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Editorial

AGRICULTURE AND THE ENVIRONMENT

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ABSTRACT

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The environment is influenced by agriculture and agriculture is dependent upon environment, a fact which can be seen in the relationship of agriculture to the landscape and in the way in which agriculture and animal husbandry are practised. Agriculture can be characterised in terms of its *pattern* or structure, and its dynamic *processes* (energy flow, nutrient cycling, succession, soil formation etc.).

If we are to ensure the survival of life on earth serious consideration must be given to both the quantitative and qualitative food requirements of a rapidly growing population and the effective production of food without overtaxing the environment. This can only be achieved within the framework of conservation and management of the biosphere and requires a thorough examination of both the patterns and processes of agriculture. The problems of arable farming, animal husbandry and food supply, and their impact on the environment, vary considerably, as is evident from a comparison between industrialized and developing countries. Economic, historical, political, sociological and other causes also play a part. Furthermore, the possibilities for, and implementation of, an integration of agriculture and environmental management depend on numerous factors, and require the use of the research potential of a great number of scientific disciplines. A scientific journal designed to facilitate the exchange of ideas on the subject is therefore much needed.

Agriculture and Environment aims to fill the need by providing a platform for discussion and a medium for the communication, information and guidance of experts from all over the world — whether they work in government, scientific research institutes, universities, private enterprise, international organizations, or any other sector of the community concerned with the problem.

This new quarterly journal, concerned with the balance between food production and environmental and biospherical management, will contain papers of world-wide interest on all aspects of the interdependence of agriculture and animal husbandry and their environment.

INTRODUCTION

More and more food has to be generated for the growing world population. This food production will have to come partly from an extension of agricultural areas and partly from intensifying agricultural methods in existing areas.

Besides this there are also the possibilities of synthetic food production and of "ocean farming".

This growing demand for a sufficient supply of food will increase the load on the carrying capacity of soil, fresh water, vegetation (including forests) and fauna. But the existing "capital" of the natural resources and existing biological conditions on earth is finite.

Therefore, it is the immense and responsible task of mankind to search for an acceptable equilibrium. On the one hand, we must seek methods for increasing food production per hectare and for extending agricultural areas in connection with the methods of producing this food. On the other hand, mankind has to contend with the stability or carrying capacity of the biosphere. By biosphere we mean the system of plants, animals, soil, water and air, which sustains all life on earth and maintains it together with the sun.

To avoid lasting or irreversible disruption of the biosphere we will have to proceed to the next decades with great insight, wisdom and resolution. However, at the same time the millions of mouths daily asking for food have to be fed.

The journal *Agriculture and Environment* aims to publish papers which contribute knowledge on the problem of attaining a balance between agriculture and the environment. It proposes to consider the complicated interrelationships between man and the earth, supply and demand for food, situation and development of agriculture and animal husbandry. These will be examined from the point of view of the finiteness, vulnerability and potential threats to the stability of the spaceship "Earth".

Adlai Stevenson said "We travel together, passengers of a small space-ship, dependent on the vulnerable water-, air- and soil supply. We can only prevent destruction by the mutual care, work, I should say, love which we spend on this fragile carriage. We cannot maintain this as long as half of the crew lives in richness and half of it in poverty; half is self-confident and half is desperate. No ship, no crew can travel safely among such contrasts. Our survival depends on our resoluteness" (Ehrlich and Harriman, 1971).

Part of this resoluteness lies in understanding the relations between agriculture and its environment and in the pursuit of a balance between food production and ecological stability. It is a fortunate coincidence that mathematical models and computers can nowadays be used as tools which make these complicated relations and their effects on the system of man and earth clearer than they might have been in earlier decades. In fact we have to organize on earth a "Houston control base" for the spaceship "Earth". Of course computer displays are only as good as the information and assumptions on which they are based. They only give us added insight to complex problems.

THE DEMAND FOR FOOD

Let us first look at the demand for food. The more people draw from natural resources, the more waste from these man-used resources enters the

biosphere and the bigger is the load on the earth's total available "capital" of soil and surface waters and its regeneration possibilities.

Actually we should only consume the "interest", as a result of the circulation of materials. By technology we can often increase the rate of interest. However, we often deceive ourselves, by thinking that technology that increases the rate at which we exploit the "capital" is really effecting an increase in the interest rate. We have to use the "interest" in a way which does not affect the durability of the production capacity. That this has not always been done is shown by the occurrence of deserts where once there were prospering civilizations, and by the presence of man-made savannas, where once there was jungle.

Meanwhile the world population is growing faster than ever before in history (Ehrlich and Ehrlich, 1970). Its present growth is exponential. In April 1975 world population is estimated to reach 4×10^9 of which 2.9×10^9 live in developing countries. In the poor countries (income per person less than U.S.$100.- per year) the increase is 2.4% per annum; in the developed countries 1.1%. Even if the almost inaccessible goal of each family averaging two-children was to be reached by the developed countries in the year 2000 and by the developing countries in the year 2050, the population would increase from the present 3.9×10^9 people to at least 15×10^9 within 80 years, or 4.5 times as many as at present. It is difficult to say with certainty (apart from the possibility of wars, large-scale illness and plagues) if the current rate of growth can continue in the future. There is, after all, no experience with removal of growth curve constraints of the world human population. Until now every biological growth has found its natural end, and it is possible that mankind itself may provide a voluntary solution to population expansion by more efficient 'family-planning' or by external means of control directed by society.

More and more people, ranging from economists and biologists to sociologists and theologians, are occupying themselves with population politics. Reward systems for family planning, as an intervention in the biological reproduction process, are opening quite new fields for synthesis of the theological, moral, psychological and sociological disciplines. Mankind faces the question of how to re-establish a population balance, which was formerly regulated by disease, starvation and natural disasters, but which now has to be regulated by a more humanitarian mechanism. In Great Britain, a Commission from the House of Commons proposed in May 1971 to limit the number of children per family by law in order to prevent the country from a demographic explosion around the year 2000, but up till now this proposal has not been implemented.

The thought that human beings could emigrate to other planets or planetary systems, even supposing that other planets are habitable, seems irrelevant.

It is clear that population control has to be a primary issue in developmental strategy over the whole world, and especially in the non- or less-industrialised countries, since they are relatively less prosperous. In the developing countries

more attention is paid at present to expenditure for defence, education and industrialisation than to limitations of population growth.

In Indonesia, for example, only 0.1% of the budget of the government is allocated to birth control. The yearly increase in population in that country, however, is over 3% (as in the Philippines, Thailand and other countries).

We should also mention here the possibility of decreasing the demand for food by not consuming food containing calories in excess of our estimated caloric requirements or by eating less meat, especially in the industrialised countries (the conversion rate of plant proteins into animal proteins in animal production systems being low). In any case this should be studied in relation to food quality, sex, age, physical activity, wealth of man and duration of life.

THE SUPPLY OF FOOD

Secondly, let us consider food supply. It is clear that the conditions on earth limit the possible output of conventional agriculture. Not less than 44.2% of the total land surface of the earth is too cold, too dry or too mountainous for the production of food. The extension and intensification of the agricultural areas is limited. There are of course impressive possibilities by using advanced future technology. Heating the cold parts of the earth with space satellites or shifting ocean currents by artificial means, to direct some warmth to the colder parts seems realizable, but it is highly questionable whether such systems are economically viable, even making allowance for overcoming the subsequent side effects. Still changing sea water into fresh water may become an economic possibility, or climate control may become possible to the degree that rainfall can be directed where it is most needed

There are still other great possibilities, which are dependent on "conservative" technological investment (e.g. irrigation), but above all, success in this field depends on the social structure of the countries in which these extensions and intensifications have to take place. Until now the Green Revolution has failed, mainly because the means and methods were not designed for the millions of small farmers, but were based on "Western style" thinking about agricultural systems. In Asia only 10% (Indonesia) to 50% (Philippines) of the total agricultural area is cultivated with the new high-yielding varieties of rice and corn (FAO, 1970), firstly because soil and climatic conditions are not always suitable and secondly because continuous artificial irrigation and chemical fertilisers and insecticides, all essential for these crops, cannot be afforded by most of the farmers.

At the moment only 10% of the land surface (1.4×10^9 hectares) is cultivated as farmland, 17% (2.4×10^9 hectares) as permanent grassland and pastures, and 23% (3.8×10^9 hectares) is covered by forests (Van Staveren, 1963). Furthermore, of the grasslands and forests a certain percentage should be maintained as it is, because it is important from the point of view of nature conservation. As noted above, the remainder 44.2% (6×10^9 hectares) is unsuitable for agricultural use for some reason.

The percentage of arable land can probably be doubled, but only at the cost of 1/6 of the existing pasture land, of 1/8 of the non-commercial forests and of 1/12 of the still-remaining nature areas. There is the possibility of increasing production by irrigation, especially if there are corresponding inputs of chemical fertilisers. At the moment, 9% (126×10^6 hectares) of the arable land of the world is irrigated. This percentage could theoretically be raised to 16.2%. Of the possible extensions, 80% are in Asia and the Soviet Union (Grünewald, 1957). In Africa and Latin America the possibilities are relatively limited because the river flows are small in capacity in proportion to the surface area of land, except for the big rivers such as the Amazon or the Orinoco. In fact, the Amazon Basin and other tropical areas could be severely damaged by traditional agriculture. Besides this, one cannot be optimistic about feeding the human-populations in the tropical areas because of the limitations in fertility. This apparent fertility of lateritic soils is all in the biomass of the vegetation (Nye and Greenland, 1965). The largest part of the African soil needs to be reforested to prevent further erosion.

Some experts (Van Staveren, 1967) estimate the potential of agriculture and animal husbandry to be such that, with an optimal application of all the present agricultural scientific knowledge, food production can be increased to five or six times the present level.

The question should, however, be asked as to whether this estimated six-fold increase in production would not endanger the ecological balance of the biosphere with consequences of irreversible pollution, poisoning of the environment, soil erosion, shortage of fresh water and timber, decrease of food quality and consequently a decrease in the population to a level in balance with the then remaining carrying capacity of the earth's surface. This increase of food production strikes against many ecological, economical and human health interests. For example: (1) in obtaining more food, problems can rise with the existing *forest resources* in the world. Forests have multi-functional purposes. They fullfil a stabilizing influence on environments, they produce wood, they offer opportunity for recreation, they possess a dominating role in the landscape and improve human living conditions in general. There is an increasing demand for wood for several purposes. When forests are cut for agricultural purposes some general thought on the environmental balance on both a small and large scale is essential; (2) in obtaining more food from the ocean, problems can arise in connection with the regeneration capacity of *fish*. There are doubts whether increased fishing can make a real contribution to world food production. The development of sophisticated new methods of catching fish raised the catch from 20 millions of tons in 1948 to 70 millions of tons in 1969. But as can be seen in the yearbook from the FAO, after 1969 there was a strong decrease in the harvest of fish. The general opinion is that this decrease is caused by over-fishing and exhaustion of the fish territories, and that it will involve a long struggle to restore them; (3) there is a factor concerning the influence of raising food production on human *health*. In a recent report of the World Health Organiza-

tion in Geneva it is said that over a million tons of chemical biocides are used in the world per annum. This has caused half a million people to be poisoned, of which 50 000 have died. Of course some fraction of these chemical deaths did not result from use of chemicals but from blundering with them (such as Hg-poisoning in Iraq).

Perhaps the production of synthetic food (fats, carbohydrates, and amino acids etc.) can provide a partial solution. But the manufacture of synthetic food depends on a natural supply of organic raw material or else has to be generated from fossil fuel or CO_2, water and energy. It has been calculated that utilising photosynthesis to its maximum can lead to a much greater production of organic material. If there is sunshine and high temperature the entire year, if there is sufficient water and chemical fertiliser, if only the most productive strains are used, all modern techniques are applied and nothing is wasted, then theoretically the gross photosynthesis per hectare could amount to 120 000 kg yearly or approx. 24 000 kg per hectare of edible organic material. In this way, in tropical areas, 120 people could live on 1 hectare (de Wit, 1968, 1969). In other words, the caloric requirements of the whole world population of 3.9×10^9 people could theoretically be produced on a surface only 17 times that of The Netherlands. Apart from the low quality of the food produced in this way, the question is whether concentration of the production, using the best irrigated soils, will be possible in view of employment policies and the given geographical, demographic, social and economic factors in the world structure. If an industrialised production of edible organic materials is ever possible, it is doubtful whether this will happen before excessive cultivation and pollution have severely and irreversibly affected the ecological balance. The problems of attaining a balance between agricultural demands and what is environmentally permissible are thus encaged by two opposite working factors. On one side there is an increasing demand for food, on the other side there are the limitations, which are imposed in order to ensure the necessary stability of the abiotic and the biotic environment, and which, to a large extent, oppose the production of starch and proteins useful to man.

RELATIONSHIP BETWEEN PRODUCTION AND STABILITY

Let us now turn to the ecological effects of agricultural practices. In order to do this it is necessary to introduce some theory about the relationship between economic production and ecological stability. There is a known relationship between the production and the stability of an ecosystem, which states that the greater the net production of the system, the less the complicated network of dynamic balance is adjusted to the physical environment. As a consequence of this, there is less intrinsic stability in the ecosystem, ecotype or area concerned (Odum, 1971).

Natural systems evolving in isolation from human activities tend toward differentiation, toward increasing variety and complexity. A natural succession

in time normally culminates in a stable ecosystem dominated by long-living, slow-growing species, in which a maximum of biomass and symbiotic functions are maintained per unit of available energy.

In the beginning of a forest succession, for example, the net rate of annual carbon fixation is at a maximum, but as the shrubs and undergrowth are displaced by taller trees, carbon fixation decreases whereas the biomass accumulation is still increasing. Thus an old pluriform forest has a low timber production but the pattern of great differentiation. A climax causes great intrinsic stability. A young uniform forest on the other hand has a high annual production, but is less biologically balanced and therefore has less intrinsic stability (see Fig.1).

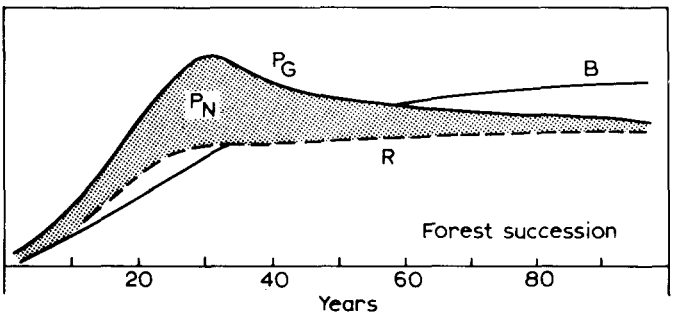

Fig.1. Example of the productivity of an ecological succession: that of a forest ecosystem (After Odum, 1969). P_G = total (gross) production; P_N = net production; B = total biomass; R = total community respiration.

High productivity and low stability thus go together in nature, as do a high degree of stability and lower productivity. A highly stable ecosystem is generally characterised by a varied, pluriform environment. High productivity is characterised by a restrained monoform environment or monoculture.

In the analysis of nature it is useful to differentiate between static, spatial organisation or *pattern* and the dynamic *process*. The pattern can be uniform and undifferentiated or pluriform and complex, with all gradations in between.

PATTERN AND PROCESS OF AGRICULTURE

Living systems are characterised by three major elements which are interconnected. These are: (1) pattern or structure; (2) rhythmic systems (e.g., the states of development of the individual organisms and the seasonal differences of a natural community); and (3) developmental processes (e.g., in plants by growth from seed to plant and back to seed).

In agriculture man intervenes (in order to obtain food) on the *pattern* side by reclamation, land use, landscape planning and irrigation, and on the *process* side by agricultural methods employed. Industrialised animal husbandry

(also called battery farming or intensive animal husbandry) and glasshouse horticulture have also intervened on the *rhythmic* systems.

Both poles — space (pattern) and time (process) — are influenced in agriculture in such a way that a maximum production is achieved with the least monetary cost. Production means and practices are furthermore intended to last for many years. Pattern tends toward enlargement of scale, standardisation of the land parcels, optimal water management and convenient opening up of the agricultural land by roads. These are being pursued to facilitate mechanisation of land use and to achieve maximum crop production simultaneously with minimal production cost.

Thanks to the increasing awareness of the necessity for conservation of nature and landscape, which has partly come about from recreational needs and the movements for environmental protection, it is more and more believed that our society should find a certain balance between productive and non-productive areas or elements (e.g. recreation grounds, bushes and nature reserves).

In areas of production, the ecosystem is limited to one or to a few organic cyclic processes. It is called an "immature" ecosystem. In the natural or non-production elements or areas of the pattern, the ecosystem is still very natural because there has been little or no intervention from man and so time has had a chance to work longer in the direction of differentiation, complexity and stability. In these major ecosystems with great complexity and large biomass, economic production is small or absent.

Immature ecosystems such as in agricultural areas are unstable and are threatened by diseases and pests. In a mature ecosystem there is greater stability. Diseases and pests are usually present but of limited impact.

An area of land with great differentiation in pattern has a greater possibility for reasonable stability of the agricultural ecosystem contained in it than an undifferentiated large-scale exclusively agricultural environment.

In an agricultural process, plant and soil life can be artificially stimulated and nourished with chemical fertilisers. Similarly, animal production is stimulated by means of such things as fodder concentrates, feed additives and hormones and hormone-active agents.

Monoculture also promotes land-use efficiency. Chemical fertilisation may induce the plant to grow more quickly than otherwise. However, rapid growth sometimes has drawbacks: It is possible that the plant becomes weakened and more vulnerable to parasites and diseases, while the natural means of control of such problems are diminished.

Chemical biocides used as a weapon against these diseases and pests may also kill animals and plants other than those against which they were intended. This may reduce the cycling of organic material in the agricultural ecosystem still further. Resistance also appears among the pests, causing the application of more and still stronger chemicals (Ehrlich and Ehrlich, 1970).

The result may be a vicious circle leading to a more and more unstable, threatened environment. Thus the Pearson Commission in its report "Partners

in Development" suggests that as a consequence the Green Revolution will have to develop more and more new varieties of rice, because disease organisms have evolved new strains to which existing varieties of rice are not resistant. Fig.2 indicates the two poles of production and stability. This figure does not of course show that all monoculture, commercial fertilisers, chemical insecticides and herbicides are bad and everything on the ecological side is good. It only points out that there must be awareness of the poles of production and stability and that in the balance of both one has to look for the isolation of agriculture and environment. The solution will not lie in either-or, but in both-and. Both in regard to the pattern and the process of agriculture, ecological wisdom will have to be incorporated again as much as possible to minimize the problems of instability, whereas on the other hand it should be realized by everyone concerned that full stability may only be attained at such a low level of production that it is not realisable. It will be the task of the agriculturist and the ecologist to find an acceptable balance between economic production and ecological stability.

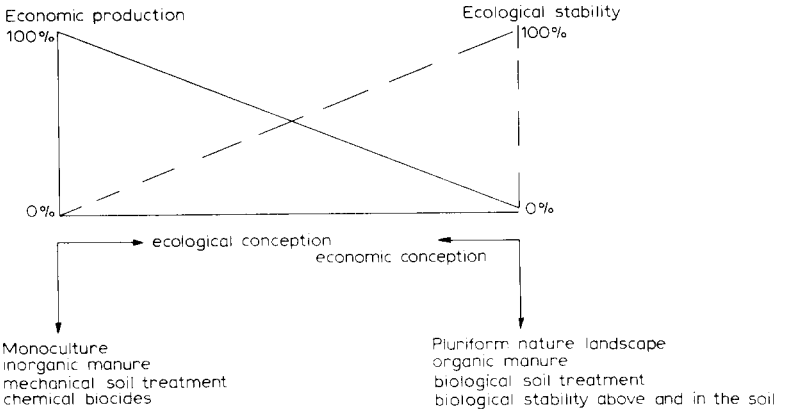

Fig.2. Diagrammatic relationship between economic production and ecological stability in terms of pattern and process.

The picture may, however, become even more complex if human society also sets other demands on a particular area. For instance, it may envisage a wider remit for forests than merely wood and cellulose production. Conservation, wildlife management, amenity and outdoor recreation may be added burdens. These changes may eventually loosen the traditional constraints and put more weight on ecological care, although the income position of the forester or agriculturist then needs to be re-examined.

A major aim of the journal will obviously be to contribute to the development of agricultural practices which are better adapted to the environment

in which they must be exercised. In certain cases, however, it may be necessary to plead for the abandonment of certain forms of agriculture, for instance the abundant spread of industrialised animal-production enterprises over a small-scale landscape. On the other hand, it will also attempt to signal new developments which might improve the world food situation or the income position of farmers without making too great a demand on the environment.

INDUSTRIALISED AND DEVELOPING COUNTRIES

The relationships between agriculture and environment differ in the industrialised and the developing countries. The industrialised countries increasingly recognize the need for environmental protection. They have in many cases the technical means to reduce harmful effects to the environment, or could develop these if needed. Whether they will be used or not depends primarily on the agricultural policy of governments and on the motivation of agricultural interests and individual farmers. The objective of farm policy in the Western world, both of agricultural authorities and of the farmer, is to raise or maintain the income of the farmer so that it is at a level comparable to that obtained in industry. If this is not achieved by the operation of a free market price, supports, output quotas and other devices may be used. Furthermore, structural measures (water management, parcel rationalisation, etc.) are often adopted to strengthen the economics of suitable farms. It is not the place here to deal with the success or failure of all these measures. Nevertheless it should be pointed out that these policies have been accompanied by and possibly even encouraged an ever-increasing industrialisation of agriculture. This in turn causes a continuing decline of employment in agriculture and an increasing replacement of labour by mechanical and chemical means for controlling agricultural processes. Environmental problems clearly result from this trend.

In the developing countries the goal of equality in income between agricultural and industrial or other labour is largely absent, as is also the system of market competition, resulting in enlargement of the more successful at the expense of the less successful operations. That agriculture till now in the developing countries sometimes causes big ecological disturbances, is more commonly a result of relative overpopulation causing erosion or overcultivation, than from chemical and technical processes. For example, although famine which presently faces a chain of countries along the south-side of the Sahara desert and Ethiopia may have had a complex origin (including climatic fluctuations), its extent has no doubt been enlarged by human population growth. This brought about an increase in cattle grazing. As a consequence of the disappearance of the vegetation the soil quality became worse and the desert expanded to the south. Food shortage exists in Chad, Niger and parts of the Sudan. Only through a programme for reforestation can man help to redress the ecological balance.

If maximum productivity with minimum cost to the producers is the goal,

as in the industrialised countries, environmental protection often conflicts with unrestricted agricultural practices. Paying attention to landscape ecology and limiting the use of some chemicals reduce the income per unit area of land, though this approach may sometimes offer a healthier environment, more natural scenery, probably a higher quality of food and more rural employment.

There are many people who think we should reorient our policies toward agricultural land-use and animal husbandry, and base these more strongly on ecological understanding, and in some cases on ethical considerations (e.g. regarding industrialised animal husbandry), and that we should fundamentally reconsider the values of: monoculture versus crop rotation; uniform agricultural land-use versus an alternation of agricultural land with other landscape elements; chemical control of pests, diseases and weed versus biological control, chemical versus organic fertilisers; mechanical versus biological soil regeneration. It is obvious that a great deal is still unknown on these topics and this opens up a vast area of scientific research and political discussions from the regional to the world-wide level.

In the developing countries the environmental effects brought on by the extent and methods of agricultural land-use and cattle farming are as big a problem as, for example, the increasing income inequality between poor and rich countries. Development of arable farming and animal husbandry in the developing countries in order to achieve a higher food production, nowadays almost inevitably means replacement of primitive agricultural methods by those developed in the industrialised countries, with all the consequences involved. Primitive methods have been applied for centuries without consideration of the productive capacity of the Earth; there has always been new farmland to produce food. Improved medical care has made the population grow, however, and it has become necessary to intensify land use and also to cultivate marginal soils. On an increasing scale this has led to over-exploitation of forest soils and overgrazing of grassland, especially in Africa and South America. The interim periods in which the land has been left uncultivated has become too short. One of the most serious consequences of all this is extensive soil erosion!

The agricultural methods used by industrialised countries, which are mainly situated in the temperate climatic zones, cannot be transferred easily to tropical areas. Rapid chemical exhaustion or hardening of the soil, salinisation as a result of irrigation, and harmful ecological side effects are the sad results of attempts to transplant Western agricultural methods.

Food-shortage, together with the impossibility of employing a growing number of people in agriculture and industry, leads to an enormous environmental problem in the cities of the developing countries. Already at least 20% of the professional population of the 1×10^9 people inhabiting these countries is more or less unemployed. This number increases each year to such an extent, that a doubling of this percentage is expected in the near future. In spite of rural development programmes in most of the developing countries

many people still leave the countryside for the cities. In the cities which are centers for activities, public services and a developing industrialisation, one expects employment and food. However, the millions of people waiting for employment and welfare settle in a very small area, which causes correspondingly major pollution problems. The rivers, in particular, cannot dispose of all the litter and waste from so many people. Rivers like the Rhine and the Volga, which require the highest level of international technological expertise and solidarity to alleviate the industrial pollution, now have their dreary counterparts in the developing countries, where surface-water pollution is principally a consequence of agricultural and food problems.

FOOD PRODUCTION AND ENERGY-INPUT

A point of special attention is the energy input in the highly mechanized and fertiliser-dependent farming in the developed countries and "green revolution" style crop production techniques in the developing countries.

As agriculture in Western countries is dependent upon fossil energy, it has recently been calculated that crop production costs will rise if fuel costs increase two-to-five-fold. Currently in U.S. agriculture 900 liters of gasoline or the equivalent in other forms of energy are used to produce one hectare of maize (*Zea mays* L.) (Pimentel et al., 1973). A return of 2.8 kcal of maize per 1 kcal of fuel input may become uneconomical when a sharp rise in energy costs occurs. "Green revolution" crop production also uses high energy crop production technology, especially with respect to fertilisers and biocides. With the possibility of a lasting world energy crisis, it seems inevitable that a careful reconsideration of the benefits, costs and risks of high energy demand in Western and "green revolution" agriculture is needed. To partly reduce energy imputs, Western and "green revolution" agricultural processing in time may have to promote alternatives such as crop rotation and green manures and to reduce the high energy demand of chemical fertilisers and biocides. Perhaps there will be in future the possibility of incorporating in corn the nitrogen-fixing capacity of leguminoses by means of plant breeding. This could raise average yields without the problems of production, transport and costs of artificial nitrogenous fertilisers.

AGRICULTURE, INDUSTRY AND ENVIRONMENT

Regardless of the validity of the specific assumptions of the recent study of the "Club of Rome", entitled "The Limits to Growth", it is clear that there is a limit to the growth in the production of material goods and food because of the limit to the Earth's natural resources and the bearing capacity of the environment. Agriculture should, therefore, try to contribute to a new balance between the necessity of food production and the maintenance or restoration of a healthy environment. It should reassess its practices. It may be forced to change from its present world-wide trend in the direction of

industrialisation. Agriculture differs in fundamental ways from other types of industry. One could raise the question of whether agriculture is an industry or a way of life. Agriculture deals with processes of life on a macro-scale whereas industry has to deal with non-living matter or completely packaged organisms. Agriculture needs to obey natural rhythms whereas most industry is not subject to such constraints. In agriculture the soil as a means of production must not be allowed to wear out; the machines worn out by industry can be renewed. Agriculture produces its next generation of resources (seed, young animals) at the same time as it produces its goods. But in industry this is not possible to do in the one and the same process. The demand for food is not as easy to manipulate as the demand for industrial products. Agriculture and industry thus differ both in pattern and process. The processes of life on which agriculture is based should be recognized, protected and well managed. Moreover, this needs to be done within the given social framework, in a world where there is a very large and growing population in need of food, in societies in which all members demand a reasonable income but also an acceptable environment in which they can breathe, work and play. We need an environment which now and in the future will ensure quality of life and life in general. This illustrates the enormous complexity of the problems with which this journal will be involved.

SUMMARY AND CONCLUSIONS

The major issues which have become clear from the considerations of the preceding pages are the following:

(1) Agriculture and its environment are essentially interconnected and affect each other (cf. 2). Besides this, agriculture together with its environment is squeezed in between the pressures of food demand and responsible ecological management (cf. 3), making the problems of agriculture and environment very complex.

(2) When considering the relationship between agriculture and its environment, we must distinguish between the pattern of agriculture in the environment and the effects of agriculturally induced pollution on the environment.

(3) Food production must continue to be sufficient both quantitatively and qualitatively for an expanding world population and it must be distributed in such a way that it is within reach of those who need it. On the other hand there is an imperfectly formulated, but inevitable need for responsible management of the biosphere, to secure the durability of agricultural production and the continued existence of all forms of life on earth. These two necessities must be implemented for an harmonic synthesis between agriculture and its environment.

(4) The supply and demand for food differ in the industrialised and developing countries. In the former the pursuit of maximum farm income by restrictive practices often causes a surplus of high-priced foodstuffs. In the

latter countries the pattern is of too little production for the number of people and continuing unemployment of farm labour. Thus both kinds of countries struggle to find solutions for totally different environmental problems in relation to agriculture.

(5) The journal *Agriculture and Environment* will on the one hand be concerned with the spatial relationship between agriculture and its environment and the effect of agricultural procedures on environment and products. On the other hand the journal will also seek contributions on a global level, which will promote a balance between a sufficient food supply for a growing world population and the requirements which are necessary to facilitate a responsible environmental management.

(6) Land reclamation and improvement, land- and water use, landscape planning, etc. deal with the spatial relationship between agriculture and the environment. The problems of mechanisation, efficiency, application of organic and inorganic fertilisers and biocide usage concern the process side of agriculture and animal husbandry. Within the format of this journal, the kind, size, geography, quality and durability of food production relate to the necessity of food production.

(7) A responsible approach to environmental management will exert its influence on the patterns or structures of rural areas and on the processes or the way in which land use and animal husbandry are skillfully employed. In addition to the environmental consequences which result from the patterns and processes of agriculture and animal farming, attention will be paid to such problems as land reallotment, agro-ecology, process management, food quality and quantity, agro-technique, agricultural economics and agricultural policies as instruments for promoting the attainment of a reasonable balance between agricultural production on the one side and its influence on the environment on the other side.

(8) The supply and demand for food, as well as the agricultural patterns and processes and their connections with the management of the biosphere, differ with the geographical, demographic, social, economic, cultural and political situations in the various countries on earth and their technological levels of development.

(9) Agriculture and environment and the food demand and production capacity of the earth cannot be seen separately from other aspects of a gradual and harmonious world development.

(10) Special attention will be paid to alternatives to the high calorie-input of fossil fuel in highly mechanised and fertiliser-dependent farming and "green revolution"-style crop-production techniques.

(11) Attention has to be paid to the possibilities and the limits of the carrying capacity of the biosphere for the whole system of earth and man. For this reason different patterns and processes of agriculture and their influences on the biosphere have to be made clear by model studies, using computer techniques.

(12) The above could contribute to a more equitable distribution and

application of the benefits of the technological civilisation which, incorporated within the natural environment but also respecting the claims for protection of this environment, would create a more stable world system.

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