussions could take place.

XV. Grassland Research Institute, Nishinasuno 75-05-17

This Institute is comparable to that with a similar name at Hurley (UK) in that it concentrates on all aspects of fodder crop growth and animal nutrition, including palatability, feeding value and chemical composition, but also animal physiology and behaviour. The scientific staff consists of 123 members.
Besides a research planning office there are 6 divisions: Grassland Planning - Ecology - Pasture Plants - Environment - Animal Science - Grassland Engineering. Each division is subdivided into a number of laboratories. In addition to the main station there is a separate Alpine Region Branch.

Unfortunately time was also rather short here, so that only a small number of scientists could be visited.
An important problem in grass production is the fact that in Japan there is a great contrast between summer and winter. In the southern regions tropical grass species produce best in summer, but are often killed in winter when the temperature drops below freezing point. Here, the temperate grasses would do better, but these show heat damage during summer. Consequently these kinds of damage are studied intensively. It seems that it is primarily the plasma membrane that is affected and the composition of proteins and phospholipids shows differences between tropical and temperate species.
Also in field experiments tropical species like Panicum and temperate species like cocksfoot and tall fescue are studied at different sites in Japan. In these experiments grazing trials are included with possible recycling of organic manure. The standard N fertilizer level in these experiments is 300 kg per ha. Species and strains show rather large differences in nitrate content under the same treatment.

To facilitate experiments on feeding value with animals the golden hamster can replace sheep, as experiments have demonstrated. Consequently a large number of experiments on comparison of feeding value are done with this small animal that is very easy to keep and to breed.

In the mineral composition of herbage large regional variations occur, caused by the volcanic soils of different origin. This holds especially for Mn and Co. Although there is nowhere a Mn shortage, high concentrations of this element are suspected to influence animal fertility. Grass tetany occurs occasionally, usually in spring, due to a large K accumulation in the preceding autumn.

On the ecology side the succession in range lands and the influence of grazing pressure on the structure of the sward can be mentioned. Also the changes in botanical composition after sowing a mixture are studied. Animal grazing habits are registered by means of TV camera's. Sward damage by trampling is a serious problem, especially on steep slopes in rainy areas.

Simulation of grassland ecosystems is carried out for three types of vegetation and compared with actual values, viz.

1. Zoysia natural vegetation, 2. grazed temperate grass type pasture, 3. intensively used pasture with short time rotation. The model is based on photosynthesis data and crop structure. It is claimed that the chlorophyll content of the leaf has a distinct influence on photosynthesis. This is demonstrated with crop chambers placed over varieties with clearly visible differences in colour from very light to dark green and concomitant differences in chlorophyll content. For this reason the chlorophyll index, i.e. the amount per unit ground surface, is considered of more importance than the leaf area index. To integrate the incoming light energy over a certain period, a simple device was constructed in that the photocurrent is led through a $CuSO_4$ solution and the increase in weight of the cathode is measured.

A rather serious drawback for establishing and renovating grassland is the difficulty to obtain grass seed in any practical quantity, due to the heavy rainfall and the high relative humidity in the seed formation period. Consequently most of the grass seed needed is imported from the USA.

Conclusions

The general impression of my visit is that the two countries, Japan and the Netherlands, are more or less on the same level in so far as the general standard of living and scientific development are concerned.

With regard to the way of living, of course, there are distinct differences in e.g. size of houses, prices, public transport and the like, but none of them is of any serious importance as far as exchange is concerned; on the contrary, they can be considered as enhancing the charm of visiting a foreign country. The only drawback is the difference in language. It is the author's impression that it is easier to travel in the Netherlands with a basic knowledge of English than to do this in Japan. However, it was not experienced as a very serious difficulty. What is important during a prolonged stay in a foreign country is to prevent isolation through lack of communication. This holds equally for both countries and it is a thing to be considered for each specific exchange.

The scientific outfit of laboratories is on the same level in both countries. Details are given with the report of each separate visit. At a number of laboratories outstanding facilities are available for studying the influence of rather narrow spectral regions on plant performance, even on a biochemical level. The same holds for climate controlled growth rooms and greenhouses. In this respect the special facilities for optimalization of plant performance can be mentioned.

Within the range of the author's own experience and from what he has seen on his visit to the scientific institutions the following suggestions for joint research present themselves. It should be borne in mind, however, that the institutions visited were selected according to interest and that there are undoubtedly many other possibilities of exchange, even on fundamental agriculture, the subject of the author's visit.

1. Studies concerning the conservation of energy in agriculture in general and more especially in greenhouses.

On the practical side there are already many contacts between several institutions in Japan and IMAG in Wageningen.

However, more research is needed to establish optimum conditions for plant growth in greenhouses, both for above-ground and below-ground parts. In both countries research in this field gets more attention now that fossile energy grows more and more expensive. Apart from fundamental aspects, as the study of separate climatic factors, the direction of research differs in both countries. In the Netherlands a series of greenhouses has been constructed in which the climatic conditions can be varied from one to another and the performance of crops compared. In Japan efforts are made to optimalize plant growth in small greenhouses or plant chambers, mainly by meu measuring and optimalizing the rate of photosynthesis. It is considered of extreme importance to use the technical facilities, the results obtained so far and the ways of thinking in the two countries in a joint effort to get results in the quickest way possible.

2. Studies concerning the relation between treatment, structure and performance of plant parts, in particular the photosynthetic performance of leaves.

In Japan, ranging from latitude 31 to 46 N, it is understandable that considerable attention is paid to the comparison of C_3 and C_4 plants. Not only that the biochemistry gets attention, but the reaction of both groups of plants to external conditions is also studied. The same subject is studied in the Netherlands as well; besides, in both countries increasing attention is paid to the influence of pretreatment on leaf structure and photosynthetic performance. Such pretreatments can evoke change in structure which look similar to the difference between C_3 and C_4 plants and combined research efforts in both countries may lead to a better understanding of photosynthetic efficiency.

3. Studies concerning problems of ageing.

Especially during the filling period of storage organs the functioning of the photosynthetic apparatus is of great importance. Prolonging the life span of wheat leaves by preventing infections has an impressive influence on yield and if

ageing could be postponed this is supposed to have a similar effect on production. In both countries considerable attention is paid to this problem.

4. Comparison of the productivity of high producing crop varieties.

In both countries experiments are running in which a large number of wheat varieties of different climatic origin are compared under optimum growing conditions for water and nutrients. It is certainly worthwhile to have close contact about the lay-out and the results of these experiments and to exchange seeds of promising varieties. In fact these contacts have already been realized.

5. Studies on environmental pollution problems.

In Japan the problem of air pollution has already received considerable attention for a number of years and controlled environment rooms and glasshouses are available to study the effects of the most important gases separately and in combination. In recent years this kind of research and the necessary facilities are in rapid progress in the Netherlands too and an exchange of experience and results seems most welcome.

6. Studies on the use of thermal energy.

In Japan the use of waste energy of power plants in regulating glasshouse temperature and in establishing hot water reservoirs for cultivation of fish etc. is studied intensively near electrical power plants. Although not directly within the author's field of work, contacts here also seem to be very profitable.

7. Studies on biological control of weeds and pests.

Work on biological weed control has been started in both countries. Contacts about methods and results seem profitable. Whether or not exchange of research workers is profitable at this stage cannot be judged sufficiently.

8. Contacts on the use of simulation programmes.

In many research institutions in Japan efforts are made to compare the outcome of experiments with simulation programmes in order to gain a better insight into the major plant processes and guidelines for future experimental work.

Appendix I

Itinerary (with indication of institutions and names of visited scientists[1])

April 07 Departure from Wageningen
08 Arrival at Tokyo
09 Discussion about the duration of the stay in Japan and the institutions to be visited; M. Kanda, T. Takakura, T. Horie
10 Free to settle in University Lodge, change money etc.
11 Visit to the Office of the Japanese Society for the Promotion of Science; J. Sugi, Y. Abe
Visit to the Agricultural Attache of the Royal Netherlands Embassy, P. Businger
12 Free
13 Free
14 I[2] Visit to Chiba University, T. Takakura, H. Oizumi, Y. Takasaki, H. Nojima
15 Continuation of visit, R. Ito
II Visit to the Agricultural Laboratory of the Central Research Institute of Electrical Power Industrie (CRIEPI), Y. Minohara
16 III Visit to the National Institute of Agricultural Sciences (NIAS), T. Egawa, Z. Uchijima, I. Tomari, T. Horie, E. Inoue, K. Inoue, T. Saito, S. Isobe, S. Iwakiri, T. Maki, T. Murakami, K. Inada, T. Mizuochi, N. Katsura, R. Ito
17 Visit to NIAS, Konosu, Y. Ota, S. Akita, K. Munakata, S. Matsunaka, I. Tanaka
18 Visit to NIAS, Kitamoto, J. Hirano, G. Takeda, H. Iwaki
19 Travel by train to Kyoto
20 Sight-seeing in Kyoto
21 IV Visit to Kyoto University, T. Watabe, K. Kyuma, S. Kuroiwa, K. Tanaka

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[1] Because in some cases titles were not known with certainty, all titles have been omitted.

[2] Roman figures refer to the same numbers used in the text.

April 22 V Excursion to the Tea Experiment Station north of Kyoto, T. Moriwaki, Katayama
23 Free
24 Travel from Kyoto to Osaka
VI Visit to the Faculty of Agriculture, Osaka University, K. Yabuki, Y. Suzuki, M. Aoki, T. Kozai, S. Hasegawa
25 Continuation of visit
26 Sight-seeing trip round Osaka
27 Sight-seeing trip to Nara
28 Travel from Osaka to Hakata by train
VII Visit to the Department of Agronomy, Faculty of Agriculture, Kyushu University, T. Takeda, W. Agata
29 Sight-seeing trip to Nagasaki
30 Continuation of visit, Saito, Oka, Sugimoto Suchija, Hirota
May 01 VIII Visit to the Biotron of Hyushu University, T. Matzui, H. Eguchi
02 IX Excursion to some grassland farms SW of Fukuoka S. Nishimura
Travel by train from Hakata to Tokyo
03 Free
04 Free
05 Free
06 X Visit to the Faculty of Agriculture, University of Tokyo, Y. Murata, Ishii, Koh, S. Inanaga, M. Samejima, A. Kumura
07 Continuation of visit, T. Saeki, Tachibana, M. Okada
08 Lecture on own work at a meeting of the Society for Agricultural Meteorology
09 Free
10 Free
11 From Tokyo to Obihiro by plane
XI Visit to Obihiro University of Agriculture and Veterinary Medicin, H. Ohara, Y. Mino, T. Shimoda, J. Maruyama, A. Hongo
Trip by car from Obihiro to mountain range grassland overnight stop at Lake Akan

May 12 From Lake Akan visit to Konsen Experiment Station, K. Hirasawa, back to Obihiro

13 From Obihiro to Sapporo by train

XII Visit to Hokkaido National Agricultural Experiment Station, Sapporo, Y. Maki, T. Yamamoto

14 Travel from Sapporo to Tohoku District, boat, train and sight-seeing bus, boat trip on Lake Towada

15 XIII Visit to Towada Experiment Station Towada, H. Sato

Travel by train to Sendai

16 XIV Visit to the Faculty of Agriculture, Tohoku University, Sendai, M. Kanda, S. Shôji, Y. Oda, S. Tsunoda, K. Sato

17 Travel by train from Sendai to Nishinasuno

XV Visit to the Grassland Research Institute, Nishinasuno, T. Okubo, T. Kawai, K. Tajima, T. Okada, Ochi, N. Takano, Kobayashi, Kubo, Akiyama, Takohashi

18 Sight-seeing to Nikko; travel by train from Nikko to Tokyo

19 Free

20 Final meeting

21 Travel by plane from Tokyo to Tel Aviv.

Appendix II

Research and Education system in Agriculture in Japan

I. Universities
   1. National Universities (Ministry of Education)
      Tokyo Univ., Kyoto Univ., Kyushu Univ., Tohoku Univ., Chiba Univ. and Obihiro Stock-raising Univ. etc.
   2. Prefectural Universities (prefectural government)
      University of Osaka Prefecture, etc.
   3. Private Universities
      Tokyo Agricultural University, etc.

II. Research Institutes and Experimental Stations
   1. National Organizations (Ministry of Agriculture and Forestry)
      a. For general aspects of agriculture
         National Institute of Agricultural Sciences
      b. For restricted purposes
         Grassland Research Inst. and Experimental Station for Vegetable Crops, etc.
      c. Regional Experimental Stations
         Hokkaido Agricultural Experimental Station and Tohoku Agricultural Experimental Station, etc.
   2. Prefectural Organizations
      Tea Research Inst. of Kyoto prefecture and Fuzisaka Branch of Agricultural Experimental Station of Aomori prefecture (Towada), etc.