ENERGY REPORT

ENERGY IN AGRICULTURE AND WORLD FOOD PRODUCTION

An analysis of the future role of the Agricultural Co-operative Movement

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May 1982

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INTRODUCTION

Food and Energy must undoubtedly be regarded as two of the key points when discussing the world of tomorrow.

The question of Food is disturbing and presents itself forcefully: to what extent shall we be capable in the future of meeting the food needs of this planet? A large part of the world's population do not in fact have sufficient to eat, and the spectre of famine recurs regularly on the international scene, with Cambodia and Uganda as the two most recent examples of this atrocious reality. It is difficult to know how many people suffer from serious food shortages, but from a whole series of studies and commentaries on the subject, it can be estimated that a figure of 500 million would not be far from the truth. But the problem of world food is not restricted to the obvious food shortages: as has been shown by serious studies such as those of Professor Klatzmann[1] of the Institut National Agronomique of Paris-Grignan (France), malnutrition affects almost one person in two in the world, i.e. more than two billion people.

In its study "Agriculture: Toward 2000" the FAO has put forward a global strategy for the solution of the world food problem. Formulated briefly at the end of the study, the four elements of the strategy are:

- modernisation of agricultural production;
- more equitable conditions;
- up-dating of the institutional framework of international policies;
- voluntary action for the preservation of the environment.

The FAO's theme is that there is no solution to the world's food problem unless the less developed countries can produce enough food to cover their own needs.

However, any increase in food production requires greater energy inputs, and according to "Agriculture: Toward 2000" these will in fact show dramatic increases.

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(1) See his excellent work "Nourrir dix milliards d'Hommes" (Feeding Ten Billion People), PUF Collection Sup. 1975.

Taking agriculture as a whole, it must be remembered that this sector has a global energy deficit, and is also increasingly affected by adverse trading conditions. The developing countries are even worse affected by this situation, because of their urgent need to develop modern agricultural production systems, which make large claims on commercial energy (fertilisers, fuel, etc.). How can the developing countries meet this challenge, when they are already confronting a whole range of difficulties: increasing external debts, repayment of which absorbs up to 60% of their export earnings; a steadily increasing food import bill; and a very heavy import bill for oil?

In addition to their economic problems, the developing countries have their specific difficulties, with small farmers short of modern technology in terms of material supplies and skills.

Another major problem for the developing countries is their lack of the financial and human resources needed for the setting up of machines and factories for the production of energy. This problem could be largely resolved through co-operative action.

In view of this, agricultural co-operative organisations must induce the governments of developing countries to include in their development plans wide-ranging investment programmes in the field of education and training, and also, as far as possible, to involve the co-operative sector in such programmes.

It is also useful to bear in mind the terms in which the world energy problem is generally presented: it is not, as with food, a case of putting an end to one of the saddest anachronisms of our time; it is not in fact the developing countries in this case which occupy the centre of the stage, but the industrialised countries with their problems of fossil energy supplies to which the OPEC countries hold the key. Some arguments tend to show the rich and industrialised countries as victims in this respect, thus somehow inverting the arguments on the food problem, where it is the developing countries which are in the weaker position.

However, Food and Energy are inextricably linked and it must be clear today that the problem of hunger in the world can have no lasting solution unless we can master the energy question.

On the question of hunger which, because of its human, social and political implications, is undoubtedly the greatest challenge faced by humanity in these last years of our century, the co-operative movement must, if it is to remain true to its ideals, use all its efforts to fight the Malthusian trends in the developed countries of North America and Europe, the main providers of agricultural raw materials. When the multinational corporations talk about over-production, with the implication that they would like to see world prices retain their present levels, co-operatives must put forward the arguments for international solidarity and the development of North-South trade.

That is the context of this report. We aim to show what practical action co-operators of all countries, rich and poor, can take at their various levels to bring about a solution to the Energy problem. We have approached the question from three angles, corresponding to the three sections of the report.

Part I will give the general framework of the Energy and Food problems. We will attempt to determine the prospects for world energy; we will analyse the nature of the link between Agriculture and Energy from various points of view, with particular reference to the position of the developing countries.

Having set out the problem as accurately as possible, in Part II we will present what is, in fact, the object of the report - the practical possibilities open to the co-operative sector in the field of energy, taking account of the specificity of the co-operative movement and of the special role played by co-operatives in the rural communities of the developing countries.

This will be followed in Part III by some examples of practical co-operative action in the energy sector, most of which relate to countries visited by members of the BECA Secretariat during the past few months.

We believe that this report will provide a starting-point from which, at the Trade Conference, co-operators can exchange experiences and thus help to promote inter-cooperative trade and economic relations in the energy field, which will contribute to the solution of the problems raised.

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The report is the fruit of close collaboration between, on the one hand, the BECA Information Centre comprising a specialist team from the agro-food sector and the international economic field, headed by Professor Joseph Le Bihan of the University of Paris-Dauphine and his assistant Dominique Colon, compiler of the present report, and on the other hand, Claude Scheuer, Executive Secretary ICA/BECA and Branko Zlataric, Consultant to the Agricultural Committee of the International Co-operative Alliance.

The considerable documentation used in the preparation of the report naturally included, in the first place, the numerous studies devoted to the subject by the international organisations, especially the World Bank and the FAO. Particular attention was given to the documents distributed on the occasion of the United Nations Conference on New and Renewable Sources of Energy, held in Nairobi (Kenya) in August 1981. Finally we must make special mention of the excellent work produced by P.J. Meynell and C.E. McKone for the Plunkett Foundation for Co-operative Studies (UK) in November 1981, entitled "A study for a programme on energy use and conservation in agricultural co-operatives and other rural groups" which we have used as the basic document on several points.

In addition to this, the report benefited from the documentation assembled by the ICA Secretariat in London and the BECA Information Centre in Paris.

We also hope that, in the course of the Trade Conference, many participants will give us the benefit of their practical experience in the field of energy, which will further extend our understanding of the problem.

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PART I : ENERGY IN AGRICULTURE AND FOOD PRODUCTION

1.1. THE WORLD ENERGY POSITION AND DEVELOPMENT PROSPECTS

In order to set the problems of Energy and Foor Production in their correct perspective, it is necessary first to give a few basic facts on the world energy position at the present time.

Present position

The position can be summed up by a few figures:

- In 1979 the world demand for Energy totalled 6.9 billion tonnes of oil-equivalent.
- The developed countries were responsible for 86% of this demand, as against 14% for the developing countries.
- 92% of world needs were met from traditional non-renewable sources, divided as follows: 47% from oil, 19% from gas and 26% from coal.
- Nuclear power satisfied only 2% of global demand.
- Renewable energy sources, primarily hydroelectricity, accounted for 6% on the world energy scale, while the new energy sources (wind, solar, biomass, etc.) played a negligible role.

It should be borne in mind that these figures concern only what may be called Commercial Energy. They obviously do not take account of self-subsisting forms of energy (wood, animal traction etc.) which have particular significance for the developing countries. We will return to this aspect later.

Impact of the energy crisis

The energy crisis, and the considerable increase in oil prices which resulted during the 70s, has been at the root of a fundamental change in the respective importance of the various energy sources. However, since it is not possible to foresee any rapid technological developments in the field of new energy sources which at first seemed so promising (nuclear and solar power), it would appear that the greater part of humanity's energy needs for several decades to come will be met from traditional sources: oil, gas and coal.

Many studies have been and are being carried out on future prospects in an attempt to forecast developments in the energy economy of the world between now and the end of the century. Among these we have chosen to present the conclusions reached by the researchers of the American petroleum group EXXON because these conclusions are representative of what is being urged by the majority of the scientific community, and also because they are based on what seem to us reasonable hypotheses, especially so far as developments in the cost factor are concerned.

In effect, this cost hypothesis envisages an increase of 50% in real terms of the Middle East price of crude oil between now and the year 2000. The expected dearer cost of oil will increase the profitability of exploiting national energy resources, whether hydrocarbons or other conventional energy, and will encourage the installation of new production processes for the conversion and utilisation of the various forms of energy.

The EXXON researchers' model anticipates a slowing down of world economic growth, estimated at an average rate of 3% between 1979 and 2000 compared with around 5% between 1965 and 1979. They attribute this slowing down to greater difficulties in realising the profits of production, and increased energy costs. The rate of growth will vary according to the type of country: for the group of industrialised countries, the average growth will be only 2.7% but will reach 5-6% for those countries undergoing rapid expansion and 3% for the others.

The principal changes, as foreseen by the EXXON model, are as follows:

- An increase in the demand for energy at an annual rate of 2.4%, which marks a very clear slowing down as compared with earlier periods (approximately 5% between 1965 and 1973). This will result, in the year 2000, in a world demand of 11.3 billion tonnes of oil-equivalent, compared with 6.9 billion tonnes in 1979.
- The increase will be more rapid in the developing countries (5% annually) than in the industrialised countries (1.2%). Consequently the developing countries, by the end of the century, will be consuming 24% of global energy as against 14% at the present time.

- The preponderance of non-renewable energy sources will decrease but they will still remain dominant since their relative share will only fall from 92% to 78%. Within this group, changes in usage will vary considerably and the share of oil will diminish considerably while gas and coal will remain constant.

The position of oil on the world energy scale will in fact drop from its present 47% to approximately 30% in the year 2000. But since the exporting countries will probably increase their own oil consumption, it will no longer constitute a resource capable of responding to increasing energy needs in the industrialised countries, which will have to be met from new non-oil resources: EXXON even envisages a reduction in oil consumption in the industrialised countries (-9% between now and the year 2000).

The share of oil will decrease in the industrial sector and in the production of electricity where it will progressively give way to coal or nuclear power. This change will be particularly marked in the USA and in Europe. On the other hand, no substitute is currently foreseeable in the field of transport, where oil products will maintain their present position. This will entail an increase in automotive fuel requirements.

Nevertheless oil will continue to play a very important role since, according to the EXXON study, the amount consumed between now and the end of the century could roughly equal the amount already consumed since oil first came into use. The implications of this are that we must continue and increase efforts to exploit difficult areas.

The share of gas should remain stable around 19% while the share of coal could increase from 26% to 28%, oil and gas progressively giving way to coal for certain industrial uses and in the production of electricity.

Nuclear energy will show considerably increased usage and will represent at least 1/10 of commercial energy produced in the year 2000.

The share of hydraulic and other renewable energy will increase from 6% to 8% while synthetic fuels, at present negligible, will cover some 4% of world needs by the end of this century.

The slowing down of global energy consumption will be accentuated by a world-wide energy-saving programme.

THE WORLD ENERGY SCALE (Prospects - EXXON)

	1979		2000	
	Billion tonnes oil-equivalent	(%)	Billion tonnes oil-equivalent	(%)
Coal	1.8	(26)	3.3	(28)
Natural Gas	1.3	(19)	2.1	(19)
Hydroelectricity	0.4	(6)	0.9	(8)
Nuclear Energy	0.1	(2)	1.1	(10)
Oil	3.3	(47)	3.5	(31)
Synthetics	-	-	0.4	(4)
TOTAL	6.9	(100)	11.3	(100)

It is obviously the industrialised countries which can do most in the field of energy-saving. On average, the consumption of commercial energy in the industrialised countries in relation to their populations is approximately eight times that of the middle-income developing countries, and more than 40 times that of the poorer countries.

Notable savings in energy have already taken place in the industrialised countries since the beginning of the energy crisis, but there is considerable room for more.

Past experience clearly shows that fiscal policies (including pricing) are one of the most effective means of controlling demand.

In concluding this section, we would again emphasise the seriousness of the economic problem posed by energy for the developing countries.

Already, as mentioned previously, because of the rapid growth of towns, industries and motorised transport in these countries, the demand for commercial energy is increasing faster than their GNP and the increased oil demand must be satisfied in the great majority of these countries by imports. The high cost of energy causes them great difficulties, and many countries are running into serious problems in order to finance their oil purchases. In 1980 oil imports represented no less than 50 billion US dollars, and the cost is likely to double by 1990. But this increase in imports is more or less unavoidable, since it is very difficult for a developing countries to restrain increased demand, particularly as energy prices on their internal markets have seldom increased at the same rate as world prices. In Indonesia, for instance, internal prices are around 40% lower than world market prices. Energy undoubtedly represents an economic problem of the first order for the developing countries, and unless a satisfactory solution can be found, their own development may suffer.

Having considered the energy problem from the global standpoint, we will now concentrate more closely on agriculture and food production as a whole.

1.2. THE IMPORTANCE OF SELF-SUBSISTING ENERGY IN RURAL AREAS - A SPECIFIC FEATURE OF DEVELOPING COUNTRIES

As has been noted, the developing countries make great use of non-commercial energy, particularly in the rural areas. It is a fact that rural dwellers in the Third World almost exclusively use non-commercial sources of energy for cooking and heating. In many countries these energy sources represent more than 85% of rural consumption (source: World Bank), the most important being wood: one-fifth of all energy (commercial and non-commercial) consumed in the developing countries originates from wood.

Over the past few years we have witnessed growing pressures on firewood resources, causing scarcity in many areas. The FAO has calculated that already more than 100 million people live in areas where firewood is in short supply. There are large zones where natural regeneration is not sufficient to replace the trees and bushes being cut down, and if nothing is done to reverse this trend - which is of course highly improbable - the firewood crisis will affect more than two billion people by the end of the century.

We must be aware of the gravity of this problem, in that the rarefication of firewood supplies causes all sorts of difficulties. Additionally, the collection of fuel takes a lot of time (between 5 and 19 days' work per month per family in the mountainous areas of Nepal) and it is often the children who have to do this, which prevents them from attending school. Further, in many countries and especially those in the Sahel zone of Africa, the desert is encroaching on the forests and this desertification will not be halted so long as the populations have no other sources of energy available at reasonable cost.

The combustion of animal and vegetable products also involves health risks, while their use as fertiliser would make possible the production every year of 20 million tonnes of cereals, providing food for 100 million people[1]. There is the additional fact that when dung and other offal are used as fuel, this reduces the amount of organic fertiliser available to the farmer.

In addition, the destruction of trees and vegetation gives free rein to erosion and reduces the fertility of the soil, leading to reduced food production and.. may, in particularly serious cases, even render the land unfit for cultivation.

During the next twenty years we shall witness in the developing countries, side by side with considerably increased use of commercial energy sources, an expanded demand for firewood for cooking and heating, and the FAO estimates already referred to envisage an increased demand for firewood of 30% by the year 2000.

Under such conditions, improved management of existing forest resources and the planting of new forests are essential. It would be necessary to plant some 50 million hectares of wood suitable for burning between now and the year 2000, in order to meet the domestic (cooking and heating) needs of the developing countries. At the present time the rate of afforestation is less than one-tenth what is needed to meet all their firewood needs at the end of the century; this is an indication of the efforts to be made by the international community. It must be remembered that the question of firewood resources affects a very large number of people, in their family life and their village communities, and concerns very large geographical areas.

It will therefore take many years for the efforts which are (and will be) made in this field to bear fruit.

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(1) Figures quoted by the World Bank.

1.3. THE ROLE OF AGRICULTURE AND FOOD PRODUCTION IN THE WORLD ENERGY ECONOMY

Some 150 years ago, almost all energy came from agriculture: horses fed on hay and oats were used for draught, and wood was used for heating. Thus traditional energy came uniquely from the products of the soil. The invention of thermal engines using fossil fuels (coal, gas, oil) put an end to this situation and, side by side with the agricultural energy sources which remained mostly outside the commercial circuits, there developed a purely commercial fossil energy sector which has, as we saw, taken over almost completely. The contribution of agriculture to the world production of commercial energy has become only marginal (around 1%).

Agricultural production is a very modest consumer of commercial energy when compared with industry and trade, using only 4.5% of available energy in the developing countries and 3.5% in the developed countries.

But the capacity of a planet to absorb and store solar energy through photosynthesis is greatly magnified by the addition of other energy in the form of fertilisers, pesticides and fuel for agricultural machines. In spite of the apparent insignificance of the above figures, we must not forget that in the developing countries, human and animal sources of energy are often of greater importance than commercial energy; in particular, the use of mechanical energy (machines, tractors, automotive fuel) is small and often insignificant.

Added energy is necessary particularly in the form of mineral fertilisers. More than half the increased output achieved by the developing countries for several decades past has been due to a rapid expansion in the use of fertilisers, approximately two-thirds of which consist of nitrogenised fertilisers generally derived from natural gas. The developing countries will therefore need to spend considerable sums on the production or import of the fertilisers necessary for their agriculture.

After fertilisers, mechanisation is the next largest consumer of the energy used in agriculture. Even with traditional methods, the shortage of labour at peak periods often constitutes a serious bottleneck. With intensive agriculture, it is hardly possible to avoid using machines to increase labour productivity. Nevertheless, the developing countries will need to ensure that increased mechanisation does not take place at the expense of jobs.

At world level, the consumption of commercial energy for agricultural production is divided as follows: 48% for fertilisers, 44% for motor energy and 5% for irrigation (source: FAO). In actual fact, the share of motor energy in the industrialised countries exceeds this figure, whereas in the developing countries fertilisers and irrigation represent higher percentages.

It must be borne in mind that the figure of around 4% quoted earlier represents only the commercial energy consumed in agricultural production. But the production is not an end in itself, and when considering the question of food as a whole, it is really the energy consumed by the whole food network which should be taken into account. In this field a clear distinction must be made between the developed and the developing countries.

In the developed countries, the greater part of the energy absorbed by the food network is not used in the production itself but in non-agricultural activities, such as processing, transport, distribution and food preparation.

We therefore arrive at the following paradox: the consumer may expend more energy in his marketing and cooking than the farmer did in producing the food. It is estimated that the whole food network absorbs between 15 and 20 per cent of the commercial energy consumed in the OECD countries.

In the developing countries, the consumption of commercial energy by the food network, not including actual farming consumption, is much lower because rural families themselves consume a large share of their produce and also use non-commercial traditional energy sources for cooking, such as firewood.

Globally the food networks of the rich and developed countries are incomparably heavier on commercial energy than those of the developing countries, and this is expressed concretely in agricultural returns and the difficulty experienced by many countries in satisfying the food requirements of their populations. It is this point that we will now consider in greater detail.

1.4. FOOD PRODUCTION AND ENERGY OR THE PROBLEM OF WORLD HUNGER FROM THE ENERGY ANGLE

The agricultural sector must continue to increase production if hunger and malnutrition are not to get worse. World production and consumption of agricultural produce increased by around 2.5% during the 1970s. But this in no way helped the hungry and undernourished, whose numbers are unfortunately still increasing. In fact, the increase in production remains globally inadequate, and also embraces considerable variation between one country and another. Thus, on the whole, the results in the middle-income countries are considerably better than those in the low-income countries where per capita production is falling.

The world food position is characterised by the extreme contrast existing between the industrialised and the developing countries.

While food surpluses accumulate in the industrialised world, the developing countries are increasing their imports of food products at a rate that they will be unable to sustain if they are to achieve their development goals.

This phenomenon helps to aggravate their financial position, which is becoming openly serious: more and more developing countries are finding difficulty in servicing their external debts.

The FAO study, "Agriculture: Toward 2000", points out that in order to satisfy the growing demand for food products, agricultural production in the developing countries must increase by 3.8% annually instead of the 2.8% hitherto. Therefore, not only must agricultural production increase at a higher rate in the future than in the past, it must at the same time adapt to the new energy situation.

When considering the question of energy consumption in the agricultural sector, we must distinguish between fossil and renewable energy sources. Comparatively recently, consumption became oriented towards fossil energy: human and animal energy was replaced by mechanical energy, and recycled organic fertiliser by chemical fertilisers, all of which increased productivity. At the present time, the world's farmers are faced with the necessity of restricting their consumption of inputs based on fossil hydrocarbons, without at the same time reducing their productivity gains and production increase.

The problem of increasing agricultural production in the developing world under such conditions can be expressed as follows: it is absolutely essential for the developing countries to dramatically increase their consumption of commercial energy in order to accelerate their production growth, and that at a time when energy is very costly. It has been calculated that for every 1% increase in production, consumption of commercial energy increases by 2.3% to 2.4%.

No solution has yet been found which will produce high yields without the massive use of production factors with a large energy content. Without a major breakthrough in research, increased production - in the tropics and the temperate zones alike - will continue to depend on commercial energy. We must not delude ourselves: agricultural technology involving the massive use of production factors based on fossil energy, as practised everywhere at the present time, is the result of half a century of research and development, while any alternative systems using new or renewable energy sources are still in the cradle: they may complement the standard technology but cannot replace it.

In the years to come, the developing countries will have to apply themselves to finding a subtle blend of new technology with the use of standard production factors based on fossil energy, in order ultimately to increase their output.

In its aforementioned study, the FAO estimates that approximately three-quarters of the increase in production necessary between now and the end of the century, can only be assured by more intensified cultivation and improved output, which will be made possible only by the increased consumption of inputs with high energy components.

The FAO envisages increased consumption of commercial energy by the agricultural sector in the developing countries, at an annual rate of between 6.9% and 8.5% between now and the end of the century, which would correspond to an approximate increase of 350% in volume consumed, compared with the present time.

USE OF COMMERCIAL ENERGY IN AGRICULTURE IN THE DEVELOPING COUNTRIES

	Annual Inc. of 8.5%	Percentage consumption				Annual Inc. of 6.9%
	Total (Million T. oil-equiv.)	Fertilisers	Mechanisation	Irrigation	Pesticides	Total (Million T. oil-equiv.)
90 countries						
1980	36	54	31	12	3	36
2000	178	57	38	4	2	138
Low-income Countries						
1980	14	59	16	22	3	14
2000	91	69	24	6	1	69
Middle-Income Countries						
1980	22	51	41	6	3	22
2000	86	44	52	2	2	68

This high rate of increase means that agriculture will occupy a relatively more important position in the world consumption of commercial energy than it does today.

Fertilisers will represent approximately 60% (see table) of the expected global increase in commercial energy consumption by the agricultural sector in the year 2000; this increase will be particularly great in certain regions of the world, such as the Far East, where the scarcity of agricultural land makes increased output the only way of achieving food equilibrium.

Agricultural mechanisation will take the second highest share in the consumption of commercial energy in the developing countries, especially in countries where land is plentiful as in Latin America.

The relative share of pesticides and irrigation in these countries will diminish (see table), although the actual quantities of energy consumed will show a considerable increase.

In addition, there will almost certainly be changes in the food networks of developing countries, so that an increasing share of their energy consumption will be taken up by non-agricultural activities (transport, processing, distribution and preparation of food).

Many developing countries are seeking to reduce their dependence on imported cereals, which usually go to feed the city dwellers. In order to develop their national production, they will need a food network which guarantees that production surpluses reach the towns; this is no light problem when one remembers that in the developing countries the urban populations are increasing at a rate which is 60% to 80% above the increase for the population as a whole, which clearly indicates that the provision of supplies for the towns must develop much more rapidly than total production. It is obvious that to achieve this, the food networks as a whole will lean more heavily on the energy available.

Nevertheless it is still possible to hope that the developing countries will make the fullest use of traditional marketing channels and will reject solutions which rely too heavily on fossil energy.

In conclusion, it would seem that current agricultural technology will impose on the developing countries what Mr. Saouma, FAO Director, called at the Nairobi Conference an "energy transition": i.e. they will have to pass from a traditional system of agriculture requiring few inputs, to production methods with a large energy content and high yields. Failing this, the calamity of world hunger can only get worse and the future food situation in the poorest countries of our planet looks grim indeed.

Without being unduly pessimistic, we must nevertheless bear in mind all the factors that might slow down this transition, nor should we forget, for example, all the human, social and even political problems invariably posed by a transition from an agricultural system with a low energy content, such as the tropical agricultural system, to one with a higher output. We must also realise that the ease with which the transition takes place will depend directly on developments in energy costs. High prices of energy for machines and automotive fuels will inevitably curb the development of agricultural structures in the developing countries, since mechanical energy in those countries competes much more directly and more strongly with human and animal energy than in the developed countries. Therefore the rise in energy prices particularly will slow down the expansion of agricultural production in the developing countries. This is one noteworthy consequence of the energy crisis and the policies of the OPEC countries, which is generally insufficiently stressed.

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PART II : POSSIBLE ACTION BY THE AGRICULTURAL CO-OPERATIVE MOVEMENT IN THE FIELD OF ENERGY

Having outlined the general picture, it remains to define the role which the co-operative movement could play in the context of the various solutions put forward for solving the energy problems in general, and those which severely affect rural communities in particular. It is our view that, so far as energy is concerned, none of the big developments we have described *a priori* excludes the co-operative movement.

We will study the various fields in which the co-operative movement already plays, or could even more effectively play in the years to come, a determining role. In each case we will define, where possible, the practical action which it seems to us desirable either to pursue or to initiate.

The selections we have made are based principally on the specificity of the co-operative movement, which places co-operative organisations in an *a priori* better position than private companies to carry out certain types of action. The importance of co-operatives both in agricultural production and in the life of the rural communities, was a decisive element in our selection, even though we have been careful not to overestimate the capacity of co-operatives, particularly in the developing countries where their resources unfortunately remain very limited.

The objectives of the agricultural co-operative movement in the field of energy emerge quite naturally from the broad perspectives of development which we have described in the first part of this paper, and which can be summed up as follows:

- Agricultural production in the developing countries can only develop fully by increasing the consumption of commercial energy.
- Traditional non-commercial sources of energy, forests in particular, will at the same time become more important.
- Renewable energies will undergo considerable expansion, both the traditional forms (such as hydroelectricity) and the newer forms (biomass, biogas, wind energy, solar energy).

We have arranged within this framework all the foreseeable measures which could be taken by co-operatives under five headings, which can be seen as so many objectives for the international co-operative movement in the field of energy.

The first obvious objective to be pursued by the co-operative movement is to do what it can to reduce the cost of energy for its members, either by the use of energy-saving techniques, or through low-cost supplies (2.1.).

The next three objectives refer to the necessary development of energy sources other than traditional fossil energy. They concern more specifically the developing countries, and can be expressed as follows:

- To contribute to the expansion (in both production and consumption) of traditional non-commercial energy forms (2.2.).
- To contribute to the development of renewable energies, both traditional and new (2.3.).
- To contribute to the development of a new form of agriculture which will be more economical of energy (2.4.).

The fifth and last objective is something entirely different, since it is a matter of solving the organisational and management problems which arise specifically when considering the question of energy. Our aim here is to show not only what co-operatives could do to develop new activities, but also what they are already doing in practice.

2.1. REDUCING THE COST OF ENERGY

Reducing the cost of energy for co-operative members can be achieved in two different ways, either by working directly on the price, or by economies in use.

The measures which co-operatives are taking, or could take, in this area affect all agricultural inputs, particularly the two largest items, fertilisers and agricultural mechanisation.

2.1.1. Controlling supplies of fossil fuels

It is important first of all to stress that anything which co-operatives may do in this field carries the danger that cheaper fossil energy could cause co-operators to relax their efforts to rationalise energy consumption.

The term 'fossil energy' as used here implies almost entirely the oil-based fossil fuels which will still predominate, at least during the next 20 or 30 years; this is because no substitute has yet been found for their use in the automotive energy absolutely essential for the expansion of agricultural production.

The sale of oil to co-operators at preferential rates is already current practice in the French, Scandinavian and American co-operative movements. Some large co-operatives even have their own refineries. Thus in Denmark a supply co-operative controls 10% of the national market in oil. In Indonesia, co-operatives distribute kerosene (paraffin) at wholesale prices to their members. In Canada, co-operatives have been encouraged by the Government to invest in the natural gas and oil sectors. It should be noted that the involvement of co-operatives in the oil network seems to depend on the nature of their relations with their governments.

In the United Kingdom, agreement has been reached between Texaco and a regional development co-operative, Midland Shires Farmers, under which the co-operative takes complete charge of farm oil deliveries. This has led to a reduction in the cost of energy for co-operators because Texaco, for whom this was an expensive operation, used to charge the farmer with the cost of transport. Such agreements are very advantageous, and we can expect to see others of a similar nature in the future.

2.1.2. Fertilisers

We have purposely insisted on the fundamental importance of fertilisers which represent, as stated, two-thirds of the total energy consumed in agriculture.

Consumption of chemical fertilisers can be reduced through the development of new techniques, such as the use in rice-growing of organisms such as azole which have the property of fixing nitrogen. Processes for recycling organic matter can be improved and their use made more general, which would reduce the need for mineral fertilisers; these new processes are linked with new biogas techniques, to which we will return later.

Savings can already be made in the use of fertilisers: it seems to us that it might be possible to end up using smaller quantities and still obtain increased yields, not to mention the more distant prospects offered by the wider use of improved nitrogen-fixing cultures, which would be an immense step forward.

Co-operatives which utilise techniques permitting the rational use of chemical fertilisers, can play an important role in providing training for other co-operatives.

As in the field of oil and fossil energy, the other method of reducing the cost of fertilisers for co-operative members would be to control their production and distribution.

In this field it should be possible to draw up a scheme befitting the specificity of the co-operative sector. It would be a case of one or more co-operatives acquiring bulk-blending equipment which would enable them to mix simple fertilisers on the spot as required. The use of such simple fertilisers has the advantage of availability and cheapness. It should not be forgotten at this stage that the co-operative sector is an important producer of fertilisers, particularly in Japan and India. As for the bulk-blending equipment, it should clearly be the most efficient type, able to produce at least cost the required blend of fertiliser, either sacked or in bulk.

This possibility was mentioned by Messrs. Rouch and Ducroquet in their document prepared for the Trade Conference in Moscow, 1980 (Capital Equipment for Co-operatives). In this report the authors outlined the requirements to be met by a basic installation capable of meeting the needs of several tens of thousands of hectares: 10,000 tonnes storage capacity, a handling capacity of 50 tonnes/hour and two 3.5 cu.m. mixers.

2.1.3. Savings in fossil energy in the field of agricultural and food production

Co-operatives are confronted by the problem of energy-saving. Some co-operatives have obtained particularly interesting results in this field, such as for example the Waterford Co-operative in Ireland which deals in dairy products, and has managed to maintain its consumption of primary energy at a constant level over a period of six years characterised by considerable expansion. It would be good policy for co-operatives which have acquired some expertise in this matter to pass their experience on to other co-operatives by organising training programmes, thus putting their expertise to full use.

The techniques for saving energy are often very simple, and may consist simply of sharing the use of equipment, of adjusting machines for lower fuel consumption, or avoiding journeys with empty lorries, etc. This would help to reduce the cost of agricultural mechanisation, another basic input of agricultural production.

In the field of transport, there are some initiatives which seem quite feasible. The key to the rational use of transport obviously lies in the circulation of information concerning the goods or individuals to be transported. Co-operatives, as well as other types of organisation, could join effectively in this process. In a developed industrialised country, one possibility would be the setting up of a computerised information service, accessible to organisations on subscription. In developing countries, co-operatives could set up offices in the larger towns to act as transport clearinghouses; the method of financing such a service would have to be worked out, but this is apparently not insurmountable as is shown by a scheme about to be launched in Tanzania.

The technology behind energy saving is often more complex, including:

- Heat recovery systems which, in dairies, enable the heat to be extracted from the milk and used to heat the water-system which warms the cow-shed. French co-operatives are very advanced in the dairy field, and should be able to perform a useful role in the development of these techniques in agricultural co-operation.
- Drying-equipment for maize and fodder which can save appreciable quantities of oil. Co-operatives involved in cereal and fodder production could help in supplying this equipment.
- Heat-pumps, which extract heat from air or water and deliver a higher level of heat with a minimum expenditure of energy. It would be useful to equip farms with heat-pumps since, although they work by electricity., the heat produced is no dearer than if it came from the fuel direct. This technology is the monopoly of private manufacturing companies.

On the other hand, where glass-house production is concerned - a field in which energy-saving is particularly important because of the intensive use of energy in this type of agriculture - Japanese (and Israeli) co-operatives can congratulate themselves on considerable achievements, particularly in strawberry- and tomato-production.

2.2. DEVELOPING TRADITIONAL NON-COMMERCIAL ENERGY SOURCES

We have highlighted the continuing importance of traditional energy sources for heating and cooking in the rural areas of the developing countries. The most important is undoubtedly wood, and this is all the more true in that the present tendency towards deforestation in some areas is leading to a scarcity situation, which must be remedied as a matter of urgency.

In this section we will also deal with another traditional source of energy more directly linked with agricultural production: that of draught-animals.

With this type of energy we approach a field in which co-operatives, by virtue of their activities and their geographical spread, are in a position to act much more effectively than any other type of organisation.

2.2.1. Wood

This is a field in which co-operatives are eminently suited to play a determining role, far better than any other economic agent.

Co-operatives can make a practical contribution in the following fields:

1. Initiating forestry plantation projects aimed at producing fire-wood to meet the needs of co-operators

Their efforts should deal above all with the expansion of rapid-growth plantations, particularly in regions of scarcity. Such plantations can produce up to six times more wood than natural forests. The urgency of this problem is such that the FAO recommends no less than quintupling the present rate of plantation[1]. Programmes of this magnitude are very difficult to carry out, and can only succeed with the active participation of the local population. Nevertheless, even from the most optimistic angle, it must be recognised that afforestation, even at this level, will not bear results for some five or six years.

Co-operatives all over the world have for several years been widely involved in projects for developing wood production for energy uses. A study by the FAO (Forestry Paper No.7) evaluated the successes and failures of various such projects, and in the light of this report it appears that the most promising results are those obtained in China

[1] The World Bank estimates that the Third World will need to plant no less than 50 million hectares by the year 2000 to satisfy its fire-wood needs.

and Korea, while experiments in Africa, notably in Mali and Upper Volta, have suffered serious setbacks. The FAO study considers the various factors leading to these results; an analysis of these factors is outside the scope of the present report, but it nevertheless seems appropriate to underline the determining role played by governmental support in the success of the Chinese and Korean co-operatives.

Co-operatives in the developed countries are also keenly interested in the production of firewood, particularly in New Brunswick and Quebec in Canada.

It is also appropriate to draw the attention of co-operatives engaged in timber production, to the possibilities of using their waste-products for the production of energy. The timber itself, that is the main tree-trunk, loses half its volume in unused wood-waste (sawdust, shavings) between the felling and the planking stages. It is now being suggested that such waste should provide fuel for the boilers which feed some of the equipment in the wood-factory: alternators, steam turbines.

2. <u>Developing and producing a charcoal-oven which would be financially accessible to members of co-operatives in developing countries</u>

The production of charcoal from forestry resources is a well-known technique which has the advantage of considerably reducing the weight and bulk of the fuel while preserving its essential calorific value. Charcoal is much easier to transport than wood, and is therefore much easier to deal in commercially.

The traditional charcoal-ovens are heavy on energy and give a low-quality product. There now exist modern ovens which produce high-quality charcoal, but their cost is considerable. There is a noticeable difference in the results obtained, since the modern ovens produce one tonne of charcoal from 6 cu.m. of wood, while traditional ovens need double that volume to produce an equivalent amount of charcoal.

This being so, it would not seem over-optimistic to hope that a co-operative (or group of co-operatives) might be found, willing to develop and produce an oven adapted to the needs of co-operators in the poorer countries and available at low cost, in collaboration with an economic partner if necessary. Obviously the co-operative(s) concerned would not restrict themselves to producing the oven, but would also take care of its distribution, the training of buyers, and maintenance.

3. Developing and producing a wood-burning cooking-stove within the financial means of co-operators

This would be a similar type of action to that described in the case of the charcoal oven, and would consist of the development and production by co-operative production units of a wood-stove adapted to the needs of co-operators. There are several types of stove already in existence which can reduce wood consumption by at least one-fifth, compared with an open fire; however, it would be necessary, more so than with the charcoal oven, to adapt the product to the social requirements of the human habitat concerned. So far as the diffusion of stoves in rural areas is concerned, co-operatives could take advantage of some experience in this field, for example in Guatamala.

The improved energy efficiency being sought in the case of the stove, could also apply to other cooking utensils, food, etc. In this connection it is of interest to describe a project currently being tried out in Zimbabwe, where the technicians are experimenting with a cooking method with low energy consumption. It functions on the principle of conservation of heat, and involves first bringing the food to the boil and then placing the pot in an insulated container to continue cooking in its own heat. All that is needed is a cardboard box and two cushions and it is therefore very cheap to make: it takes 3 metres of cotton to make the cushions, which may be filled with grass, cotton, nylon stockings, pieces of newspaper, or any other similar material. According to Avis Chikwana, director of the project, this apparatus would make it possible to save one-half of the fuel currently used in the country for cooking.

The production of a cheap and energy-efficient wood-stove would seem as important as the development of quick-growing varieties of trees, if there is to be a lasting solution in the coming years to the pressing problem of firewood shortages.

4. Organising the distribution of firewood and charcoal

Finally, co-operatives can and must play an important role in controlling distribution and prices. To do this they must invest in storage capacity, transport, and handling equipment, to enable them to act as wholesalers.

2.2.2. Animal traction

In spite of the inevitable advance of mechanisation, animal traction energy still has an important role to play, not only in the developing countries but also in certain developed countries such as Japan.

As a result of increased energy costs, the whole of the developing world is now taking a fresh look at this potential source of energy, since the rational use of draught animals would make it possible to defer the inevitable, but costly, mechanisation of agriculture. It has been estimated that this form of energy will be used by some 2 billion people for the next 20 or 30 years.

The question of the future position of draught animals in the energy scale is seen quite differently in Africa - where their use is not traditional - and in the rest of the Third World, where animals have been associated with agricultural labour from the beginning of time.

The first priority for improving the efficiency of draught animals must be an improved form of harness. In this field, as in those analysed in the preceding section, the co-operative sector could take action, and has the choice of two distinct methods:

- It could develop, produce and distribute a cheap harness, of better quality than those currently in use, and also take care of the buyer's training.
- It could confine itself to distributing the harness produced by other economic sectors, and here also ensure training of the buyer.

The better alternative would be the development of a new form of harness, and here co-operatives in the advanced countries could provide valuable experience for countries in need.

2.3. DEVELOPING RENEWABLE ENERGY SOURCES - NEW AND TRADITIONAL

Hydraulic energy is the most widespread and the most important of all renewable energy sources (6% of the world energy supply and 23% of world electricity production), and is the only one which can be called traditional.

Co-operatives have an important role to play in this field, in the same way as in the development of new forms of renewable energy (biomass, biogas, solar and wind energy).

2.3.1. Hydraulic energy

Hydroelectricity is bound to undergo considerable expansion, particularly in the developing countries. It is a striking fact that these countries use only a small part of their hydroelectric potential (between 6% and 8%). Large hydroelectric installations and dams give rise to difficult problems of various kinds, particularly in the field of ecology. This is why more and more experts believe that there is room for smaller production units, in addition to the large installations which are still indispensable.

Co-operatives could intervene at two levels:

- In the field of primary technology, with the installation of hydraulic rams and water-wheels;
- At a more sophisticated level, with the construction of small electric power stations to produce up to 50,000 KW. In this case, co-operatives could go into production of small power stations in isolated areas in the developing countries, where they would be very suitable since they would produce electricity more economically than could be done with diesel generators.

The setting up of these small power stations could also provide the opportunity for creating workers' co-operatives, assuming that governments can be induced to assist by subsidising such initiatives, particularly in the carrying out of infra-structural works.

This is what has happened in Japan where, at the request of the co-operative movement, the Ministry for Construction has subsidised small electric power stations (between 150 and 10,000 KW) to meet local needs. Another mini-power-station project exists in Bilar in the Philippines. Further projects are being carried out by the French Co-operative Movement in Botswana and Burundi; these also include the creation of co-operatives.

2.3.2. Biomass

The term 'biomass' comprises the matter of animal or vegetable origin which can be transformed into energy by biological or thermo-chemical processes. Such matter consists essentially of animal waste (dung, bedding) and the parts of vegetables not useable for human food.

The use of wood as firewood and as the raw material for the manufacture of charcoal is already an example of the use of biomass. In other words, biomass is a source of energy which has been in use for a very long time. In this section we will deal with all its other aspects, except for what is called 'biogas' which will be dealt with separately in the following section.

By using biomass, agriculture could - as we shall see - become an important source of commercial energy. In addition, and this is essential for understanding the general interest in this type of energy, biomass is the only source of renewable energy which allows the production of a liquid or gaseous fuel able to feed, where necessary, a motor vehicle or tractor.

Biomass allows the production of two types of alcohol with a high energy potential: methanol and ethanol. The former is the cheaper (between 0.40 and 0.90 francs/litre in 1980) but modern engines will only take a maximum of 2% methanol in the petrol. On the other hand, ethanol (between 1.10 and 1.30 francs/litre in 1980) can be mixed with petrol to the extent of 10% to provide an automotive fuel, gasohol, which is already widely distributed in the U.S.A. It is from gasohol, particularly, that the importing industrialised countries can reasonably hope to see a reduction in their oil bills. It should be noted that engines can even be modified to work entirely on alcohol, as has been done in Brazil where, in 1979, alcohol used as automotive fuel already equalled one-fifth of aggregate petrol consumption.

There are two main processes used for transforming biomass into gaseous or liquid forms of energy:

- dry-stage processes using combustion (pyrolysis, gasification);
- wet-stage processes at atmospheric temperatures, using micro-organisms (anaerobic digestion).*

The techniques for the production of ethanol most widely known to the general public are undoubtedly those of fermentation and distillation. Not only the United States, but also Brazil, Thailand, Indonesia and the Philippines, have started on this type of production.

* The term 'anaerobic' describes micro-organisms and certain live tissues which survive without air, hence without oxygen, and draw the energy they need from the organic substances which they decompose.

It is quite obvious that such developments have the blessing of the governments concerned, to which must be added, in the case of the United States, pressure from the farmers' lobby which sees in this development a fresh market for its surpluses. It is in such countries as the United States, i.e. countries which combine surplus agricultural capacity with an energy deficit, that the expansion of fuel production can be most easily be justified.

Nevertheless such production can also prove of practical interest in remote agricultural areas which have to pay inordinate transport costs in order to obtain supplies of standard fuels.

Ethanol can be obtained through fermentation from sacchariferous products (especially sugar-cane), from roots and tubercles (particularly manioc, potatoes, beetroot, Jerusalem artichokes) and cereals (especially maize and possibly sorghum).

We now come to the problem which interests us here: the action that co-operators can take in the field of producing energy from biomass.

It is clear that co-operatives which produce plants with an energy potential are a priori interested in the production of fuel on the farm. Thus, in the United States in 1979, 5,000 farmers sought permits to distil ethanol, while in the same year the farmers of the Middle West were obtaining alcohol at 0.65 francs/litre. Another interesting initiative: a company in Colorado distributes plans, complete with audio-visual instructions, for installations costing some tens of thousands of dollars and producing 75 litres of ethanol.

The development of small installations for the production of ethanol on the farm is an obvious field of action for co-operatives, but it should be added that such installations may still not prove profitable.

All the same, this does not preclude co-operatives from installing industrial equipment for the production of ethanol, and it is possible to imagine a system such as that which operates satisfactorily in Australia, under which the farmers cultivate sugar-cane which is then processed by their own jointly-owned production plant. For those governments concerned with the equitable distribution of income in the rural areas, such solutions should be encouraged in that they would avoid what has happened in Brazil, where it is a few big enterprises operating large production units which have profited, almost without assistance from the Public Authorities. Apart from Brazil, the other countries which use sugar-cane as an energy crop are: India, Cuba, China, Mexico and Pakistan.

After sugar-cane, manioc is the energy crop most commonly used, both in Brazil and in the Far East. We have no knowledge of any co-operative achievements in this field, although a group of private firms has initiated a project funded by the International Finance Corporation, for the production of 60,000 litres/day of ethanol with material collected from 600 small farmers.

If fermentation and distillation are relatively simple techniques which can, if necessary, be employed at farm level, the same does not apply to the two dry-stage processes described earlier: pyrolysis and gasification.

The technique of pyrolysis would seem only possible for use by large co-operative organisations, but it is quite obvious that in this field co-operatives have no particular advantage over the private sector. On the other hand, with gasification we get much closer to a field of concern to the co-operative movement, in that this process can be carried out using small industrial installations, which seem suitable and fully adapted to use by producers' co-operatives which dispose of large quantities of waste from dry vegetable matter. Gasification produces carbon-monoxide and hydrogen which can be used to obtain a substitute for natural gas, methanol and also electricity. It is in the interest of co-operatives to invest in this field of activity and to take a close interest in all the methods of exploiting this process, which requires only small production units, located close to the final users of the product.

Biological processes for transformation of biomass to produce methane are now in full progress, and the first concern of the co-operative movement must be to keep up with technical developments, in order to be able to stimulate practical projects to meet local needs. Among the plants which can be used for biological processes using anaerobic digestion are:

- maize, currently used in New Zealand;
- water hyacinth (Eichhornia crassipes);
- marine algae.

To sum up, in the biomass field, however important the role of co-operatives may be in certain cases, it is no more important than that played by other types of organisation, particularly those in the private sector.

2.3.3. Biogas

The term 'biogas' as used here means the energy obtained from human, animal or vegetable wastes (in fact, any organic matter) by means of the biological process we have already quoted, methane fermentation (or anaerobic digestion).

This biological process is based on a relatively simple principle and depends on maintaining organic material at a certain temperature (around 35°C) for a certain period (between 15 and 40 days) under anaerobic conditions; the combustible gas produced by this process is methane.

The various production techniques for biogas are of proven success and it is already technically possible to put them into practice on a large scale, both in developing and developed countries.

India and China have developed a rudimentary technique using simple equipment (basically a vat, more often called a digester) and this technique has been adopted by several other developing countries. The production of biogas in the industrialised countries involves more sophisticated processes using wastes from dairy or intensive-breeding units.

Biogas - and this is its main point of interest - adds energy possibilities to the normal use of wastes which, as in the case of dung, are buried in the ground for the reconstitution of humus. Methane fermentation could put an end to the peasant's dilemma in the Third World, who has to decide whether to use his animal excretions as a source of energy by burning them, or to bury them as fertiliser. To sum up, one could say that biogas allows the simultaneous increase in the availability of both fertiliser and fuel.

In addition, the use of biogas in rural areas in the developing countries has other advantages, such as:

- a reduction in the amount of working time devoted by women to collecting wood;
- a reduction in the pressures exerted by human habitation on the ecological environment, caused by felling trees and burning animal excretions.

The interest shown in biogas in the developed countries is of a quite different kind, since it is concerned principally with saving energy and the fight against pollution.

In practice, biogas can be used for heating premises (private and business), or for feeding stationary internal-combustion engines. This type of engine, after suitable modification of the carburettor, can be used to run a generator for the production of electric current, an irrigation pump, or a ventilator for drying hay.

Biogas is difficult to compress and transport; in any case, in rural areas the gas is all used locally. This characteristic explains the a priori important role to be played by the co-operative movement in the development of this type of energy. The nature of the co-operative movement's involvement naturally depends on the technology employed.

The first level of co-operative involvement concerns individual biogas production units, which can operate using the animal excreta from only three cows. Use of this type of unit may cause problems connected with maintenance, which the individual farmer is unable to carry out. Co-operative structures should assist their members in the acquisition, construction and exploitation of small biogas production units, by providing credit and maintenance assistance, as well as specialist advice in the choice of equipment. Such assistance is already provided in China to individual owners of digesters, by teams provided by the communes.

But the cost of biogas production units is still relatively high, especially in relation to the financial possibilities of peasants in the rural areas, and under such conditions, the logical solution would seem to be the construction of larger production plant to meet the needs of the whole village community. In fact, the co-operative itself could take in hand the installation of the biogas plant. Installations of this type are common in India and China, and international organisations are apparently prepared to help in their financing. Several hundreds of village biogas production units are being planned in India.

The co-operative movement could do something even more useful by participating practically in the development of cheap biogas production units, which could then be widely distributed in the countrysides of the Third World. The Chinese equipment is currently the cheapest, and could perhaps provide inspiration for such development.

The co-operative movement could also try to further the use of human excreta as raw material for the production of biogas. Such use comes up against various taboos, even though small processing units could prove very useful and are economically viable with a population of more than 500 persons.

In the developed countries and for more sophisticated types of technology, such as the use of methane fermentation to process the wastes from battery-breeding, the co-operative movement could also play a useful role, as can be seen from the work carried out with digesters by certain Irish co-operatives. At the same time it must be remembered that co-operatives have no particular advantage in this field over other types of economic organisation.

2.3.4. Solar Energy

The techniques for capturing and utilising solar energy are numerous and varied, ranging from the simple food-drier to sophisticated techniques such as photovoltaic cells. Although quite promising, these various techniques are only in the early stages of industrial exploitation, in developed as well as developing countries.

As we shall see, there are many measures which co-operative organisations could take in the field of solar energy, the nature of which will depend on the technique used.

Solar driers take various forms, from the simple polythene tent used in many parts of Africa and Asia for drying fish, fruit, etc., to the special cabin fitted with a solar collector. Co-operative structures provide a framework within which individuals could join together to gain access to solar driers. Solar technology is undoubtedly the field which can, and must be, developed the most rapidly by co-operative organisations in the developing countries.

In the developed countries, solar driers of larger dimensions could offer an economically advantageous alternative to mechanical driers using fuel, as would seem to be shown by the example of an Italian co-operative in Perugia where a solar collector of 74 sq.m. has been installed for drying tobacco; this solar drier has led to a saving annually of the equivalent of 3.5 tonnes of fuel.

The other method of preserving commodities is by cold treatment, and in this field also solar energy appears to provide a solution suitable for areas situated a long way from traditional fossil energy supplies. Co-operatives could set up ice-making plant at village level, using a technique which has already been well tried and has proved economically viable even for small projects. Such plant, linked to cold-stores, would make it possible to preserve agricultural produce pending sale, which could be extremely significant from the economic point of view.

Solar energy also comes into the crucial field of water supplies, a daily problem for hundreds of millions of men and women in all continents. This pressing problem could be solved locally by the installation of solar pumps, as suggested by the Sahel example.

In the Sahel, which is frequently subject to drought, boring has made it possible to retrieve significant quantities of water from the second phreatic layer which - an important point - unlike the first, is not dependent on the vagaries of waterfalls and is also not subject to pollution. Bearing in mind supply difficulties (bad tracks) and the lack of technical infrastructure, all the evidence shows that solar pumps, which need very little maintenance, are the only satisfactory means of extracting this water.

In this context it is of interest to quote, among others, the equipment developed by the French engineer Guinard which has been installed in many of the African countries in that region (Cameroon, Mali, Senegal, Nigeria, Upper Volta). The equipment functions as follows:

In the morning approximately one hour after sunrise, when the sun has reached a height of 20 to 22 degrees above the horizon, the pump starts itself up and rotates for a few minutes before delivering. As the speed of the pump increases, the first drops begin to trickle out. When the sun reaches a sufficient height, the flow reaches the maximum which it maintains for three hours before diminishing again towards dark.

The only maintenance required is cleaning the solar panels to prevent dust from reducing their efficiency, which is necessary every 8 days or 3 months, according to climatic conditions.

The main disadvantage of this type of equipment is its high cost, although such monetary criteria lose their validity in a situation such as the Sahel where no other satisfactory solution has been found.

The installation of pumping stations for water, which could be used both for human food and for irrigation, should be a preferential field of action for co-operatives, particularly as the co-operative structure is in a position to attract the financial means necessary for such operations. In addition, the French co-operatives have already achieved practical results in the field of solar pumps, having installed one in Mongolia, near Dalanzagbad, which functions very satisfactorily.

Another initiative by French co-operatives is also worthy of note, which was to set up production in Hungary, on a co-operative basis, of solar panels to be used for irrigation.

Future technological developments are likely to bring down the cost of photovoltaic pumps, which are of particular interest to developing countries because of their extreme simplicity and exceptional durability.

Another possible field of action for co-operatives is the design and production, as with wood stoves, of solar stoves suited to popular requirements in terms of cost and technology; the greatest progress in this field seems to have been made in India.

Among all the new sources of energy, solar energy is undoubtedly the one in which governments and international organisations are taking the greatest interest, and this would be an opportunity for co-operators to participate in some of the projects being set up. The creation at the end of the 1970s by the Economic Community of West Africa of a regional centre for solar energy at Bamako in Mali, is a manifest example of such interest.

2.3.5. Wind energy

Wind energy has its origins in the sun: the flood of astral rays causes unequal heating of the atmospheric masses of air, giving rise to circulatory movements between zones of differing temperatures and pressures.

One of the essential advantages of wind energy lies in the fact that it is captured in mechanical form and can thus be used direct; hence the time-honoured use of windmills for producing flour.

The transformation of wind energy into electrical energy is a profitable operation. In addition, and this is undeniably its trump-card, the techniques of wind energy are already fully developed: it is not necessary to wait for scientific progress in this field in order to put it to industrial use.

Co-operatives should take a close interest in small wind-powered production units (less than 100 KW). Such units are intended to function independently and are designed for specific uses such as:

- pumping water for human consumption and irrigation;
- heating;
- providing electric current for small installations in isolated areas.

On this small scale it is easily possible to deal with the necessary storage of the energy produced. The method most generally employed is that of storage-batteries.

Setting up such equipment could be of great economic utility in isolated regions where climatic conditions are particularly favourable, in spite of the comparatively high cost of this type of energy. In this field, the choice of site is the determining factor.

In our view, co-operatives should take the initiative in the field of wind energy projects, wherever climatic and environmental conditions are favourable.

It remains to be seen whether such initiatives would be restricted to giving members access to wind-powered equipment for the production of energy, as well as providing maintenance, or whether co-operatives could not take in hand more ambitious initiatives, possibly in association with other economic partners, for the production in whole or in part of the necessary equipment, together with its distribution and maintenance.

2.4. CONTRIBUTING TO THE DEVELOPMENT OF A NEW ENERGY-SAVING FORM OF AGRICULTURE

The technological context of agricultural production will almost certainly change, and the co-operative movement must use all possible methods to support any research, wherever carried out, leading to the development of more productive and less energy-expensive agricultural methods.

The object of this section is to outline some of the more promising lines of research being pursued in this field. We shall see that we are dealing most often with fundamental research all over the world, in public and private laboratories, relating to what is now generally called biotechnology.

The first line of research is concerned with photosynthesis, and its rather ambitious aim is to try and improve the efficiency of the process. Photosynthesis is in fact very inefficient, in that less than 1% of the energy contained in the sun's rays is fixed by the plant in the form of chemical energy.

Photosynthesis is the result of an extraordinary combination of very sophisticated processes, and it is quite utopian in the present state of knowledge to hope to improve its efficiency in the short term.

On the other hand, in the longer term, better knowledge of the internal mechanisms set up in the course of photosynthesis could lead to improving the protein, lipid and sugar content of the plant, and hence the nutritional value of agricultural produce. It is on these internal mechanisms that a whole series of fundamental research is taking place.

Nitrogen fixation by the plant constitutes another axis along which several research programmes are already being undertaken in the laboratories.

Most plants are in fact not capable of obtaining all the nitrogen they need directly from the atmosphere, and the consequent shortage must be made up by the use of fertilisers. The capacity of some plants, legumes in particular, to fix atmospheric nitrogen is due to the action of certain bacteria found either in the soil or in the roots of the plant itself. It has been possible to calculate that these bacteria enable between 50 and 60 million tonnes of nitrogen to be fixed annually, which is equivalent to the volume consumed by the agricultural sector throughout the world in the form of nitrogenised fertilisers.

Very precise studies are currently being made to determine the most efficient bacteria associated with each legume. Tests are also being made to determine whether certain bacteria could not be used in combination with plants other than legumes, cereals in particular, to improve their fixation of nitrogen.

Other research is much more ambitious, and aims at intervening in the mechanisms involved in nitrogen fixation by the plant. It has been discovered that one particular enzyme, called nitrogenaze, is responsible for nitrogen fixation, which gave researchers the idea of trying to locate what it is in the chromosomal structure of certain bacteria which leads to the appearance of this enzyme. The object of this research is to make it possible to transfer, by genetic manipulation, the relevant part from one bacterium to another in order to confer on other types of bacteria the property of fixing atmospheric nitrogen.

Another line of research currently being explored consists of finding means of obtaining nitrogenaze through synthesis. A discovery in this field would be of major importance, since fertiliser manufacturers would then be in a position to produce nitrogen directly at a cost to defy all competition; it has been possible to calculate that a few kilograms of enzymes would be sufficient to generate the equivalent of the total world production of nitrogenised fertilisers, which indicates the enormous impact that such discoveries could have on production conditions.

2.5. OVERCOMING ORGANISATIONAL AND MANAGEMENT PROBLEMS INVOLVED IN SETTING UP ENERGY PROJECTS

It is obvious that co-operatives will be unable to realise the ambitious objectives we have described, unless they can overcome the organisational and management problems inherent in such action.

It is essential that co-operatives pay close attention to government policies in the field of energy; since the beginning of the energy crisis, the public authorities in most countries are intervening more and more in this field, taking appropriate measures to encourage energy-saving and the development of new forms of energy. Thus it is often possible to obtain government credit and other forms of assistance for certain types of project.

Before going further into the analysis of organisational and management problems, let us remind ourselves of the following fact: action such as we have described is not within the province of the individual, and depends on co-operation for its fulfilment.

If co-operatives are to carry out their projects successfully, they must overcome the problems involved, and it is obvious that they will need advice at all stages of a project from conception to realisation.

In this section we will first present, as fully as possible, the various sources of finance possible for the projects mentioned; we will then elaborate on various management techniques, and will conclude with a glance at the role which could be played by computerisation in the approach to these questions.

2.5.1. Sources of Finance

It is important to distinguish between the financing of small projects, usually concerned with non-commercial sources of energy, and the larger projects involving more sophisticated technology.

In effect, co-operative organisations are usually in a position to finance only modest projects. Only a few large co-operative organisations, supported by co-operative banking systems, can assemble sufficient financial means to carry out the larger projects.

As a general rule, once a project reaches certain dimensions, co-operatives must call on external sources of finance. This problem was considered on a global scale at the International Conference on Energy held recently in Nairobi where it was decided, in view of the specific nature of the energy problem, to discuss the setting up of the equivalent of a World Bank to specialise in energy.

But for the present it is only an idea, and when a co-operative in a developing country wants to initiate an energy project, it usually approaches the development banks in its own country and the international finance bodies. These latter are very numerous, and it seemed useful to make a brief inventory, divided as follows:

1. Large co-operative movements (and other Non-Governmental Organisations) in the developed countries;

2 The various bilateral agencies set up by the principal developed countries to assist the developing countries: CIDA (Canada), ODA (U.K.), NORAD (Norway), SIDA (Sweden), AID (U.S.A.).

3. The multilateral agencies belonging to the United Nations which, strictly speaking, do not provide capital but technical assistance. Organisations in this category are: FAO, UNDP, ILO, etc.

4. The other multilateral agencies of the United Nations whose object is to provide finance: the most important of these is undoubtedly the World Bank family (comprising IBRD, IDA and IFC). Mention must also be made of the agencies linked to

regional banks such as the African Development Bank and the Asian Development Bank.

5. Private sources of finance to which the co-operative sector has hitherto seldom resorted, since their interest rates are much higher than those of the UN financial bodies.

These different sources are not incompatible, and it is usual to apply to several financing bodies in connection with any one project.

2.5.2. Management techniques: Feasibility Studies and Energy Audits

Before deciding whether to grant credit, a lending organisation will undertake a special study, known as a feasibility study, to evaluate the project.

This study, dealing with all aspects of the project (technical, economic, human resources, environment) enables the potential lender to judge its economic viability and, in the final analysis, its financial profitability.

However, for anything concerned with energy, feasibility studies come up against a particular problem, which is the difficulty of forecasting future trends in energy prices, particularly oil, which makes it very difficult to estimate precisely to what extent the energy produced will show an economic advantage.

Co-operatives with projects in the energy field must be clearly aware of the decision procedures of lending organisations, and of the central role played by feasibility studies; in this way they will be able to orient the conception of the project in the right direction and present requests for financing which stand a better chance of success.

The nature and specificity of the energy problem requires another type of approach: the energy audit. This consists of a detailed analysis of all the energy-flows within any production system, in order to determine the areas where there are energy losses or where savings in energy could be made. The energy audit makes it possible to test scientifically the efficiency of any method aimed at saving energy and, in so doing, it consitutes an indispensable element in energy management. The energy audit should form part of all feasibility studies relating to projects where the energy element is a determining factor.

Every phase of a project, from conception to realisation, requires a thorough knowledge and mastery of numerous managerial techniques, of which the feasibility study and the energy audit are only two aspects. In this field co-operatives will need the assistance which a structure such as BECA is in a position to provide. In our view, such assistance should cover equally the search for financing and the training of the personnel necessary to set up the project.

2.5.3. Computerisation

The development of computerisation is a fact of present-day life. The rational use of computers adapted to the specific needs of the rural world can make considerable progress possible in all aspects of farm management.

Linked to electronic measuring instruments, computers can automatically control certain basic elements in agricultural production, such as the humidity level of stored grain or the composition of animal feed.

Computers can also help fundamentally to rationalise the use of energy, allowing substantial energy savings. Certain results seem to show that a reduction in the consumption of energy of the order of 2% to 3% can be achieved when automatic systems are used for irrigation, ventilation or heating.

It is undeniable that computers will play a fundamental role in the future development of co-operative organisations: it is likely that many co-operative organisations will very shortly become owners of computers to which all their members can be linked. It is not fanciful to imagine that in the years to come, more and more farms, at least in the developed countries, will have keyboard/screen systems giving the farmer access to all the processed data and programmes of a central computer. By this means the farmer of tomorrow will have access to information on local conditions (price variations, etc.) and to the co-operative organisation itself, and will be in a position to manage his farm more efficiently, including the energy aspect.

One can see BECA becoming a supplier of computer services for co-operatives, and promoting solutions adapted to the co-operative sector in all areas of production and management, especially in the management of energy.

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PART III : SOME EXAMPLES OF CO-OPERATIVE EXPERIENCE IN THE FIELD OF ENERGY

The last part of this paper aims at a brief presentation of some examples of co-operative experience with regard to the energy problem. We will first examine the experiences of two developed countries particularly active in this field - Japan and France; we will then refer to the Israeli case which has some original aspects; finally the co-operative achievements in the Philippines, which will give us an approach to the problem from a developing country.

3.1. JAPAN

Japan, the third economic power in the world, is a very interesting case so far as energy is concerned, in that it is almost wholly dependent on imported fossil energy, oil in particular. In 1979 agricultural requirements rose to 11 million KWH, or 2.5% of the energy needs of the country. Japanese agricultural co-operatives alone account for half the total agricultural consumption of energy in the country.

The Japanese Central Union of Agricultural Co-operatives has carried out considerable research aimed at reducing energy consumption within the sector, and has produced practical results in the field of glass-house cultivation, which is very widespread in Japan and involves high oil-consumption. It is one of these achievements that we will mention in this section.

The Union's research in the field of glass-house cultivation has led, among other results, to the development of a new system which allows the automatic adjustment of the screen in glass-houses where strawberries, melons or water-melons are grown. Obviously it is in the producer's interest to keep the screen as low as possible, which by reducing the maximum space to be heated, allows considerable savings in energy. However, to keep the screen permanently lowered is naturally out of the question since this would obstruct work on the plants.

Under the new system, the screen is at its lowest during the night and automatically adjusts to a higher level during the day to permit the necessary work. Considerable savings in energy have been achieved, as the first trials show: with the screen lowered to 0.8 m., a temperature of 10°C can be maintained in the glass-house (when the external temperature is between -7°C and -8°C), using 20% to 25% less oil than with the traditional system of having the screen at a height of 1.7 m.

3.2. FRANCE

The energy crisis has led France to make considerable efforts, on the one hand to limit consumption of fossil energy, particularly oil, and on the other to develop new sources of energy.

French agricultural co-operatives are concerned to maintain their overall consumption of energy at a reasonable level, and here the Agricultural Co-operative Union of S.W. France (U.C.A.S.O.) has made a notable contribution in the form of a tractor, 'Tractocoop'.

It must not be forgotten that agricultural machinery is the second highest consumer of agricultural energy, and forecasts indicate that coming decades will see an increase in the consumption of energy through mechanisation.

The 'Tractocoop' project was born at the First International Co-operative Trade Conference, held in November 1978 in New York, on the proposal of Mr. Jean-Baptiste Doumeng as Chairman of the Economic Bureau of the Agricultural Committee (BECA) of the International Co-operative Alliance. The project proposed that the strategy already adopted by BECA of furthering inter-cooperative trade, should be extended to the field of tractors and other agricultural equipment. The project involves carrying out, on behalf of and in accordance with the instructions of a co-operative organisation, assembly of a type of tractor having a registered trade-mark and the necessary attachments and reliability to guarantee its technical competitivity against other makes.

'Tractocoop' is now a reality, and the co-operative movement has thus demonstrated that it is capable of practical achievements. The tractor is distributed by methods which put the purchaser to least expense, particularly in the matter of credit. The method chosen is to place at the disposal of farmer-members of co-operatives or of para-cooperative organisations (in the developing countries) a reduced range of tractors at prices 35 to 50% lower than the competition, while still maintaining (in the developed countries) the collaboration (for guarantee and maintenance purposes) of mechanics and repair-dealers specified by the farmers as having their confidence, and who are willing to co-operate in this project in return for reasonable remuneration.

3.3. ISRAEL

Israel suffers from a lack of energy resources, which is why the Israeli government has made energy its absolute priority, both by turning existing energy sources to best possible use and developing new sources. Israeli co-operatives participate actively in this national effort.

Solar energy constitutes an important element of Israeli strategy in the energy field, which is not surprising bearing in mind the high level of sunlight it enjoys. The public authorities have taken drastic measures, and it is nowadays forbidden to construct any building in Israel without a solar system for water-heating.

The use of solar energy necessitates investment in equipment and consequently maintenance. But bearing in mind the modest cost of the apparatus and its average life-expectancy, such investments are quickly written off. As an indication, a solar water-heater costs between 1,500 and 4,000 francs(1), varying with the complexity of the equipment, with a life-expectancy of between 10 and 12 years.

This determination to reap the maximum profit from the opportunity offered by the country's high level of sunlight has led to some original solutions, such as the construction in the Dead Sea of a bowl with a surface area of 7,500 sq.m. in which a system of plasticised nervures takes advantage of the exceptionally high salt content of the Dead Sea to capture and store the sun's heat, which a special turbine then transforms into electricity.

Israel can also congratulate itself on some very remarkable achievements in the field of irrigation. Bearing in mind the country's lack of water, the question of irrigation takes on particular importance. It is a question not only of finding new irrigation

(1) Approx. US $215 to $570, at 1982 exchange rates.

methods adapted to local conditions, but also of developing new techniques which make the least demand on water resources. The most remarkable of the Israeli achievements in this field is undoubtedly the drop-by-drop irrigation systems which are automatically regulated by computer.

3.4. PHILIPPINES

The Philippine co-operatives can also boast of practical achievements in the field of solar energy. It is worth noting that these achievements have been made possible thanks to close collaboration with the public authorities of the country. The Philippine co-operative sector is recommending, among other projects, solar panel systems to provide both hot water and air conditioning. The same systems can equally be used for desalinating water or drying agricultural produce.

The co-operatives have also looked into the technology of photovoltaic cells, and a production project for solar energy using this technology will shortly be set up in some of the remoter rural areas.

But the Philippine co-operative movement is not interested exclusively in solar energy, and has taken other initiatives of great interest, among which we would like to quote that of the Sugar Co-operative Development Institute.

This organisation has highlighted the economic properties of a tree commonly known as 'ipil-ipil', the leaves of which are rich both in protein (20%) and fibre (14%), thus making excellent animal feed. The trunk of the tree can be used for energy purposes. The rapid growth of this tree is a major advantage in that the leaves can be harvested only 7 months after planting, and the trunk can be felled at the end of the first year. This being so, it is hardly surprising that the widespread planting of ipil-ipil is being considered as a means of reafforesting the country.

The initiative of the Sugar Co-operative Development Institute of the Philippines is a particularly good example, as it is eminently desirable that co-operatives in all the developing countries should make efforts to develop as far as possible their local resources.

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GENERAL CONCLUSIONS

The general survey which we have carried out in this report leads to a certain number of conclusions.

1. The co-operative sector has a major role to play in the field of energy in both developed and developing countries.

The extent of the possible action today open to co-operatives is in fact remarkable and co-operatives could be very much on the way to setting up integrated energy systems, utilising various types of technology in different fields.

2. Co-operative action in the energy sector will particularly affect the rural areas of poor countries where, better than anyone else, co-operatives can make a practical contribution to changing the lives of millions and millions of men and women and helping them in their daily struggle against hunger and under-development. Co-operatives, then, can make an undeniable contribution to the solution of the agricultural energy problem, which is an indispensable preliminary to any lasting improvement in the food position in the world, a cause of concern to all.

In this context, the development of renewable energy offers particularly remarkable opportunities to the co-operative movement, notably in the exploitation of biomass in all its forms (including firewood and biogas).

3. The co-operative sector must unreservedly encourage the use of animal and vegetable waste for the production of energy, but should be rather more cautious in the development of energy crops, which risks competing with food production and thus threatening world food supplies.

The harvesting of energy crops cannot in fact contribute to any great extent to meeting world energy needs, without raising the problem of competition between energy and food; if a combustible liquid such as ethanol is to represent even as much as 1/100th of the total world energy consumption, it would require no less than double the present area of sugar-cane plantation.

Such potential competition between food and energy leads us to stress the responsibility of the large cereal-exporting countries which, taking account of the position here outlined, should be extremely cautious in their use of agricultural crops for the production of fuel, otherwise they risk endangering world food supplies. The co-operatives in those countries should be fully aware of this fact and act accordingly.

4. It is necessary that co-operatives should be fully aware of the importance of technological changes connected with developments in biotechnology, which would obviously have a considerable effect on the perspectives developed in the first part of this paper. It is quite clear that if, thanks to some genetic genius, it became possible - for example - to develop cereal varieties capable of fixing atmospheric nitrogen, this would alter the whole situation of food production.

5. The co-operative sector will intervene primarily in those areas where its originality and specificity are clearly displayed. In effect, co-operatives are by nature the only type of organisation capable of taking into account certain needs in sectors normally renounced by the private companies, and where the public sector is unable to intervene effectively. The rural areas of the developing countries are in this respect a particularly suitable area for co-operative intervention.

The co-operative movement will surely play a determining role in the development of energy consumption in the agricultural field, if only because it is in the best position to introduce, by means of information and training, various important innovations.

6. Co-operatives must not a priori confine themselves to their traditional activities, since they can just as well take action in those areas hitherto reserved for the private companies. In this respect the development, production and marketing of 'Tractocoop' has led the way and other leads can be taken by co-operatives, whether in the field of wood-stoves or of solar panels. Co-operatives also have the ability to produce and distribute cheap industrial goods, which will contribute to increasing inter-cooperative trade. In addition, co-operative development as such will not necessarily exclude

economic collaboration with other parties, and clear-cut agreements with private enterprises can make an appreciable contribution.

7. Co-operatives are under the imperative necessity of satisfactorily mastering management techniques, without which they will be unable to carry out any of the activities mentioned. In this context, the ability to obtain financing from international organisations is particularly important, and at this level the co-operative sector must insist, among other things, on the specificity of the actions it can undertake in the rural areas of developing countries. It is also undeniable that the mastery of management techniques depends on the diffusion and rational use of the facilities provided by computerisation.

In this respect, co-operatives can greatly benefit from the assistance and advice which a structure such as BECA is in a position to provide.

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