CLUB OF BOLOGNA

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Proceedings of the 1st Meeting of the Full Members

(Bologna, 8-9 November 1989)

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CLUB OF BOLOGNA

PROCEEDINGS

OF THE 1ST MEETING

OF THE FULL MEMBERS

OPENING SESSION

SESSION 1
Agriculture and mechanisation after the year 2000 (presentation of preliminary analyses)

SESSION 2
Process and product innovation
in the agricultural mechanisation

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and proposals for future activity

Bologna
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XX EIMA

Edizioni UNACOMA

1 - Opening Session

Ing. Giancarlo Vezzalini
Chairman UNACOMA Rome - ITALY

Ladies and gentlemen, greetings. I am particularly happy to express to all those who are participating in the first open meeting of the full members of the Club of Bologna a welcome from UNACOMA, the Italian Association of Agricultural Machinery Manufacturers which I have the honour of representing.

This meeting is being held on the occasion of EIMA's twentieth anniversary, of the 20 years of life of this exhibition of the agricultural machinery industry, with 1440 exhibitors, including 312 from 29 different countries.

This initiative was conceived, planned and implemented by UNACOMA in 1969 to offer agents from all over the world the chance of assessing the widest possible range of machinery in an exhibition exclusively devoted to mechanical technologies for agriculture.

However, right from the start EIMA has been much more than a simple "shop window" of the sector's production. It offers above all a chance for an overview of mechanization, of investigating the problems it creates and discussing them with the scientific and research worlds, for a continuous innovation of processes and products.

I would like to remind you that as far back as 1970, and thus at its outset, EI-MA presented the results of the "National Project for Integral Mechanization of Farms", promoted by the Italian National Research Council (CNR) which at that time considered the goal — achieved in later years — of using machines in all culti-vation and processing operations as a "new frontier" in mechanization.

Certainly at that time no one imagined the potential which electronics and information technology applications would have in our sector; however, the project had the merit of posing the problem and indicating effective solutions for the times in which they were proposed.

Another important moment in our relationship with research occurred in 1981, ten years after the first initiative, when the results of the "National Agricultural Mechanization Project", implemented over the five previous years, were illustrated in the framework of eight projects concerning "food sources", all financed by the CNR.

On that occasion, besides exhibiting at EIMA the prototypes of machines produced with that project, the CNR organized an international symposium for analysing and comparing research carried out in Italy and other countries, mainly involving the mechanization of harvesting agricultural products.

Finally, in 1987, in the absence of a coordinated research project on mechanization of a public nature like the two previous ones, UNACOMA took the initiative of organizing an exhibition on the re-search carried out by national university institutes, CNR and the Italian Ministry of Agriculture, and promoted the Inter-national Symposium on Research and its Publication. Hence the Club of Bologna, created to fill the need for a forum, in-formal and voluntary as it might be (but precisely for this more authoritative), for debate. A debate on the important issues we are faced with, on agricultural trends and thus on the role which mechanization must play in a political and economic scenario which has profoundly changed in the past few years, and which is certainly destined to undergo further changes.

This is not the place to anticipate the subjects which form the basis of your first discussion. I only want to stress the soundness of this method of approach, in terms of both nationalities and competences. I also want to congratulate everyone who has felt the need to compare their experience with that of others, to give their contribution towards solving common problems.

The world is, by now, considered a single

global entity, and if this is really so — and I believe it is — I think that putting one's knowledge at the service of all in order to achieve a common goal is the best way to prove that we are really citizens of the world. In our case, this means finding the most suitable machinery for enhancing agriculture in terms of income and quality, involving both the products and the agricultural entrepreneurs of the different countries.

It is with these sentiments and these ideas that I once again express my satisfaction and the gratitude of the Italian agricultural machinery manufacturers to you all for being here with us today, together with the best wishes for profitable work and the success of this initiative.

Thank you.

Prof. Giuseppe Pellizzi
President of the Club

Thank you very much Ing. Vezzalini to you and to UNACOMA. In effect, as Ing. Vezzalini mentioned, in November, 1987, an international symposium was held he-re in Bologna on the subject of agricultural mechanization. The symposium was en-titled "Research and Information-Spreading on Innovations for Agriculture and Industry in the Year 2000", and it was sponsored by EIMA and UNACOMA.

During the closing session of the convention, in which numerous foreign scientists participated, a proposal was made for the periodic exchange of information between countries on the state-of-the-art of agricultural mechanisation, examined from the points of view of manufacturers, farmers and the scientists. One of the objectives was to help define the industry's outlook for the future and its specific requirements.

This proposal was based on the following considerations: the deep evolution experienced internationally by productive agriculture, the increasing internationalisation of the market in terms of both animal and vegetable products and machinery, and the need to protect the rural environment. Consequently, there appeared to be a compelling need for improved and deeper understanding of the evolutionary process in course in various socio-economic, and hence agricultural, systems, as well as the development of mechanisation as an essential tool for agricultural production processes, though in different forms in the various areas involved.

The proposal was welcomed by UNACOMA, which represents all the Italian manufacturers and whom I wish to officially thank on this occasion. UNACOMA felt that it was capable of meeting this need by promoting the establishment of the Club of Bologna for the study of strategies for the development of agricultural mechanisation.

Today, the Club is holding its first open meeting, during which the initial contributions made on this subject will be discussed.

According to its internal rules, the Club is an independent association with two types of members: the first are full members, or high level experts from various countries who are willing to personally work on projects, as well as representatives of international, public and private organizations; and the second are associate members, or all those interested in keeping up with the strategic analyses that the Club expects to carry out (without being directly involved in them, however) and in freely discussing the various results obtained and drawing any useful conclusions.

Therefore, the Club of Bologna intends to be a permanent "observatory" for the study, analysis and investigation of the subject of agricultural mechanisation on the international level. The goal is to de-fine possible strategic paths of development as a function of various countries' current and future requirements and on the basis of alternative scenarios. Let me repeat that all of our work will be based on knowledge about the specific needs of

various agricultural situations, different manufacturing realities and markets and the consequent need for technical assistance. This with the aim to gain a clearer understanding of what can be done and of how and where to do it.

Clearly, UNACOMA has an ambitious and wide-ranging project to place at the disposal of the international mechanical-agricultural community. It requires voluntary commitment and dedication on the part of all members, without any other form of compensation than the satisfaction gleaned from having contributed to a more rational development of agriculture and machinery through the logical expression of one's research and knowledge.

With this goal in mind, invitations to join the Club have been extended to the most highly qualified experts working in various countries and in different areas of this field. They range from agricultural engineers to machinery manufacturers, from economists to agronomists and from those people responsible for agricultural policy to the farmers themselves.

Naturally, as preliminary activities we-re undertaken by the organizing Commit-tee, which later became the present Management Committee with members from prestigious research institutes in France, Germany, Japan, Italy, the U.K. and the U.S., the first question posed concerned whether the idea itself was justified or whether it was a duplication of activities already in progress. Specifically, this question regarded projects that had already been undertaken by various national governments and international organizations (the FAO, UNIDO, UNDP, W.B., etc.), which had been working in the field of agriculture for years. In other words, we did not want to "reinvent the wheel"!

An analysis carried out in this regard convinced us that there was no danger of duplication and that the activities conducted by agencies and organizations, whether national or supranational, had never espoused the goals of our "permanent observatory", even though numerous, valuable studies specially designed to assist developing countries, as well as several, more general analyses had been carried out. Furthermore, a thorough analysis aimed at reaching the same general goals upon which the Club is based has never been at-tempted, despite the fact that today, as a global vision of problems is becoming more and more essential, this analysis is more necessary than ever.

Once our worries in this regard had been put to rest and we became even more convinced of the need to fill this gap for the benefit of the entire world, the Management Committee began to invite experts with various especialisations in the field to join the Club and the numerous, often enthusiastic, positive responses, which gave us great pleasure, further strengthened our conviction to act. The Committee al-so began to discuss how to organize future activities on the one hand and on the other how to set up an initial analysis that would make it possible to take stock of the situation and make several forecasts about the future, within the framework of alternative scenarios for development.

The first such activity is today's meeting, which should help us get to know each other better and discuss some operative proposals, in addition to beginning debate on the issues which are the subject of the reports listed on the agenda.

While these reports will be discussed more fully later on, I would like to take a minute here to mention some preliminary, operative proposals that will be examined in more detail tomorrow morning and which concern the following points:

— the extension of Club membership to associate members, or to all those who, for various reasons, are interested in the developments of this observatory and would like to work with it by contributing any information they might have available;

– the establishment of a permanent technical staff made up of some young re-searchers and engineers whose task would be to collect and make available basic

documentation. In this regard, it would be very important to establish files containing all the studies conducted in this field, and especially those carried out by international organizations;

— the breakdown of research activities by geographical region with the appointment of area coordinators. One possible way of proceeding could involve division into the following four areas: America; Asia and Oceania; Africa; Europe, the Mediterranean and the Middle East;

— the definition of a research program-me to be carried out on the international level by following common methodologies to be determined.

I realize that these proposals are highly ambitious and difficult to accomplish, but I feel I should also emphasize their absolute necessity.

They will involve considerable initial effort on the part of full members, both in terms of the extension of Club member-ship to new full and associate members from various countries and the initial need for more frequent meetings.

All these problems, the structure and the organization of the Club meetings as well as the activity to carry out in the near future will be examined, discussed and de-fined in the 3rd session.

Ing. Vezzalini has now to leave us for other official engagements; let me express him once again, on your behalf, deep thanks for the hospitality offered and for the support of UNACOMA.

G. Vezzalini

I wish to renew my thanks to prof. Pellizzi and to all of you and to express the hope of a successful meeting and a pleasant stay in Bologna. Thanks for your cooperation in favour of a more rational development of the agricultural mechanization in the world.

SESSION 1

Agriculture and mechanisation after the year 2000

(Presentation of preliminary analyses)

G. Pellizzi

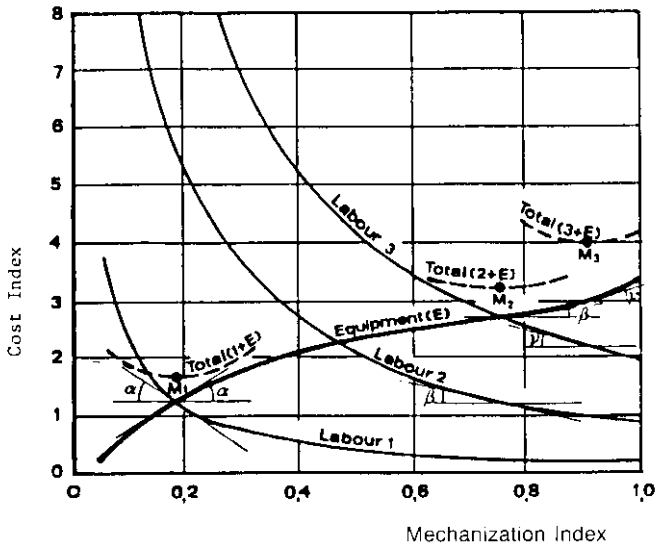
In the field of agriculture, machinery plays a service role which makes it possible to carry out the various operations that are necessary for the existence, development and improved quality of crops and animal productions.

In addition to the intrinsic technological quality of machines and their technical suitability for these operations (in relation to the type of soil involved and the biological, physical and chemical properties of the various products), machinery must meet specific economic requirements, the most important of which is accomplishment of agricultural operations in the least expensive way possible.

This is the reason why it is necessary to determine the work productivity of various machines, which, in relation to the cost of labour, can ensure the accomplishment of various operations at minimal costs. When the hourly cost of labour varies (this figure depends on the level of economic development in each country), the optimal levels of mechanization also change, and hence the most suitable work capacities and machine characteristics can be identified. In general terms, examples of these correlations are provided in the accompanying figure.

It was felt that a preliminary examination of some case studies, using a common approach that was as homogeneous as possible, would represent an initial contribution to increased knowledge about this problem, with an eye towards the development over time of a more complete research project involving the countries represented by active members of the Club of Bologna. The goal would be to create the proper conditions for an initial discussion on the subject, with the hope that all Club members would then want to develop similar analyses in their own countries. The ultimate aim is to have a general framework of comparable data that will make it possible to carry out a comparative analysis and reach conclusions which are generally valid for the future.

The four case studies presented here concern: France, Italy, Japan, and the U.K. The results of the analyses carried out will be illustrated by the individual authors.



Increasing the mechanization levels, the cost of the use of the machinery per hectare increases too (cur-ve E); at the same time, because of the labour productivity growing, labour costs decrease. Therefore, for every wage level (curves labour 1-2-3) it is possible to find the mechanization level minimizing the total costs (M_1, M_2, M_3).

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Agriculture and Mechanization: the Japanese Case

1.1. *Development Over the Past 20 Years*

1.1.1. The socio-economic development of Japan since 1970 is indicated in Table 1.1. in which all monetary values are expressed in 1970 prices.

In the last 18 *years*, the total population of **Japan** has increased by 17.7%. The number of farm workers has, however, decreased drastically: from 17.4% down to 7.9% of the total labour force. That is, 10% of farmers have left their farms and moved to other jobs. Meanwhile, the service sector has developed at a significant rate with an increase in employees of about 10%.

Farm mechanization in Japan has released more farm labour than the above 10% who left agriculture, because the number of part-time farmers in the 2nd category whose main income is from the non-agricultural sector has been steadily rising and is now about 70% of those on Japanese farms as shown in Table 1.2. Consequently, the ratio of agricultural income to the total fanner income has been decreasing.

The gross national product (GNP) at 1970 figures rose by 405% (in US$) and by 258% (in yen), while the gross agricultural output (GAO) rose by 146% (in yen).

1.1.2. The area used for agriculture (AUA) decreased by 7.6% from 5.796.000 (2205m^2/inhabitant) in 1970 to 5.358.000 (2709m'/inhabitant) in 1986. The present AUA consists of paddy field (54.7%), ordinary upland field (23.6%), orchard (10.0%) and meadows (11.7%).

In management terms, the area of 5.358.000 ha can be broken down into 4.222.850 farms with **an** average size of 1. 27 ha/farm. The distribution of farm size is as follows; 41.1% of farms are under 0.5 ha in size, 28.3% are 0.5-1.0 ha, 21.5% are 1-2 ha, 5.9% are 2-3 ha and 2.9% are over 3 ha.

Reduced rice consumption has caused a surplus of rice and the controlled production of this crop has been in effect for the last decade. Consequently, rice field area has decreased by 14%, and meadows have increased by 119%. Imported feed together with greater domestic feed production has stimulated the production of livestock. Rice cultivation has also shifted to other crops such as soybean, wheat, vegetables, flowers and fruits.

An increase of yield per ha has been achieved even for the surplus rice (by 14.9% over a 17 year period). During this same time, yields per ha of other crops rose as follows: wheat: 63.2%, potatoes: 55.6%, soybeans: 34.1%, tomatoes: 8.8%, mandarin oranges: 34.6%, and grass for fodder: 11.0%. These results were achieved by the development of cultivation technology in the form of high yield varieties, more effective fertilizer application, deeper tillage and the timely use of machinery.

Nonetheless, the self-sufficiency ratio of Japanese agriculture dropped from an 81% level in 1970 down to 70% in 1986.

In economic terms, mechanization was the key technology in solving the labour problem. Figure 1.1. indicates the index ratios of labour, energy and machinery prices fanners had to pay to the prices paid to them for their agricultural pro-ducts. The labour index rose quite steadily, whereas the machinery index generally decreased and remained under 100. The energy index was rather stable until the petroleum crisis, and then suddenly shot up, although it subsided to some ex-tent thereafter. In the cost of rice production in Japan, the sum of machinery and labour costs remained almost constant (about 70%) for the last two decades. La-

bour has been replaced by comparatively cheap machinery. However, the total production cost has gone up, and the price of agricultural products has increased by an average 117^{0}7o as a result.

The increased use of various production factors such as pharma-chemicals and machinery created a situation in which the 60.4% rise in net product was sharply inferior to that of GAO, which was 145.8%.

1.1.3. In rural areas, most young people do not want to succeed to their pa-rents' occupation. The increase in number of elderly men and women working farms together with the great number of part-time farmers has stimulated the pre-valence of small and light machine equipment with automatic control so that no difficult adjustments are needed.

On the other hand, full-time farmers now own larger machines and utilize their excess machine capacity either by renting other acreage and thus expanding their total area, or by custom operation; one example of this latter is the "machine-ring" system.

The ratio of machinery investment to agricultural income has increased considerably. However, the ratio of machinery investment to total farm income and to farm management expenses has gone down, as indicated in Table 1.3.

The increase of farm machinery represented by tractors and harvesting machines is indicated in Fig. 1.2. Power tillers or two wheel tractors were replaced by four wheel tractors which have rapidly in-creased since 1970. For rice harvest, the binder system with natural drying and a thresher was widely used in parallel with the combine system with an artificial dryer in the early 1970's. Thereafter, however, the increase rate of binder systems dropped, while the number of combine systems has risen sharply, and this has promoted the mechanization of rice cultivation in Japan.

Installed power in kW on farms is calculated from the number of machines and their average horsepower. Figure 1.3. shows the sum of the installed horsepower of tractors, power tillers, rice transplanters, binders and head-feed combines. There has been quite an increase in installed power in the last two decades. The energy expressed as a ratio of the energy cost of farming to the price index has risen only slightly. On the contrary, power utilization has dropped due to reduced operational hours (21.6%) and the increase in installed power (231%). Power utilization (h/kW) is obtained by dividing the annual operational hours by the installed power in kW. These figures suggest that Japanese farmers are today putting more power into their farming, but with less efficiency. A typical Japanese rice farmer owns about 504 kg/ha of machinery.

1.1.4. With the restriction of rice cultivation and depressed rice price, the farm machinery industry has been suffering from a recession, and the number of companies manufacturing farm machinery is now 10% lower than in earlier years. At present, there are 1,177 companies with 4 or more employees, and a company has 30 employees and annual production of 624 million yen in average.

Production of farm machinery is rather concentrated in the segment including tractors, rice transplanters and combines mainly for paddy fields. These machines are made by larger companies. Tractors are manufactured by 10 large companies and combines by 28 companies. Implements for upland crops have primarily been produced by smaller companies in re-cent years.

Export accounted for 23.1% of the annual farm machinery production in 1987. The main items were tractors (11.3%) mainly to the USA and Canada, lawnmowers (4.3%) mostly to the USA and other miscellaneous implements (7.5%). The ratio of imports to exports was 15.4% in 1970, and the main items were larger tractors from the USA, France, F.R. Germany and Italy.

1.1.5. Innovations in Japanese farm machinery in the last two decades occur-red in the field of automation and safety. Machines and facilities with microprocessors or computers have been introduced. Rice cultivation with transplanting is now fully mechanized and the labour requirement has been decreased by 57^{0}1o. However, Japanese rice farmers still put in 504 hours of labour per ha in 1987, and this was reflected in the production cost. Cost reduction by means of direct seeding and other techniques is expected.

Efforts have been made to mechanize upland crops by developing small-scale machines for soybean, rootcrops, vegetables and feedcrops. Machines and environmental control devices for green house cultivation have been developed, and are now used extensively. Energy saving devices in this area have also been deve-loped, and are in practice to some extent.

1.2. *Prospects for Future Development*

1.2.1. With the decrease in the number of individuals working in agriculture together with the increase in wage level in the years ahead, farm mechanization will continue to be the most important technology for Japanese agriculture. The number of part-time farmers may decrease slightly in the future, and the acreage per farm may increase to a certain extent. However, the basic characteristics of small-scale farming with a considerable number of part-time farmers is not expected to change.

In relation to this, the following is expected for Japanese agriculture.

— Increase of product quantity and quality to raise farm income.

— Lowered cost of machinery, facili-ties, chemicals and other inputs to increase profit.

— Improvement of cultivation and me-chanization as well as marketing techniques by means of information technology.

— Development agricultural processing in rural area to increase farm income.

1.2.2. The following are examples of R & D targets of the Institute of Agricultural Machinery, BRAIN, Japan for the coming decade.

— Development of machines and facilities for higher productivity such as more efficient tractors and engines, a tillage system to promote soil fertility, and implements with more accurate operational capability.

— Development of high capacity ma-chines for paddy, upland, meadows, hor-ticulture and *the livestock industry.*

— Development of machines and facilities for the effective utilization of energy as well as waste from livestock farming with the emphasis on environmental conservation.

— *Promotion* of safety and *amenities* in farm mechanization.

— Improvement of durability and *re-liability* of machines and facilities.

— Application of high technology to develop new machines: New materials, sensors, robotics and *autonomous travel-ling systems* for example.

- *Development of facilities for mechanical grafting of vegetable seedlings and an automated system of measuring plant growth.*

— Application of information technology to farm mechanization: technical data-bases, new instrumentation and data processing system as examples.

1.2.3. For the further development of agriculture toward 2010, the following points should be emphasized.

— Development of mechanization systems suitable for small-scale farming in various regions in the world, because this type of farming is predominant, with 3/4 of the world's population supported by small farmers.

— Development of new machines for new crops not only for food and feed but also for fuel, feedstock, fiber, fertilizer and even for fine chemicals. These crops also include forest and marine biomass.

— Development of new machines and devices to combine biotechnology with agricultural production.

– Development of information systems to optimize agricultural production and economy: by artificial intelligence, for example.

— Development of agricultural product processing technology in combination with agriculture for rural areas.

Table 1.1. - Japan: economic and social indicators

Indicator		Year		
		1970	1980	1987
Total population	(millions)	103.720	117.060	122.090
Labor force	(%)	49.7	48.3	49.8
Working population	(millions)	50.940	55.360	49.110
	(%)	49.1	47.3	48.4 (1988)
Engaged in				
— agriculture	(%)	17.4	10.4	7.9
— 2nd industry	(%)	35.2	34.8	33.6
— other activities	(%)	47.4	54.8	58.5 (1987)
GNP at 1970 prices	(billion US$)	203	501	1.246 (1986)
Agri area used (1000 ha)		5.796	5.461	5.35

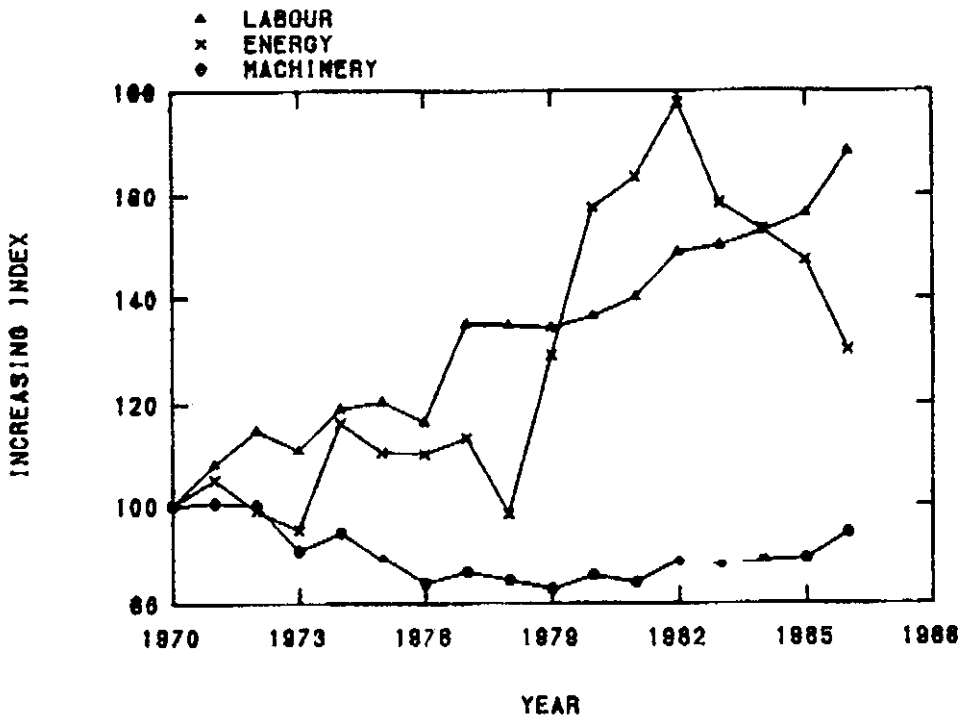

Fig. 1.1. - Increase/decrease of labour, energy and machinery prices in relation to the price of agricultural products

Table 1.2. - Agricultural indicators

Indicator		Year 1970	1980	1986
Number of farms	(x 1000) (%)	5.402 (100)	4.661 (100)	4.331 (100)
Full-time farms	(x 1000) (%)	845 (15.6)	623 (13.5)	643 (14.8)
Part-time farms	(x 1000) (%)	4.557 (84.4)	4.038 (87.5)	3.688 (85.2)
1st category	(x 1000) (%)	1.814 (33.6)	1.002 (21.7)	660 (15.3)
2nd category	(x 1000) (%)	2.743 (50.8)	3.036 (65.8)	3.020 (69.9)
Agricultur income / Total farmer income	(%)	41.3	17.0	14.5

Table 1.3. - Farm machinery investment in terms of farm income and management expense

Index		Year 1970	1980	1986
Purchase value of machinery / Agricultural income	(%)	10.19	17.75	19.40
Purchase value of machinery / Total farmer income	(%)	4.20	3.02	2.81
Purchase value of machinery / Farm management expense	(%)	13.59	11.51	10.69

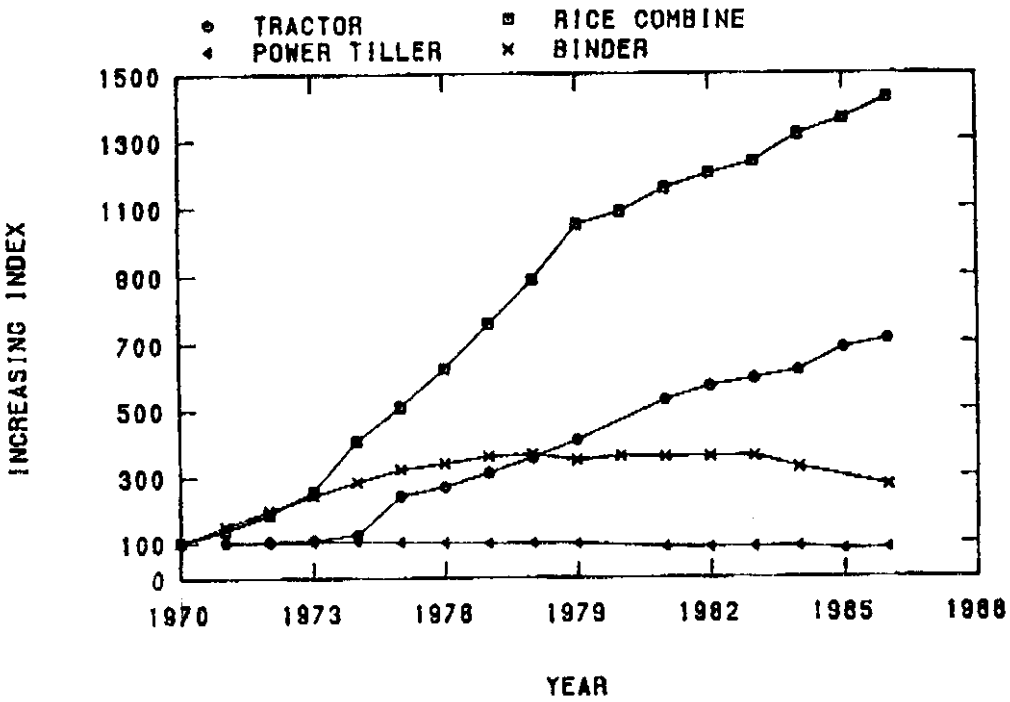

Fig. 1.2. - Development of farm machinery fleet in Japanese agriculture

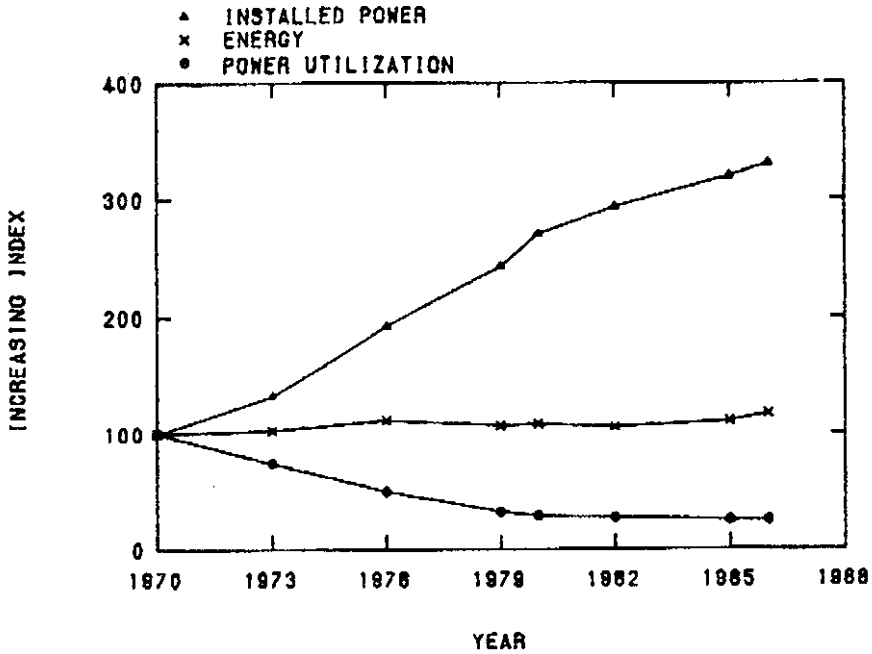

Fig. 1.3. - Development of installed power, energy consumption and power utilization in Japanese agriculture

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Agriculture and mechanization after the year 2000 a review of united kingdom trends and status report

Introduction

This analysis and presentation has been prepared along lines proposed by Professor Pellizzi to attain parallel analyses from representative areas and nations of the world. Although the statistics included have been obtained from national sources and are as far as possible accurate, the interpretations and the predictions for the future are my own and should not be regarded in any way as "official". I would emphasise the great difficulty of making predictions and suggest that the following need always to be taken into account:

a) The predictions are made by a re-search engineer who inevitably tends to be somewhat over-optimistic on rate of change and on the take-up of technology.

b) United Kingdom agriculture, due to the nature of the country, including its offshore position as far as the Continent of Europe is concerned, its substantial north to south dimension, and its varying regional economies, is not a homogeneous whole and figures and predictions tend to represent an average of things which perhaps should not be averaged.

c) There may be an element of my over-drawing situations, giving over-confident predictions and "black-and-white" analyses since such statements allow and en-courage a better discussion.

Statistical Indicators

Table 1 lists the principal UK social and economic indicators giving both national statistics and those relating to agriculture and associated industries. The obvious trends are a fairly stable total population, increase in the proportion working as more ladies now work, and a substantial de-crease in the number working in the agri-cultural industries. The amount and pro-portion of land used for agriculture has dropped, due largely to the development of urban communities, roads and other infrastructural features.

Table 2 outlines some examples of the achievements of agriculture showing ave-rage wheat yields to increase by 50% over the last 20 years, whilst the increase in milk yields is only a small amount less. There is rather less evidence in maximum yields but it is known that several farms have exceeded 12 t/hectare on different occasions when growing wheat. We have evidence that maximum milk yields can exceed 7,000 1/year. The percentage of food which could be grown indigenously, which is actually supplied from the United Kingdom, has increased from 60.5% in 1970 through to 73^{0}7o-75% in the later years. It is a weather-dependent figure and can change by 3% or 4% depending on the weather at crop ripening an harvest ti-me in particular. Some 75% of the cereal crop in the United Kingdom is planted in the winter or autumn season and therefore over-winters in the ground.

Prices of agricultural commodities and of inputs such as machinery, are difficult to obtain with a high degree precision, but Table 3 lists the index of producer prices with the year 1980 given as 100, and also includes costs of machinery and other equipment and separately of tractors. The achievement of agriculture in maintaining a price index well below national inflation is clear from this table. In part this is undoubtedly being achieved by improved mechanisation although one cannot separate the proportion of that effect from the proportion obtained for example from improved crops and animals. The figures for tractors and machinery are extremely difficult to obtain since, throughout the period, increased sophistication has inevita-

bly appeared on both tractors and machines and this cannot easily be rated. It is probably fair to say that a very significant proportion of the increase in price has been due to an improvement in the specification, including an improvement of the quality of and its life. Noticeable among the very successful price reductions on agricultural produce is the situation with eggs where, due to mechanisation and intensification, the price has reduced significantly.

Table 4 shows the statistics of the population of tractors and certain machines on United Kingdom farms. The figures for tractors include certain horticultural types of very low horsepower and for interest the number of track laying tractors within the population is singled out. The most obvious trend in this table is the drama-tic reduction in the number of ploughs and a significant reduction also in the numbers of combine harvesters and drills. These re-ductions are considered to be largely be-cause of the increase in unit size and unit capacity to the extent that less are needed to achieve the same total task. The increase in the number of forage harvesters is a commentary on the substantial movement from hay forage to silage forage requiring the harvester for chopping.

In table 5 the profile of power levels of tractors is compared between 1980 and 1988. An earlier figure is very difficult to use since it was drawn up on different classification lines but the statistics given do clearly demonstrate the increase in high horsepower tractors as a proportion. It would be the author's impression, however, that in the last two or three years sales of very large tractors have probably not increased, although the 60kW to 100kW classification is probably increasing still.

As a commentary to the number of per-sons employed in agriculture I extract in Table 6 the figures from the EEC 1988 re-port "The Agricultural Situation in the Community". It should be noted that the-se data relate to persons employed in agri-culture, hunting, forestry and fishing. They also include all persons working for remuneration or who are self employed, plus unpaid family workers. The very rapid reduction in numbers are apparent and are consistent with decreases in other nations.

Table 7 lists the population statistics of the principal animals and birds on UK farms. Here the numbers of dairy cattle have dropped largely as a result of the milk quota system introduced within the Community. Beef cattle are substantially unchanged as are sheep, whilst with pigs there is a small reduction, but this may not be a significant trend. A similar comment could probably be made on poultry al-though within the UK as a whole there probably has been a small but significant reduction in the amount of meat eaten.

The Agricultural Engineering Industry

The United Kingdom agricultural and equipment industry is characterised, as are so many other national ones, by the broad range of company types, with a relatively small number of large tractor companies and a wide range of machinery companies, down to many that are farm-based or individual workshop-based making one or two different products. Historically, the number of companies has increased as shown in Table 8, whilst the number of workers employed has dramatically de-creased. Due to inflation, the value of ma-chinery and tractors produced is not a very helpful statistic although this is given in what may be rather approximate terms. The breakdown of company size statistics is given in Table 9 for the year 1987 and shows clearly not only the very large number of extremely small enterprises but al-so the presence of a number of very large ones..

The UK industry is of course characterised also by being the main, or one of the main, production centres for three large multinational tractor manufacturers. Of the tractors manufactured, a high propor-

tion, probably approaching 90%, are ex- addition the UK imports trac- however, from an extremely wide range of sources with tractors available ported. In from what is clearly a high proportion of tors, the world's manufacturers.

Table 1. - UK social and economic indicators

	1970	1980	1987
Total population (millions)	55.5	56.3	56.9
Working (active) pop. (millions)	25.3	26.8	28.2
% of total population	45.6	47.1	49.6
Population in employment (millions)	22.5	25.3	
% of total population	40.5	45.2	44.5
Engaged in forestry, fishing (thousands)*	468	370	322
% of working population	1.8	1.4	1.1
Engaged in manufacturing (thousands)	8,339	6,807	5,145
% of working population	32	25.4	18.2
Engaged in other activities (%)	66.2	73.2	80.7
GNP (at 1970 prices) £ million	51,661	66,371	75,596
Agricultural area uses (million ha)	19.1	18.97	18.62
% of total area	79.4	78.73	77.3

* employees, excluding farm owners, partners and wives

Table 2. - Wheat and milk yields

	1970	1980	1988
Wheat yields, average tonnage/ha	4.2	5.9	6.2
Milk, average litres/yr	3,750	4.760	5,250
Max. yields - unable to find reliable data			
Milk (max)	1988	approx 6,510 l/yr	(J Nix)
Winter wheat (max)	1988	approx 8 t/ha	(J Nix)
Milk (max)	1980	approx 5,750 l/yr	(J Nix)
Wheat (max)	1980	approx 6.25 t/ha	(J Nix)
Milk (max)	1974	approx 4.773 l/yr	(J Nix)
Wheat (max)	1974	approx 5 t/ha	(J Nix)

Table 3. - Index of producer prices of agricultural products (1980-100) Uk

	1973	1975	1977	1979	1980	1981	1982	1983	1984	1985	1986	1987
Cereals	50.5	60.0	82.5	97.8	100.0	110.2	118.7	131.5	121.6	115.8	16.7	117.1
Animal/ Animal Products	44.3	59.1	79.1	92.1	100.0	110.0	118.7	119.9	122.7	115.8	116.7	117.1
Milk	39.0	61.7	79.8	88.2	100.0	109.9	120.0	123.2	121.0	130.8	135.7	137.2
Eggs	56.8	61.0	80.9	87.9	100.0	106.1	107.9	95.9	111.2	104.3	92.9	97.0
Machinery and Other Equipment	29.9	45.5	68.4	87.1	100.0	107.7	115.9	121.7	129.4	137.1	144.5	148.7
Tractors	0.20	—	—	89.4	100.0	107.3	113.8	123.0	134.1	143.8	150.2	151.2

Table 4. - UK figures (in thousands)

	1970	1980	1987
Tractors	510.8	531.02	532.610
Tracklayers	13.6	11.83	10.0
Wheeled	430.8	519.191	522.61
Combine harvesters	66.0	57.213	54.520
Ploughs	308.2	218.619	174.485
Forage Harvesters	23.390	46.980	50.726

Table 5. - Power levels - England and Wales only

	1980	%	1988	%
Power Units (2, 4 WD)				
Under 7kW	11.550	2.8	10.300	2.5
7kW-25kW	41.723	10.2	28.800	6.9
25kW-40kW	143.158	35	110.000	26.5
40kW-60kW	157.40	38.4	155.500	37.4
60kW-80kW	45.345	11.1	83.900	20.2
80Kw +	10.413	2.5	26.900	65.5
	409.591		415.400	

Table 6. - Persons employed (in thousands)

1970	1980	1987
792	654	592

Table 7. - Population of principle animals and birds, in thousands

	1970	1980	1988
Dairy cows	3,244	3,224	2,911
Beef cattle	1,304	1,467	1,371
Pigs	8,088	7,815	7,626
Sheep	26,080	31,446	29,045
Poultry	143,430	135,105	127,984

Table 8. - Number of companies and workers

	1970	1980	1987
No. agric. engineering companies	557	644	884
No. of employees	52,900	37,400	20,800
Value of machinery, tractors, etc.	£95M	£967.4M	£1153.4M

Table 9. - Size, employment and output - 1987

Group Size	Enterprises	Employmet	Gross Output
	Number	Thousands	£M
1-9	720	1.7)	
10-19	85	1.2)	224,0
20-49	38	1.3)	
50-99	23	1.6)	
100-199	18	2.8	115,2
100 & above	10	12.2	913.1
TOTAL	884	20.8	1252.3

Agricultural and Mechanization Trends

1. General

For the agricultural engineer I think that this commentary is best addressed by ma-chine type. Innovatory trends will gene-rally be common with the rest of Europe and to a considerable extent will have been introduced around the world. Where this is so I will not mention them specifically.

2. Tractors

In common with other countries the size of power unit has increased substantially. Four-wheel drive, which 20 years ago was present on less than 10% of UK tractors, is now much more common for reasons of stability and traction. UK soils tend to be wet when worked and therefore the provision of adequate traction is al-ways something of a challenge. With so much mouldboard ploughing practised this cannot easily be attained by the use of dual wheels and where they are used it tends to be largely for more secondary tillage activities and for spreading the vehicle's weight on such processes as drilling, rolling etc. The UK was relatively early in introducing protective cab regulations (1967) and maximum noise restric-tions (1973) and therefore virtually all tractors are fitted with some type of protective structure. In the large majority of cases this is a complete cab and with the variable and often inclement weather there has been little demand for uncabbed trac-tors for field work although their "runa-bout" use in the livestock farm is often cited. Due to many years of relatively un-restricted capital purchase on farms many new tractors have been purchased without the old one being sold, and there-fore many farms are, in strict economic terms, over-provided with tractors. The-re are therefore many tractors on farms which are permanently attached with a loader, scraper or some other tool for oc-casional use.

The use of track laying tractors has tended to be severely limited by the high pro-portion of farms which involve road travel. In addition, in contrast to the United States for example, tractors and trailers are used almost exclusively for the tran-sporting of agricultural materials within the farm and to a significant extent off the farm.

Future trends would seem to me to include development of a desire for higher speeds (although this is not yet publicly apparent) due in part to a growing objection to slowly travelling agricultural equipment on rural roads. Concern on soil structures is increasing and the greater use of lightweight vehicles and equipment may develop. Very low pressure tyres, such as "Terratyres" have become used quite extensively.

In connection with farm vehicles, one must indicate the relatively high proportion of specialist vehicles which have been used for crop spraying and fertiliser distribution. These in the main aim to provide either very low ground pressures or very high crop clearance. They are used to a considerable degree by contractors but are also possessed by a number of the larger farmers. It is my impression that many of their characteristics could have been de-rived from specialised versions of standard tractors, but it may very well be that their production would not suit the large scale tractor manufacturers, and therefore their provision by smaller companies may be economically appropriate.

3. Tillage equipment

Although there was a move in the 1960s to replace conventional tillage and planting techniques by direct drilling or zero tillage, in the case of cereals this has retracted very considerably due to problems encountered by broad leaf and persistent weeds and by soil rutting in our wetter conditions. Although some direct drilling is still practised, particularly for crops

such as oil seed rape, it is relatively un common now, to be replaced by either a reversion to ploughing followed by second-dary cultivation in a similar manner to ear her more traditional practices, or by a re- duced cultivation system involving tinec machines but several separate operations The reversion to ploughing and its still high proportionate use, is also to a consi· derable degree due to pressures to avoid or limit straw burring.

Such pressures built up in the early 1980s and after perhaps a year or two of reduced pressure, appear to have resurged in this last year to the extent that I would expect straw burning to be pretty well non-existent within the next five years. However, this is despite the fact that only 50% of the straw produced by UK agriculture is needed for consumption within the industry and therefore 50% needs to be disposed of in other ways.

In the main this straw is now incorporated and is responsible for the sale of straw choppers and spreaders on combine harvesters, for the use of autumn soil breaking practices with tined machines and for the greater use of ploughs, often with a wider access between the frame and the furrows for proper incorporation of the straw.

The drilling of cereals has not changed substantially over the last two decades, perhaps however there has been a retraction from the combined planting of the seed the incorporation of the fertiliser, largely to the farmers' demand for very high speed planting when weather window op-portunities exist which are likely to be shortlived.

One feature that has become increasingly common on drills is the provision of means of creating "tramlines" for succeeding operations. These tramlines or unplanted areas corresponding with the tractor wheel track, are created as means of more accurate spraying and fertiliser distribution whilst not running down the crop while carrying out these processes.

4. Crop Protection

The intensive arable agriculture of the United Kingdom is highly dependent on chemical protection of crops with substantial use of herbicides, fungicides, insecticides and also other chemicals for the shortening of straw. it is perhaps significant that some 15% of the input costs of growing cereals is related to the cost of protective chemicals. A similar input al-so derives from nutrient chemicals. High investment has occurred in the area of equipment for crop protection with increasingly wide sprayers and fertiliser distributors, the substantial use of electronics in these machines to record area completed, forward speeds, dosage levels, and more recently such things as materials remaining and equivalent area capacity of those materials remaining. Safety of the operator and environmental safety are increasingly recognised as important charac-teristics and there is a growing interest in systems which separate the operator from the concentrated chemical. There is also likely to be an increasing interest, which has already started, in techniques which reduce spray drift. It is for this reason that air assisted spraying is being promoted and accepted, although there is still little evidence that this increases the deposition. There is tree and bush crops. Drift is re-cognised as even more of a problem, and in this area it is likely that advance will be made particularly in the use of electrostatics as well as improved profile of spraying.

In fertiliser distribution due to an inten-sifying recognition of high nitrate levels in the soils increasing steps are likely to be taken for better timing of the application and perhaps some increased attention to better spatial distribution.

5. Harvesting

The most important crop in the UK is grass and, with all dairy cattle, most

young stock and a proportion of other fat-stock to be housed indoors through the winter months, the provision of forage for feed for these animals is of prime importance on many farms. Traditionally the UK farmer has made hay but the spring and summer weather is unreliable and in particular over the last 20 years hay has been almost entirely supplanted by silage. In extreme cases three grass forage crops may be taken off the same land al-though two is much more common, and in many cases only one crop is taken. Mechanisation of the silage crop is influenced by a number of important factors.

a) Grass crops are very lush and with increased concern about environmental is-sues that encompass effluent from silage pits and stores, wilting of the crop to re-duce the moisture going into store is common although not universal.

b) Many of the farms are farmer-owned and operated with a minimum of assistance and therefore silage making needs to be carried out either as a one-man operation or in collaboration with other farmers, or by a contractor.

c) In order to obtain good quality silage bunker pits must be filled quickly. This has resulted in labour problems dealt with only partly (b) above but it has particularly resulted in new techniques being explored.

d) Among the new techniques of very considerable importance are the making of silage in large round bales which are then stored in plastic bags or more recently the wrapping of these large bales mechanically by a thin plastic film with adhesive and stretching qualities.

Because of ever widening mowers for economic and work rate reasons the wilting of the crop has become increasingly difficult. Conditioners which have been a very successful innovation have become increasingly somewhat limited with very large windrows in that although they still considerably somewhat limited with very large windrows in that although they still considerably increase the wilting rate, the size of the windrow has tended to work against them and decrease wilting rates. There is thus a considerable demand for other methods of moisture removal. The plastic bag bales are difficult to handle without damage to the bag, they look rather unsightly when piled at the farmstead, and although wrapped bales are better in both of those circumstances I do suspect that their unsightly piles in the countryside may lead to further resistance against their use. Another factor in the making of silage is its delivery to the animals, and this does present some problems with the bale ap-proach, although the move is still in the direction of bales and away from clamp silos. Tower silos have been relatively un-satisfactory in the UK due to the types of forage used including very high moisture contents and rather long crops which ha-ve made mechanical unloading less than totally reliable.

The grain harvest is for the arable farmer an extremely critical time of the year, again because of the variable UK weather. It is quite possible to have many rainy days during the harvest season so that in a good, dry year, it would be possible to complete harvest on many farms in three or four weeks, but in years of less good weather the harvest period can stretch on for at least three months, hence many farmers are over-equipped with combine harvesters and at the same time very well sup-plied with tractors and trailers to provide transport, and this emphasises the importance of that particular machinery. The stripping technique of harvesting has certainly excited attention in the UK, and with the world record in rate of combine harvesting which is typically held in the UK because of our high yield crops and highly sophisticated mechanisation, having been doubled by the stripper harvester, I forecast that there will be a still further rapid increase in the use of the strip-ping technique in order to cut down harvesting times and make the yield less de-pendent on weather conditions. The strip-per also deals with the problem which is

common with our harvest, that of lodging crops, due to heavy rains in the preharvest period.

The grain moisture content at harvest can vary from as little as 13^{0}7o or 14^{0}7o at which it may safely be stored for long periods, to up to 30^{0}7o at which it must be dried rather quickly and, with 15^{0}7o moisture removal, in quite an expensive process. Virtually all arable farms will possess a means of grain drying although this is very variable. Continuous flow driers, on-floor driers using large buildings, and in-bin driers, are all commonly used and there is little relationship between the size of the farm and the type of drier. Fuel costs are not regarded as terribly high al-though they do have a significant influence on total cost, and for this reason most driers are powered by oil, certainly the continuous flow types using high drying temperatures. There is an interest in the automatic control of the drying process be it in continuous flow driers or in bulk storage driers using buildings or bins, when ambient or near-ambient air is employed.

Also at harvests we need to consider horticultural crops of which in the UK the most important are potatoes and leaf vegetables. There is also a significant harvest of the sugar beet crop. Many of our potatoes are grown on stony soils so the-re is still a substantial interest in and need for the separation of stones from potatoes during the harvesting process. There is al-so a need for improved equipment having sophisticated capabilities for the grading and sorting of potatoes since they are increasingly being sold by the supermarket and in other areas in a wide diversity of ranges for different purposes. One trend in the harvesting of leaf vegetables has been to employ gantries to gain access and harvest the crop. Gantries have the facility for reducing soil damage and there-fore reducing the effect of bad soils on both the current and following crops. A typical example would be in the harvesting of cauliflowers where both soil advantages and access advantages at times when market prices are high, have given substantial financial benefits to the users.

6. Livestock

As will be seen from the animal and bird populations above, the dairy, meat and eggs industries are normally large with the average herd over 70 cows and a high proportion of cattle in herds of greater than 100. Although some carousel milking parlours have been introduced these have tended not to be either popular or long lasting such the majority of cows are now milked in herringbone types of parlours with a pit and with typical sizes varying from 4 x 8 to 8 x 8 units. Advances over the last decade are clearly in the main concerned with the incorporation of electronics for automatic identification, feeding and some yield recording. We believe there is a substantial demand for equipment and techniques for automatic oestrus detection, and for subclinical mastitis detection. There appears to be a substantial interest among the more progressive dairy farmers in robotic cluster attachment and the automatic milking systems that can arise from this advance.

Pigs are commonly kept indoors in large buildings with pen accomodation and sows have traditionally been tied up. The-re is a demand, however, for systems permitting sows to move around in their building and hence automatic identification and feed control has been introduced with some interest. The control of feeding systems for pigs is in demand but perhaps the most important among the equipment that can be sold for the intensive meat producer - be it pigs or poultry — is equipment for waste handling and treatment. Environmental factors are very important in the UK and the pressure from the non-farming rural population on farmers to re-duce odours, dusts and effluents, is already at a high level and perhaps still increasing.

The environmental control of livestock buildings is clearly important to stock growth efficiency and our work has shown both proper climatic control and air quality improvement through the reduction of dust and pathogens to be economically important to the farmer. The improvement of these environments by filtration and positive air control using fans or automatically opening shutters is an area where potential still exists for further mechanisation. I would expect greater attention al-so to be given to means of handling and transporting animals in view of the intensification of welfare lobbies.

7. Farm Management

The employment of computer based technologies to assist in decision making and management of farms is clearly an area for future growth. The UK was amongst the earliest countries in the world to begin to adopt personal computers for farm management use. Their increased use has however been somewhat limited, I be-lieve, because the initial use and the sales to farmers were perhaps based on only a limited understanding of the farmer's management needs. However, the use of in-formation technology for farm decision making or decision support is beginning to increase, although it still has not moved far from the management of finance to the management of crops or animals.

Conclusions

Of necessity this paper can only be a very brief appraisal of agriculture and me-chanisation of agriculture in the UK. It tends to have concentrated on a rather in-ward look to the industry whereas it should be clearly realised that diversity is one of the particular issues at the moment and that non-agricultural enterprises such as small factories and offices on farms, tourism and education through farm visits, are a rapidly increasing sector. Out-side agriculture the newer industries of fish farming or acquaculture, and to the United Kingdom, of farm forestry, are being given increased attention. Although a great deal of attention is given to the idea of new crops, very few have taken off in a substantial way. There has been some increase in linseed recently, perhaps some return to greater growth of pulses such as peas or beans, but still very much for the traditional markets of human food or feedstuffs for livestock. The economics of growing agricultural crops for industrial feedstocks and even fuels are still some way from being favourable although I share a belief with, I think, many thinking UK farmers that somewhere in the early part of the next century farming will be the source of these materials which are currently mainly derived from petroleum sources.

In this final section it is perhaps worth underlining those factors which underpin the demands of today's agriculture whichever sector it is in. Clearly the first of these must be the economics and with in-creasing competition coming from increased world trade, from alternative foods and fibres, and from intensified competition within the UK, then the reduction of input cost of agriculture and hence the production cost, must still continue to be a prime consideration. Added to this in many areas there is still a shortage of readily available labour on farms so that new mechanisation techniques that reduce labour input costs are still respectable, and in many cases appropriate. Added to these economic factors, however, is a very rapid and quite strong increase in the pressures coming from socially motivated de-mands on the farmer. Prime above these is the preservation, or hopefully improvement, of the rural environment as part of the "green" initiatives of the present time.

The farmer is feeling such pressures in relation to straw burning, because of both crop protection and nutritional che-

micals, and their finding their way into the soil and water courses, livestock and other farm wastes including silage of fluent, odours and dusts coming oft farms, and perhaps to a lesser extent the interference with traffic in rural areas b3 farm tractors and machinery occupying the roads.

Second to these environmental issues the concern about the welfare of farm ani- mals. Intensive housing is increasingly re- ceiving a bad press and it may well be that customers will exert sufficient pressure or the livestock products of farms, that more extensive and perhaps traditional tech· niques may need to be considered. A more likely need is to produce systems which are both reasonably sparing in labour and other demands, but at the same time give animals more freedom than currently. Ad- ded to the housing and keeping of animals will undoubtedly be the need to improve their transport and their handling both within the farm and between the farm and the abattoir.

Against these socially motivated needs it is perhaps somewhat anomalous that the needs of the farm worker seem these days to be given rather lower priority. The safety and welfare of the workforce which was so much an issue in the 1970s now seems to be taking a rather lower profile. Nevertheless it is with us and I expect that by the beginning of the next century the users of equipment will demand not only comfort and safety but a reasonable level of sophistication to give their task both status and skill which is competitive with that in other — generally factory-based — industries.

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This is not the place to give you all the statistics on the situation in France and its agriculture. it would in fact be too long and boring. For those who have specific problems and questions, there are some very good statistical documents published in the form of books by various countries or by the EEC. I personally often consult them. Today I will just mention a few things which seem to me essential for understanding the most important issues in the future of agricultural mechanization.

It must be said first of all that in France, as on the other hand also in Europe, the percentage of the active population working in agriculture is falling considerably, just as the weight of agriculture in the context of the gross national product is also declining (7.1% in 1973 and 4.1% between 1980 and 1983). Agriculture is thus becoming a strongly minority component and its position is changing from that of 50 years ago.

Secondly, agricultural income increased in France up to 1973, fell with the first oil crisis, then rose slightly again, without however achieving the levels which would ha-ve been expected. It fell again with the second oil crisis and did not increase again in a significant manner.

These two phenomena are part of a new situation in which farmers are no longer experiencing the exceptional conditions they enjoyed when it was absolutely necessary to feed an undernourished population.

But let us take a closer look at some indexes:

1) The evolution of incomes of the en-tire population and the evolution of incomes of the agricultural population. The first figure regards 1973 and the second 1984. It can be observed that almost everywhere the average income of agricultural workers has fallen in relation to the in-

come of the rest of the population. In France, for example, agriculture remains on the level of average incomes, while those of the population as a whole are increasing. It should be noted that the 100 index is not equal in all countries: it corresponds to the situation recorded at a time between the two dates chosen for the comparison.

2) Again in France, intermediate consumption rose from 25% to 45%, whit operating costs increased only slightly, material depreciation was almost constant and incomes were decreasing.

These different elements, in my opi- nion, are essential for understanding quite consistent transformation of the average situation of farmers over the last 10 20 years.

How has the French agricultural machi- nery industry changed over the same pe- riod?

It is interesting to start by recalling European production and the consumption of tractors and agricultural machinery in the various countries. It can be observed that production in Germany is much greater than consumption, production in France is lower than consumption, that in Italy...

Let us now analyse the evolution of the importance and significance of mass production:

It can be observed that, except for trac-tors, which represent a relatively significant mass-production — although much less than automobiles or trucks — machinery is mass-produced in a small or very small scale, which obviously creates particular industrial problems and makes it difficult to absorb technological innovation.

Let us now consider the structure of the French agricultural machinery industry:

We have around 500 manufacturers, unionized to quite a large extent, seeing that 86% belong to the tractor manufacturers' trade-union. At the same time, dealers and rural craftsmen are also important, since they are more or less equal in number to those employed in manufacturing.

The analysis of the evolution of the agricultural machinery market confirms what has just been said: it is a market in steep decline. The significant rise in 1988 in my opinion created a certain illusion. This apparent rise only represents a reco-very from 1986 and 1987, when consumption had fallen a little more than the norm. It can easily be noted that the decline in the agricultural machinery market in France has been quite strong. According to our analysis, this phenomenon is not surprising and will probably continue. Some irregularities can also be noted in 1986-1987 and even as far back as 1985. All this illustrated the features of the market in France (but probably also in the other industrialized countries) consisting of strong, random fluctuations with a gene-rally downward trend.

The decline is in the order of 2-3% each year, which means that in ten years time it will reach almost 30% and obviously involves considerable figures.

It is also interesting to examine the evolution of the number of wage-earners in the agricultural machinery manufacturing sector and compare it with the total turnover of this industry.

Turnover/wages is another index. A strong increase in productivity of the agri-cultural machinery industry can be seen in France, linked to the introduction of automation and numerous robots. This automation and robotization — the results of which are clearly visible in the factories — will also very probably have a similar effect in the agricultural sector.

It must also be recalled that the agri-cultural machinery industry in France is greatly exposed to the risks of the European common agricultural policy which — as you well know — fixes agricultural prices and keeps them higher than the prices which would very probably be charged if the European organization did not exist. A convincing example in this context is given by milk quotas. We know what would

have happened to milk production if the-re had been no quotas and if prices were current ones: it would have considerably exceeded consumption. Certainly no one wants to have production equal to consumption, because the economic optimum of the system — that is the creation of stockpiles necessary to guarantee adequate food supplies in lean years — places optimal production much higher than ave-rage consumption. But the choice of the quota system has heavily influenced the organization of production, and therefore the machinery industry, which under-went a considerable shock following the decision to cut down surpluses.

Thus the problem we are all faced with is that of knowing which indicators and which systems we can use to anticipate the future.

Some link investment in agriculture to agricultural incomes, but there is not just one agriculture. There are many different agricultures in the same country. And this obviously means that it is very difficult to make predictions based on agricultural in-comes. And in the same way, if we want to make forecasts, we must start by putting aside global statistical results for agri-culture and turn to farm technical-economic results, in order to calculate the impact which technical progress could have on agricultural income in a certain number of cases considered to be significant. Only then will it be possible to extrapolate these results using general statistical data. And after having done this, it would still be necessary to estimate the impact of the anticipated trend of agricultural in-come on the decrease in agricultural prices over the long term, and consequently on the new structure of incomes and the market. I myself was rather surprised after making these kind of calculations and I think you will be interested to hear about these results.

When we assessed the impact of technical progress — considered over five years — on a French cereal producing farm, we found out that income would in-crease by 5-10% if technical innovations were used. And this is already contrary to what is normally asserted, and that is that agriculture cannot finance technical progress. On the contrary, it seems that if one asks agriculture to invest in technical innovation, one can obtain a 5-10% improvement in incomes.

Alongside this profit, a 10-20% decrease in working hours was recorded, which provoked a situation of chronic unemployment for agriculture. But for the rest, by optimizing the management system, keeping the working hours constant — and in particular rotations — additional profits of 20-30% could be obtained. And this is already an important fact.

A present farm can thus considerably improve by optimizing crop rotations and keeping its area constant. It can also improve — always keeping its area constant — if it uses materials produced by technical progress.

And there is also the fact that technical progress shifts the area limit which corresponds to the farmer's full employment. And this means that technical progress enables working time to be reduced or — by keeping the working time constant — enables the area of the farm to be considerably increased.

Therefore, by combining optimization of decisions on crop rotations and itineraries with the use of technical progress, we have had the possibility of doubling the income of a farmer in the case examined. Agriculture must thus prepare itself to cope with new and important changes.

Ladies and gentlemen, these were some considerations on the present situation of French agriculture which open very inte-resting prospects for technical progress, but also help us to realize that sociologi-cal and socio-political elements will clearly predominate over technical elements, and that predictions in this context will become even more difficult and uncertain.