The
Ecologist
Journal of the Post Industrial Age
Vol.5 No.3 March/April 1975 40p

Ecological Vision In American Literature
Diversify Or Be Damned
First Aid For A Half Dead Sea

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This month's Cover: Elizabeth Moya

All communications should be sent to: The Ecologist, 73 Molesworth Street, Wadebridge, Cornwall PL27 7DS, England.
Tel: Wadebridge 2996.

Advertising enquiries to Interpress, 19 Anne Boleyn's Walk, Cheam, Surrey. Tel: 01-642-5826

Published by Ecosystems Ltd.
Registered Office as above

Distributed by: A.M.D. Ltd., Roding Trading Estate,
London Road, Barking, Essex IG11 88U.

Ecologist Vol. 5. No. 3.

Printed by Penwell Limited, Parkwood, Callington, Cornwall.

Comment

HOW MUCH DO WE NEED?

We publish in this issue of The Ecologist the F.O.E. report on the future of food supplies in this country and their recommendations to the Government for achieving a greater degree of national self sufficiency. There is no doubt that more and more communities living in the affluent society are becoming aware of the plight of the millions starving in the third world, and of the reality of famine on a global scale. For reasons ranging from fear to ecological common sense and from domestic prudence to real concern for the threatened nations, people are asking what contribution we, as individuals, can make.

Two questions therefore need to be asked. First, How much do we need? and second, How much can we save? There is no doubt that our western way of life with its dependence on highly processed and convenience foods is not only intolerably wasteful but is nutritionally disastrous. A comparison of the incidence of certain non-infectious diseases and internal disorders (diverticulitis – piles – hernia – diabetes – heart disease – appendicitis – among others) in Western man and in native communities leaves no doubt that the affluent societies are eating themselves into chronic ill health. It may therefore be said that the requirements of good health, domestic economy and a just distribution of world food supplies are compatible. If every household in our country were to cut its total intake of meat, fats and sugar by one fifth, the family would be healthier, the housekeeping bills smaller and the total amount of food consumed by the population so reduced that the government would be able to make immediate reductions in the present crippling food import bills.

Is the one fifth cut envisaged an impossible target? Consider what we survived on during the last war when, as is well known, the nation's health actually improved. In 1940 when food rationing was introduced allowances per head per week were 2 ozs. of butter, 2 ozs. of margarine and 4 ozs. of cooking fat – a weekly total of ½ lb. The proportions altered from time to time but the total remained in that area throughout the war years. Sugar started at ¾ lb. and fell to ½ lb. (a *daily* intake of ½ lb. or more is not unusual now and the British consume more sugar per capita than the inhabitants of any other 'rich' country). Meat was rationed by price (an unbelievable one and twopence worth per head per week) which in effect worked out at one small steak, or two skinny cutlets or about 7 ozs. of stewing meat per person. Cheese varied from 2 ozs. to 4 ozs. a week, with extra allowances for manual workers. One egg a fortnight and one rasher of bacon a week were eked out by terrible biscuits, baked beans or tinned peas on 'points'. Most of us would have to cut our present consumption by much more than one fifth before we tumbled to a comparable level.

The most essential cut is in consumption of meat, particularly of cereal fed meat. Although experts cannot agree on the exact conversion rates of cereal protein to meat protein there is no disagreement on the basic fact that cereals fed to livestock are thereby being wastefully used, and if millions of tons of corn now being used as animal fodder were released for human consumption from three to five times as many people could be fed as can eventually benefit from the meat product deriving from it. The most profligate cereal users are the producers of intensively fed chicken, pigs and calves. Not only are their methods inhumane but their products are unwholesome and often actively damaging to human health, and the conversion rate is poor even though it is achieved with the aid of chemical additives. Furthermore these factory farmed products cater for an artificially created market which results in gross over production so that millions of chicken (which in a few miserable weeks of life have consumed thousands of tons of grain based feed) have recently been slaughtered to make fertiliser and glue.

Home producers of beef and lamb are in a different category. Although in the recent past they have leaned heavily on imported concentrates – or concentrates manufactured from imported grain – indigenous breeds of beef cattle and sheep can survive and be fattened on grass, and the price of bought feeding stuffs is already causing farmers to look to their own land to produce grass and grass products such as silage to feed their stock. Nevertheless even in this area the quantity of meat will fall as an increasing acreage is used for growing cereals, and livestock is confined to the hills and moors.

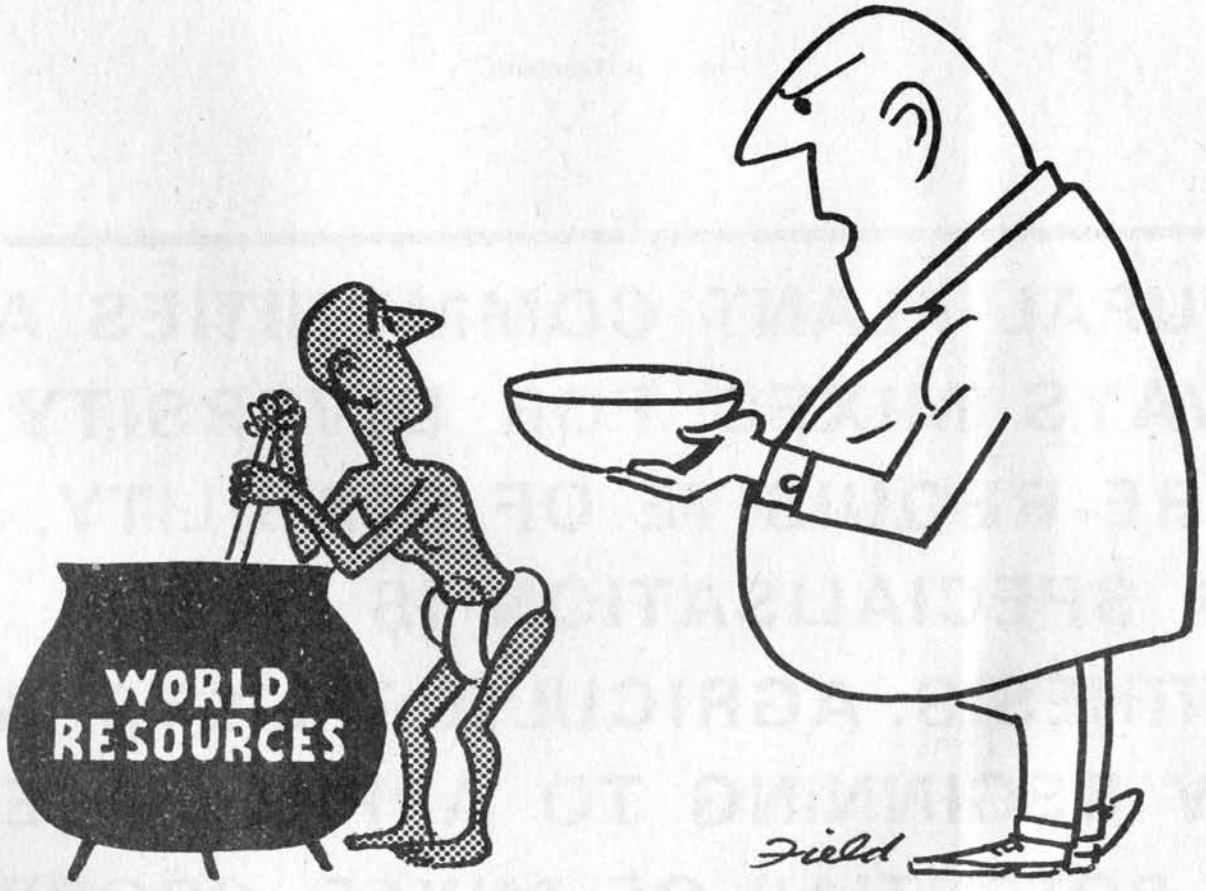
How else can we save? Quite clearly by making some effort towards feeding ourselves and our families. That more people are already doing so all the time is evident from the growing waiting lists for allotments and the fact that the demand for vegetable seeds now equals the demand for flower seeds for the first time in decades. We can vary our diet with home grown fruit and vegetables, while the single pig and back yard hens fed on household waste will go some way towards replacing the supermarket products that we reject. The possibilities open to a community with a small piece of

land are numerous and intriguing, but the transition from supermarket shopper to self-sufficiency expert is fraught with difficulties and the sheer physical effort of digging a cabbage patch is much greater for the uninitiated than it is for the country man or woman born to it. Daily new groups take to the land, many of them doomed to fail and to see their utopian dreams crumble through shortage of cash, sheer lack of expertise and unrealistic expectations. Clearly there is a need for support schemes and people, to give initial training to aspiring smallholders. We print on page 102 an outline of one such enterprise which could well serve as a model for others. Many organisations exist to help with advice to new and would-be subsistence farmers, and many marvellous hints can be found in their literature. Colin Richardson's Self-Reliance News Letter is full of practical suggestions and country wisdom. Readers contribute accounts of their own failures as well as successes.*

Our first priority therefore must be so to reduce the demand for factory fed pig meat and poultry that the producer is forced out of business and huge quantities of grain are thereby released for human consumption. If as seems probable the only way to achieve a saving big enough to contribute to redressing the balance between the rich and the poor countries, is by having the necessary change in our eating habits imposed upon us, let us urge the government to bring in food rationing, not sometime in the future when they are forced to it by famine conditions, but *now* whilst its usefulness can still be turned to good account. By doing so they will show themselves to be far sighted, concerned and courageous, whilst incidentally stiffening the will of the people to aim towards personal self-sufficiency.

Ruth Lumley-Smith

*£1.00 per annum for 6 copies from Colin Richardson, 29 Dartmouth Avenue, Huddersfield HD5 8UF.

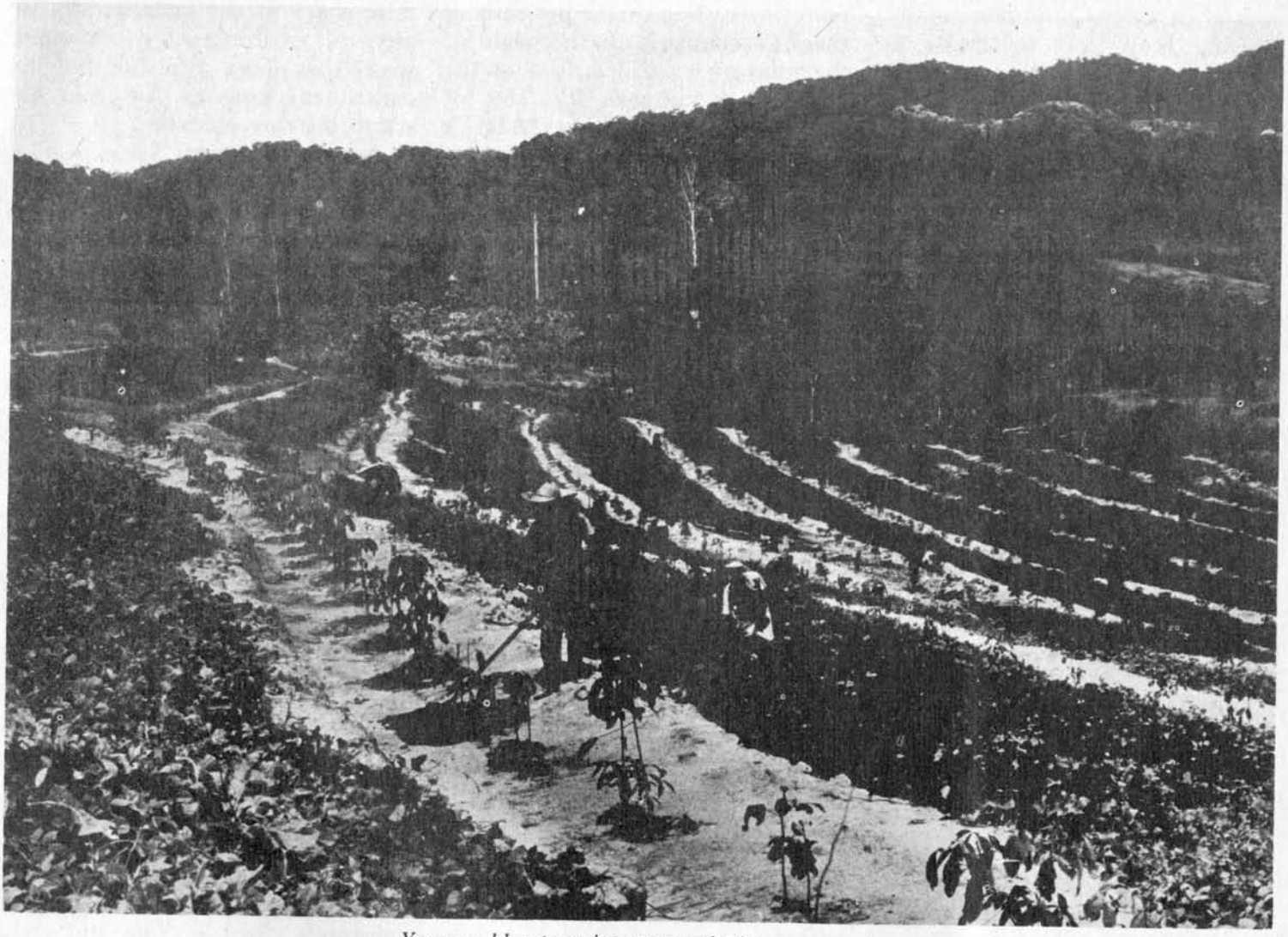


"MORE !"

Diversify or Be Damned?

by R. B. Trenbath

NATURAL PLANT COMMUNITIES ARE ALWAYS MIXED FOR DIVERSITY IS A PRE-REQUISITE OF STABILITY, AND SPECIALISATION IS ITS ANTITHESIS. AGRICULTURALISTS ARE NOW BEGINNING TO APPRECIATE THE POTENTIAL OF MIXED CROPPING AS A MEANS OF CONTROLLING DISEASE



Young rubber trees intercropped with groundnuts

When we observe that most natural plant communities consist of a mozaic of individuals of many species, we are perhaps struck by the relative simplicity of crop communities in "advanced" countries. Apart from the generally small populations of weeds, the plants of a present-day crop field have very similar and often identical genetic constitutions. Man has not always grown his food in such a way though. In neolithic times, the first crops were mixtures of cereals with a wide range of weeds. Selection practised through thousands of generations, seed cleaning, and the development of cultural methods against weeds reduced the heterogeneity of these early crops.

During recent years plant breeders have aimed to produce genetic uniformity within crop varieties, and the use of selective herbicides has simplified the weed flora. To make mechanisation more profitable, farms have been amalgamated and hedges and fences have been removed; consequently, individual sowings are more extensive. The genetic differences which originally existed between varieties grown in various localities, regions and continents are disappearing as the multitude of locally-adapted varieties are replaced by a relatively small number of widely-adapted, higher-yielding types.

This extensive planting of a few varieties is a natural consequence of the success of the plant breeders of CIMMYT (International Centre for the Improvement of Maize and Wheat, Mexico) and of IRRI (International Rice Research Institute, Philippines), but it now causes grave concern among crop scientists.[1] To allow the "miracle varieties" to express their full yield potential, they are given abundant fertilizer and irrigation, which predispose them to disease and pest attack; in addition, the world-wide distribution of the same genetic types provides ideal conditions for the evolution of races of disease and pest organisms able to attack them. In view of the danger of widespread epidemics leading to calamitous yield losses, it is now being felt that heterogeneity should be reintroduced into the crop fields in some planned fashion.

This article examines some of the evidence and speculation about the possible advantage of growing mixed crops. As mixed cropping is still widely practised under conditions of primitive agriculture, it seems worthy of further consideration.

Types of mixtures grown

When it is believed that some favourable interaction occurs between the plants of certain crops, the crops are often cultured together for most of the period of growth. Thus, in Malaysia a cover of groundnuts is often maintained under rubber for the whole life of the trees (see photograph). Shorter-term mixtures which are sown and harvested together are the grass-legume hay combinations and the dredgecorn (oats and barley) grown in Britain.

When there is space temporarily

unused in a crop, another rapidly-growing crop may be taken by interplanting. In India vegetables are planted between rows of young sugar cane, and in Malaysia tobacco is planted among young rubber (see photograph). By interplanting vegetables in ripening paddy two weeks before the rice is harvested, Taiwan farmers are achieving up to five crops in one year.

Where the sunlight may be very intense, shade trees are planted over many crops. In a remarkable article on traditional mixed cropping methods in India, A. K. T. N. Aiyer[2] has described how under one system up to three separate age-groups of shade trees are mixed within the same field with each planting of shade tree being followed by its own planting of crop areca. In the desert oases of the Sahara, a similarly three-layered canopy is sometimes produced by planting drought-tolerant date palms to protect the shorter fruit trees, which in turn shade a carpet of vegetables. Shade trees may also serve to support climbing plants such as peppers and betel. Some of the more complex mixtures described by Aiyer have many of the characteristics of natural plant communities; i.e.: stands of individuals of uneven age, and of a wide range of species and growth habit.

Yields of crop mixtures in the absence of disease

Mixed cropping is so widespread that it might be thought that a solid scientific basis for it would have already been discovered. This is not so. The question of how the yields of mixtures compare with yields of pure cultures has really only been answered for mixtures of rather similar components such as varieties of grain crops or species of grasses, and then only in relatively short-lived crops. In a series of experiments involving 139 50:50 two-component mixtures of varieties, 64 per cent of the mixtures yielded more grain than the average yield of their components' pure cultures.[3] Out of the dry-matter yields of over 300 mixtures of grasses or cereals again about 60 per cent were greater than their average pure culture value.[4] Perhaps more interesting, in 37 per cent of the 344 comparisons the yield of the mixture exceeded that of the better pure culture. This sort of advantage, termed "overyielding", is of great interest to agriculturalists, but unfortunately the margin by which the mixtures overyielded was usually not large enough for it to be due to anything but inevitable experimental error.

A few instances of apparently real overyielding by mixtures are however known: strong evidence of overyielding has been found in individual mixtures of rice varieties (overyielding by up to 20 per cent on a series of occasions), barley varieties (by up to 24 per cent in a series of treatments), grass varieties (by up to 15 per cent in two treatments), and flax with linseed (up to 31 per cent in a series of separate experiments). Mixtures of leguminous and non-leguminous species also sometimes overyield by up to about 10 per cent, given the right conditions. With the exception of work on legume-nonlegume mixtures, surprisingly little has been done to follow up, understand and add to this list of cases of observed positive effects.

When advocates of mixed culture realise that the above results are quite exceptional, they often maintain instead that the real benefit from growing mixtures lies in the greater consistency of overall yield from season to season. According to Aiyer[2], this seems to be the general belief of peasant farmers; I have heard it myself from a Burgundian farmer standing by his mixed field of rye, 2- and 6-rowed barleys, wheat and oats.

The observation that complex communities like tropical rain forests are more stable in their composition from year to year than simple arctic communities has led ecologists[5] to suggest that the difference is due to the greater diversity of plant and animal species in the rain forest. Although the evidence presented by Sir Charles Elton and others appears compelling, experiment and theory[6] suggest that greater diversity and complexity of themselves lead to *less* stability. The observed relationship in nature seems therefore likely to be due to some other factor, possibly differences in the stability of the physical environment or the time which has been available for the constituent species to coevolve stabilising characteristics.

Another argument for expecting that mixed cultures should produce more consistent yields is based on the differing responses of species to weather conditions. For example, when maize is thriving, potatoes may look distressed (and vice versa). A combination of the two might be expected to produce at least some crop whether the season is sunny or dull. This sort of "insurance" mixture of contrasting components might be recommended where the variation between seasons is so great that no one species or crop variety performs well in all years.[7] An analogous argument applied to space rather than time justifies the use of oats-barley mixtures in Denmark on problem land which has a mozaic of acid patches; oats thrive on the acid spots where barley fails, and barley dominates elsewhere

Returning to results of experiments with mixtures of rather similar components, it seems that the stability (consistency) of a mixture's yield is, like the yield itself, only rarely greater than that of the more stable component grown pure (3, 4, 7) but usually greater than the average of the stabilities of the pure components. Some special conditions under which mixtures might be expected to yield more consistently than pure components will be considered later.

Another sort of stability, about which experimenters seem to know little, is long-term sustainability of production. Since individual species make differing demands on the site and have differing requirements for soil nutrients and other resources, continued occupancy of an area by the same species is likely to result in deficiencies (quite apart from the build-up of pests and diseases). A carefully planned mixture of species is sometimes able to alleviate such deficiencies. Thus, the leguminous groundnut grown between rubber trees is able to control erosion and supply "fixed" nitrogen (see below) to the roots of the rubber; without some input of nitrogen, rubber production falls steadily. Similarly, a shrubby

Eupatorium species planted under cinchona and tea in Indonesia benefits the plantation crops by providing mulching material. This safeguards long-term production by controlling erosion and weeds, and by encouraging the turnover of nutrients by litter-decomposing organisms.

Interactions between mixture components

In closely-planted agricultural crops, individual plants compete strongly for the supplies of plant growth factors (light, water and nutrients). When alternate plants of a pure culture of crop A are replaced by plants of crop B to make a 50:50 mixture, if plants of A compete more strongly than do plants of B for the growth factor in shortest supply, the plants will grow better in the mixture than they do in pure culture; the reverse will be true of plants of B. Uneven sharing of growth factors between the components of mixtures leads usually to roughly equal percentage increases and decreases in per-plant yield of the components as compared with their performances in pure culture. If the farmer is aiming at a particular proportion of the components' products in the yield, he will therefore need to know the likely effect of competition when deciding what proportions to plant. This type of interaction between components results in overall mixture yields lying somewhere between the yields of the pure cultures of the components (even if the mixture contains several components). The slight tendency for the higher yielding components to be stronger competitors may explain the tendency for the yield of a mixture to be greater than the average pure culture value.

The tendency for mixture yields to be better than might be expected may also be partly due to differences between the components in the way they exploit the site's growth factors. There are so many human examples of fruitful cooperation between unlike partners that well-chosen combinations of plant species could also be expected to perform better than either alone. One well-tried type of combination contains a leguminous species with one or more nonlegumes. Through the presence of symbiotic bacteria in their roots, plants of leguminous species are able to take in, "fix" and utilise nitrogen from the soil air. Because they draw on this usually unavailable source of nitrogen, leguminous species leave most of the soil's nitrogenous compounds available for use by associated species, Also, as the legume's roots die, the fixed nitrogen becomes available in the soil. Hence, on a soil where nitrate is in short supply, a mixture of clover (a legume) with a grass (non-legume) may overyield. Mixtures such as rubber and groundnut (Malaysia), sugarcane and soybean (India), and cereals and field beans (Greece) are expected to exploit this same principle. Importantly, where there is little nitrogen in the soil, the non-legume component in the mixture often has a much greater protein content than in pure culture;[2] under such conditions, a mixture of grass and

A cash crop of tobacco between young rubber trees

clover will usually be preferred as fodder to pure grass (or to pure clover, which may cause "bloat").

If the components of a mixture differ in the times at which they make demands for soil nutrients or light, the mixture may use site resources more effectively. Experiments with mixtures of early and late season potatoes at Wageningen, Holland,[3] have shown overyielding by more than half of 54 mixtures, sometimes by up to 50 per cent. Mixtures of flax (early maturing) and linseed (late maturing) overyield for the same reason.

Another sort of difference which is expected to lead to an advantage for the mixture is the occupation of different layers of the soil by the roots of the components. Aiyer[2] suggested that mixtures should be compounded to exploit the whole depth of soil. Although this point has never been tested directly, in an experiment with mixtures of oat species, I found that 5 out of 5 mixtures overyielded on deep soil whereas only 1 overyielded on shallow soil; the root systems of the components of the best yielding mixture were in fact later shown to occupy different depths in deep soil.[4]

Tall vegetation often greatly alters the microenvironmental conditions below it and use may be made of this in compounding mixtures for use in harsh climates. The use of shade trees for protection from sun (and drying winds) has already been mentioned but trees may also have other effects. Thus, it has been observed that growth begins earlier in spring under trees in Salamanca probably because the soil there is not so cold at night. The removal of trees from groundnut plantations in Senegal (for the sake of "neatness") seems to have caused planting date to be much more critical than previously; the trees presumably used to moderate the microclimate under them. Taller growing components may act usefully as wind-breaks.

Crop mixtures may also have advantages under certain unfavourable conditions such as frost, lodging and weed infestation. In mixtures of wheat varieties in Czechoslovakia, frost-hardy varieties have been found to protect less hardy ones. Similarly, cereal varieties which do not lodge (get beaten flat) in bad weather, may hold up weaker-stemmed components. In an experiment in Adelaide, Australia, a wheat variety which lodged in pure culture was prevented from lodging in all 5 of its mixtures with other varieties. Trials at IRRI in the Philippines have shown that if mung bean is grown mixed with maize, the weed-smothering effect of the mung protects the easily-infested maize.

Agriculturalists are belatedly coming to recognise the potentialities of mixed cropping as a powerful and non-polluting means of controlling pests and diseases.

There is growing interest at present among ecologists concerning the possible effects of chemicals released by plants of some species on neighbouring plants (allelopathy). Most of the well-studied examples involve substances which inhibit the growth of other plants of either the same sort (autotoxicity) or of other sorts (allotoxicity). In a mixture of individually autoxic species, the plants of each component will to some extent escape the inhibitory influence of neighbours of its own species and so mixtures could overyield. Thus, it has been suggested that certain desirable forest trees which suffer badly from autotoxicity in Queensland ought perhaps to be cultivated in mixtures.

Regular overyielding by a certain mixture of rice varieties in India suggests that one variety can sometimes actually stimulate the growth of another. In this case, it was shown that some growth-promoting substance travelled from plants of one component to those of the other. An observation that the presence of certain species of Eucalyptus tree can double the productivity of the pasture in which they stand may be explained by allelopathic stimulation, or, on the other hand by microenvironmental effects. The strongly depressive effects of other Eucalyptus species on pasture growth do not seem to be due to competition for resources but rather to allotoxicity. Although the possibility has not been tested, a mixture of allotoxic components would probably yield below the poorer-yielding pure culture.

Pests and diseases in crop mixtures

A considerable body of traditional lore exists[9] to recommend the "companion" planting of certain crops with other crops. The advantages claimed are usually that the companion plants reduce pest damage in the others. Occasionally combinations conferring *mutual* advantage may be found, such as tomato and asparagus where the tomato will be protected from at least one species of parasitic nematode and the asparagus will be protected from asparagus beetle.

In the tropics where crop pests cause especially serious damage, foresters and planters have long since recognised that individuals of a species in pure culture are often more heavily damaged than individuals of the same species interspersed among individuals of other species. Accordingly, in Brazil the native rubber tree cannot be grown in pure culture although it can survive the level of pest attack suffered in the natural mixed forest.

Agriculturalists are now belatedly coming to recognise the potential-

ities of mixed cropping as a powerful and non-polluting means of controlling pests and disease. For instance, recently at the National Institute of Agronomic Research, Paris, the incidence of foot rot in a susceptible wheat variety was found to be halved in a mixture with a resistant variety. Again, in Reconquista, Argentina, it was found that intersowing cotton with maize led to an 80 per cent reduction of pest numbers on the cotton and a doubling of its yield.

To be able to choose combinations which are tolerant of pests and diseases, the grower needs to know something of how an attack in a mixture may differ from one in a pure culture. The presence of two or more kinds of crop has several effects:

1. *Fly-paper effect.* Because many pest and disease organisms tend to be specialised to attack just one or a small group of host species, the individuals of other plant species in a mixture constitute a potentially absorptive barrier to movement between those plants which can be attacked. Insect pests usually have a stage in their life cycles where they disperse from their host plants apparently to colonise new ones; at this stage they are often poor at recognising suitable food plants and steering themselves towards them. The spores of fungal diseases are passively transported by wind and rain-splash and so are even less likely to find a new host plant. Depending on the proportion of the species in the mixture a fraction of the dispersing individuals will be intercepted by non-host plants. Where the dispersing insects or spores cannot "take off" again, they are lost from the population of their species. This loss onto an inert "fly-paper" reduces the rate of build-up of epidemics in mixtures of susceptible and resistant plants.

2. *Compensation effects.* Where a crop is attacked during vigorous growth, infected plants compete less strongly than healthy plants for growth factors. Plants surrounding a diseased individual therefore yield more than otherwise and compensate to some degree for the lower yields of the attacked plants. A mixture of crops which differ in their susceptibility to a series of diseases may thus produce total yields which are more consistent than those of any of the pure cultures if the various diseases are favoured by different types of season.

3. *Microenvironmental effects.* The presence of companion plants creates a microenvironment for the susceptible crop which differs from that found in pure culture. This different environment may affect the host-parasite relationship in subtle ways:

(a) By acting on the potentially attacked component changing its susceptibility (from that in pure culture). For example, banana crops under shade trees in Malaysia are less attacked by the most damaging of a series of leaf-spot disease (although they are more susceptible to the less damaging ones); the leaves of coffee grown under shade trees in Indonesia provide a less suitable diet for woolly aphids and hence are less attacked.

(b) By acting directly on the attacking organism. For example, where broad-leafed trees grow within stands of spruce, the higher humidity (or possibly lower temperature) of the air is unfavourable to the growth of spruce-bud worm; cocoa under shade trees in Ghana is less attacked by mistletoe because this parasite requires high light intensities for the establishment of its seedlings; the odour of shallots (more effective than onions) prevents the carrot root fly from finding inter-planted carrots; wheat without awns (sharp projections from the ear, as in barley) is protected from birds by being mixed with an awned variety.

(c) By influencing the populations of the natural enemies of the attack-

ing organism. For instance, in the Philippines, the corn-stalk borer is less abundant in maize-groundnut mixtures because spiders which prey upon it are more numerous in such mixtures than in pure maize; citrus under shade has leaves with a thinner cuticle which allows leaf miners within them to be reached more easily by parasitic wasps; black-currant bushes planted in Californian vineyards support an alternate host for a parasite of a pest of the vines thus increasing its effectiveness in controlling the pest; buckwheat planted among broad beans is said to attract hover flies which prey on the bean aphids.

That most of the examples available show improved control of attacking organisms may be the consequence partly of the greater interest in well-tried, successful mixtures, and partly of the lesser emphasis which negative results naturally receive in reports. Nevertheless, crop mixtures seem to have potential where crops are threatened by pest and diseases.

Multilines and disease

When a crop variety which has a new gene for resistance to some disease begins to be widely used, individual races of the disease organism appear which have a virulence gene which overcomes this resistance. Such races multiply rapidly on the variety. Sometimes, disease races with the necessary virulent gene are very rare at the time of introduction of the new resistance gene and so this resistance gene will protect the new variety for several years before the virulent races have built up to a destructive level. Such effective resistance genes are called "strong".[10] A resistance gene for which corresponding virulent races are already present in quantity at the time of its introduction will be ineffective and "weak".

Since the Green Revolution is likely to increase the rate at which resistance genes are overwhelmed by virulent races,[1] and since in some crops there is already a shortage of new strong genes, we need to find how best to deploy our limited supply of resistance genes. As part of a possible best strategy, the growing of "multiline" varieties has been suggested as a means of bringing the crop into a stable equilibrium with the disease races.[10] A multiline variety is a mixture of genetic types (lines) of a crop similar in growth characteristics but which differ in the resistance genes which they carry. Such varieties have already been produced for wheat (in Colombia) and oats (in Iowa, USA).

Since mixed cropping often involves staggered plantings and selective harvesting it tends to be labour intensive. If it is soundly practised it may require less pesticide, weed-killer and fertiliser, and so be a low-polluting method of farming.

To appreciate the arguments in favour of multiline varieties (multilines), it is necessary to understand why some resistance genes appear strong and others weak: at the time of its introduction, a gene will seem strong if the disease races carrying the virulence gene to overcome it have been at a competitive disadvantage compared with the races not carrying the virulence gene, as they grew together on the old varieties. In simple terms, on the old varieties, this surplus virulence gene in a disease race conferred a disadvantage which kept it rare. The greater this disadvantage, the stronger the corresponding resistance gene in the crop would appear to be.

If we consider now a multiline made up of four lines where each carries one of a series of new resistance genes, A, B, C and D, each line will only be attacked by races which have acquired through mutation the virulence gene, *a, b, c* or *d,* corresponding to that line's resistance gene. Each of these races will face a strong fly-paper effect which will limit its multiplication and thus the harm it can do. If for some reason one race becomes relatively common, the damage it inflicts on the corresponding line will be to some extent compensated for by better growth of the other components. However, if further virulence genes are acquired through mutation, races such as *ab, bc,* and *ac*, will appear. Being able to attack two components of the multiline instead of only one, the fly-paper effect on them will be weaker, their multiplication rates greater and the opportunity for further mutation greater. When a super-race, *abcd,* is finally produced, all components of the multiline will be susceptible to it.

However, even when the super-race is present, the multiline may not be destroyed provided that the resistance genes on which it has been based are all sufficiently strong. For this the super-race, growing on any one of the four components, would have to be so seriously disadvantaged in competition with the other races that they reduced its rate of population growth to about that of their own. In other words, the potentially more dangerous generalist races

would be held in check by the less dangerous specialist races, and the system could come to an equilibrium.

There are unfortunately some uncertainties in this attractive picture:

1. For some diseases, too few strong resistance genes are available in the crop for a multiline to be made (e.g. in potatoes against late blight). However, the production of new resistance genes by, say, irradiation, or the use of new techniques of hybridisation may make more genes available.

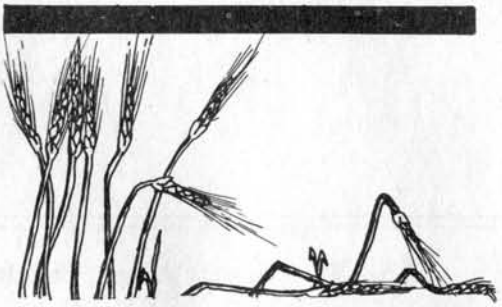
2. High strength in the resistance genes is vital for the success of a multiline but unfortunately strength does not depend only on the resistance gene itself. Given a different set of "old varieties" in the explanation above, the same resistance gene might for example appear *weak* when introduced.

Since the nature of the lines chosen to carry the various resistance genes will affect the apparent strengths of these genes in the multiline, the choice of lines could be crucial. At present the lines to be used are chosen for their agronomic performance; it seems important to select them also for their ability to maximise the apparent strengths of the resistance genes.

3. While it is known that the presence of non-virulent spores on a leaf can sometimes prevent infection by virulent ones ("cross-protection"), the presence of virulent spores can sometimes make non-virulent ones cause infections ("potentiation"). While cross-protection could increase the resistance of a multiline to attack, potentiation could decrease it. Too little is known about these phenomena to yet say which is the commoner.

4. Although experiments have measured disadvantages to races carrying many virulence genes (potential super-races) when mixed with races carrying few virulence genes, it is not clear yet whether this disadvantage is strong enough to balance the advantage to the former of their wider host range. Mathematical models now being developed may be able to show whether any equilibrium will be at a low enough level of infection for it to be worth aiming for. A stable equilibrium is not wanted if it leaves our crops regularly devastated!

5. While a multiline can be reconstituted each year to meet shifts in the relative frequency of the attacking races, an optimised set of rules needs to be worked out to replace the rule of thumb used so far in Colombia and Iowa. There are opportunities for the application of control engineering techniques in disease and pest management.



Unless the Green Revolution changes course, much of the world's green could turn to rust-red almost overnight.

Crop mixtures and the future

This article has shown that in a series of cases mixed cropping has biological advantages over the use of pure cultures; multilines may also have advantages. However, in real life, it usually is not biological but economic advantage which decides what farming and cropping systems are actually used. Since mixed cropping often involves staggered plantings and selective harvesting it tends to be labour intensive. If it is soundly practised, it may require less pesticide, weed-killer and fertiliser, and so be a low-polluting method of farming. Where there is rural unemployment, where capital is in short supply and where production must be sustainable without expensive fossil fuels and pollution control, mixed cropping is a possible solution. Thus in Nigeria and Malaysia, rubber planters are being advised to interplant their rubber with cash crops to raise capital for replacing old stands. The jobs so created can help to slow or reverse the drift to the towns.

It has been emphasised already that for mixed cropping to be biologically advantageous, the mixture components need to be chosen with care. Unfortunately, the interactions among the plants, animals and micro-organisms in a crop are so subtle and specific to particular locations that present knowledge only provides a rough guide as to what new combinations of crops and varieties should be tried. If then the possible advantages of mixed cropping are to be exploited, local experimentation will be needed, using a range of possible components and a series of seasons. In the search for "ecological combining ability",[11] the traditional combinations should perhaps be evaluated first, as at the International Rice Research Institute in the Philippines. Better, more compatible components for mixtures are being actively sought in many research centres. Examples where ranges of types are under test include trials of shade trees for cocoa (Sarawak) and for tea (India), of intercrops for rubber (Malaysia), of grasses for hay mixtures, (UK, USA, USSR) and even of strains of nitrogen-fixing bacteria for introduction into the legume component of grass-legume mixtures (Australia). If the difficulties of managing diversity in the crop field can be overcome, diversity in this and other forms will help to safeguard our crops against pests and epidemic disease. Unless the Green Revolution changes course, much of the world's green could turn to rust-red almost overnight.

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WILL BRITAIN

Early in 1974, Michael Allaby, former managing editor of *The Ecologist* and now a freelance writer and consultant, Colin Blythe, of Friends of the Earth, and Colin Hines, of Population Stabilization, commenced a study of the future of food supplies in Britain. As the country's economic situation continued to deteriorate, as world food prices rose and stocks fell, and as bad weather reduced harvests in many of the major cereal growing regions, they felt it was time to ask the question "Will Britain be able to feed itself in the years ahead?" They tried to take account of every aspect of a complex situation and in the summer they published their first paper. In it they concluded that:

"Broadly, three things decide whether we get enough to eat: the availability of surpluses in other countries, the willingness of producers to supply us, and our own ability to pay the prices asked. In none of these matters, we submit, may Britain look forward with confidence to the end of the century."

The paper stimulated discussion, as it was meant to do, and it was rewritten in the light of those discussions, with some of its data brought up to date and an historical perspective added by Christopher Wardle.

The article that follows is a much abridged version of the new, revised paper. For reasons of space it has not been possible to produce the mass of supporting data and reference that relate to the statements it makes, nor has it been possible to include seven appendices. These present in much more detail the arguments for a population policy, the efficiency with which energy is used in British agriculture, the economics of fertilizer use showing the extent to which fertilizers have experienced diminishing returns, the change in our climate, problems of water supply and irrigation, the prospects for improving the supply of fish, and additional data relating to current patterns of food consumption and overseas sources of supply.

The paper entitled *Losing Ground* is obtainable from Friends of the Earth, 9 Poland Street, London W1V 3DG, price £1.00.

STARVE?

A Friends of The Earth Report

by Michael Allaby, Colin Blythe, Colin Hines and Christopher Wardle

Historical Perspective

Since the mid-18th century the UK has not produced enough food for its domestic requirements. While this situation has been partly due to the country's size and location, the most important causal factor has been the attitude of successive governments towards agriculture. For over a century, from the repeal of the Corn Laws in 1846 to the UK's entry into the EEC, the government deliberately followed a cheap food policy, permitting the trade of most agricultural commodities without restrictions such as tariffs and quotas. Consequently, consumers in the UK were able to purchase food from the cheapest source, regardless of origin. Since food products from overseas were often produced more cheaply than at home, large quantities of food were imported.

At the beginning of the Industrial Revolution it was widely believed that the pursuit of a cheap food policy would enable industrialists to keep wages down. It was also thought that countries exporting food products to the UK would in turn provide an outlet for Birtain's manufactured goods.

As might be expected, the cheap food policy weakened domestic agriculture. During the 19th century agriculture declined and many left the land. However, the painful effects of the decline were compensated by a rapidly growing industrial sector which absorbed much of the surplus work force.

After a prolonged period of depression, alleviated only during the two world wars when the harassment of sea routes reduced levels of imports, agriculture began to recover in the late 1940s. The early provisions for stimulating domestic agriculture, the most important of which was the guarantee of prices to farmers for most agricultural products, were included in the 1947 Agriculture Act. By ensuring remunerative prices and a safe market for domestic producers, the government hoped to create conditions conducive to the expansion of agricultural production.

Initially, the government bought farmers' produce at the guaranteed price and resold it to customers. However, in 1951, the government stopped buying directly and, instead, paid farmers the difference between the market price received and the guaranteed price. In addition to guaranteeing prices, the government also provided production grants to assist farmers in particularly poor areas (e.g. hill farmers) and to encourage the adoption of certain agricultural practices (e.g. the use of artificial fertilizers).

This agricultural support system operated in much the same fashion until the UK joined the EEC. However an important modification was made to discourage the overproduction of commodities covered by a guaranteed price. Standard quantities for certain of these commodities were imposed, and if total production exceeded this figure, the deficiency payment was reduced on a pro-rata basis.

This agricultural support system was financed by the Exchequer. However, in the early sixties, world prices for many agricultural commodities, particularly cereals, were depressed. Since the UK still imposed almost no restrictions on food imports, countries with large surpluses were free to dump subsidised food exports on the UK market. This caused a downward pressure on domestic food prices so that the gap between market prices and guaranteed prices widened.

Feeling that the resulting increased cost of the agricultural support programme would be politically unacceptable and would place too great a strain on the economy, the government imposed minimum prices on imported cereals. Apart from this measure, and commodity agreements with certain nations regarding the purchase of sugar, butter and bacon, the UK continued to follow its policy of allowing consumers to purchase from the cheapest source.

This policy was abandoned in 1970 when the newly elected Conservative government decided to

impose levies on food imports. The monies generated by the levies were used to help finance government agricultural programmes. With this change, the cost of supporting agriculture was switched from the taxpayer to the consumer. The consumer policy that had begun with the repeal of the Corn Laws began to change to a more farmer oriented policy as the UK prepared to join Europe, where agriculture had always been protected.

Two years later the UK joined the EEC. At the negotiations for entry the British government agreed to institute measures to ensure that UK agriculture complied with provisions set forth by the EEC's common agricultural policy (CAP). The most important of these measures concerned the gradual raising of guaranteed prices to UK farmers so that by 1978 food prices at the farm gate and retail level would be virtually uniform within the EEC.

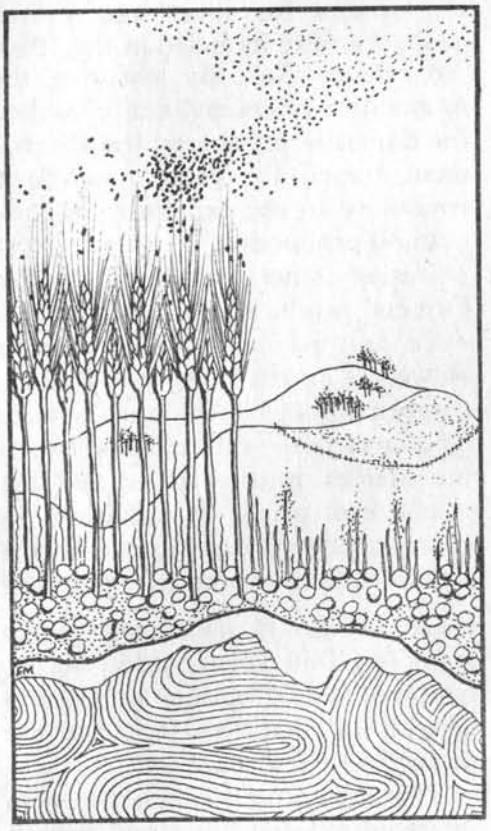
The Transformation of Agriculture

There can be little doubt that the government support of agriculture which began after World War II had the desired effect of stimulating domestic food production. Between 1953-54 and 1972-73, the net output of agriculture in the UK almost doubled. This rapid increase was due to a transformation of British Agriculture, a transformation greatly facilitated by government support in the form of guaranteed prices as well as production and capital grants. The transformation itself was brought about in several ways. With the rising cost of labour and the relative cheapness of capital, farmers began to substitute capital for labour. The exodus of labour from the land which began in earnest in the 19th century continued until, by 1973, only 1.3 per cent of the population in the UK was actively engaged in farming. Farm sizes tended to increase as farmers attempted to benefit from economies of scale made possible by mechanisation. The proportion of farms classified as large (300 acres or more) doubled between 1953 and 1972. Finally, the dependence of agriculture on high levels of industrial inputs rose dramatically.

Adverse Effects

While this transformation of British agriculture resulted in large increases in net output, not all aspects of the change were so desirable. In many instances, government pricing policy prevented farmers from accumulating sufficient capital to finance mechanisation. Since farmers had no access to capital markets some were obliged to leave farming, while others were subject to industrial takeovers. Poultry, pork and egg producers were particularly vulnerable to take overs by interests in the food processing industry, interests that were often more preoccupied with constraints imposed by technology than with those imposed by biology.

Government pricing policy also led farmers to specialise in the most profitable forms of production. In the case of arable crops, the relative profitability of cereals led to a rapid expansion in acreage devoted to grain. Between 1953 and 1973, the percentage of total arable acreage sown to cereals increased from 45 per cent to 55 per cent.



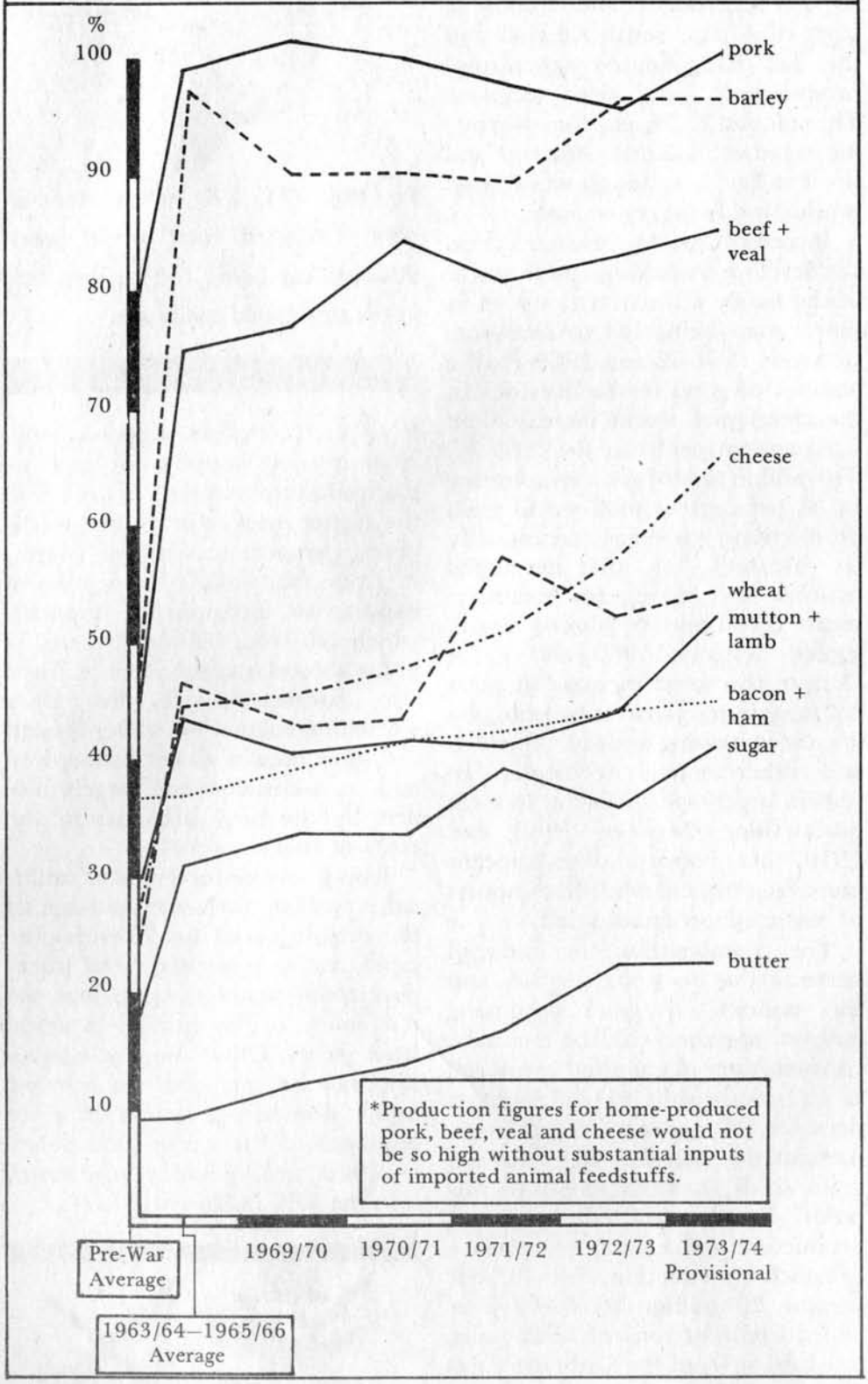
Soil blows which had seldom been a problem occured more frequently.

The growing availability of subsidised artificial fertilizers, combined with the relative profitability of cereals, persuaded many farmers to abandon the practice of ley farming (which involves seeding cropland back to grassland every few years, thus resting the land and allowing it to restore its natural structure and fertility). As a consequence, soils in many areas deteriorated. Soil blows, which had seldom been a problem, occurred more frequently on some of the lighter soils of East Anglia and the East Midlands. By the mid-sixties, farmers themselves became concerned with the adverse effects of cropping practices. The NFU conducted a survey among its members to ascertain the extent of the problem, the results of which led to a full enquiry conducted by the Agricultural Advisory Council. Their report, published in 1970, concluded that modern farming practices were indeed having a detrimental effect on soil structure in certain regions. In addition, they stated that continuous cropping had created serious problems in pest and disease control.

Nor were consumers and producers entirely satisfied with government agricultural policy. While the food policy prior to 1970 did ensure that UK prices remained considerably below those in other European countries, many consumers were angry at what they considered to be the misuse of public funds to support domestic agriculture. On the other hand, farmers were dissatisfied because they felt that the treasury – which controlled subsidy payments – had only one aim: ". . to ensure that the financial cost of farm support did not increase substantially from year to year." Government support of agriculture in the form of direct payments to farmers remained virtually unchanged during the sixties. With guaranteed prices for agricultural products rising slightly less than the costs of farm inputs, farmers found themselves being squeezed economically. While prices received by farmers rose on average by 41 per cent during the period 1954-72/73, prices of farm inputs rose by considerably more.

With the price/cost squeeze tight-

HOME PRODUCTION* AS A PERCENTAGE OF TOTAL SUPPLY



ening, some farmers were forced out of agriculture, while those remaining were obliged to specialise still further. This situation tended to encourage more farmers to abandon sound husbandry practices (such as the ley farming discussed earlier) in favour of those which were, at least in the short term, more profitable.

The 'modern' British agriculture which evolved just after the war was considered by many to be one of the most efficient systems in the world. Such claims, however, could only be justified if efficiency were measured by such traditional farm management yardsticks as labour productivity. Using techniques of energy accountancy, modern studies show that British agriculture ranks among the least efficient in the world.

Limited Progress Towards Self-Sufficiency

The rapid growth in agricultural output after World War II succeeded to a certain extent in reducing the UK's heavy dependence on imported food. The impetus for this move towards achieving self-sufficiency was initially provided by the government agricultural research programmes begun in the fifties. In the sixties, the government implemented a series of programmes designed to increase further the import-saving role of agriculture. Three selective expansion programmes ran consecutively from 1963-73 and were aimed at increasing production of certain temperate climate foodstuffs. The government estimated that the increased production arising from these programmes could reduce the annual cost of food imports by between £160 million and £220 million.

Despite the progress made towards achieving self-sufficiency, the UK still depends on imports to meet much of her domestic food requirements. In 1972-3, imports provided over 50 per cent of the butter, sugar, bacon, ham, mutton and lamb, and over 40 per cent of the wheat consumed. More important, *the upward trend in domestic food production has not led to a decline in the total value of food imports;* on the contrary they have more than doubled in value between 1953 and 1973.

The Increased Cost of Food Imports

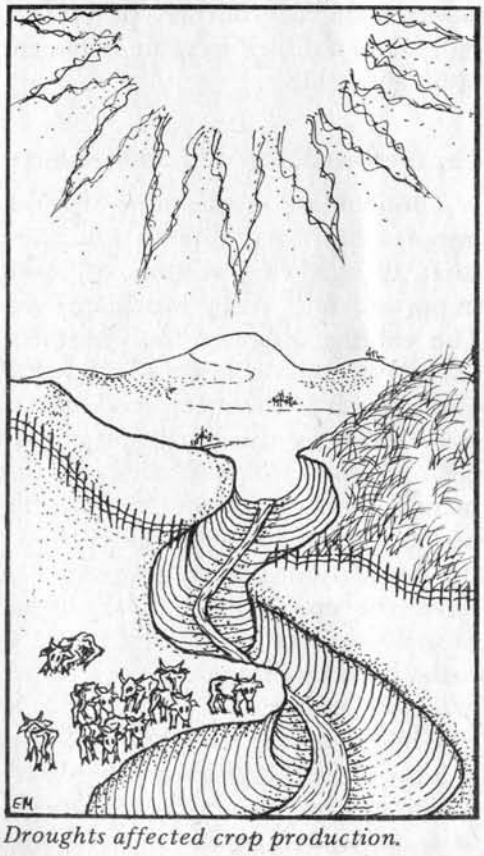
The increase in the value of food imports has been due to two factors: the growing volume of food imported, and rising world prices. The volume index of food imports rose 21 per cent between 1953 and 1973. Much of the increased volume was caused by the expansion of the UK's population, as well as an increase in consumer purchasing power. Between 1953 and 1973, the population increased 8 per cent. Since the growth in domestic food production was insufficient to meet rising food requirements, more food had to be imported.

While the rate of growth in the volume of food imported has slowed down, prices of imported foods have continued to rise, especially in

recent years. This rise in prices was due to a combination of several factors. First, during the fifties and early sixties, the world market for several agricultural commodities – and in particular cereals – was somewhat depressed. To prevent prices to producers from falling below acceptable levels, governments in several major cereal producing countries instituted price support programmes. However, such programmes tended to encourage farmers to expand rather than contract productive capacity, with the result that stocks of certain cereals accumulated.

Realising this inherent weakness in price support programmes, these same governments created incentives that would reduce productive capacity. In the United States alone, government programmes led to 50 million acres being taken out of production, a move which was later to have the gravest consequences for world food stocks.

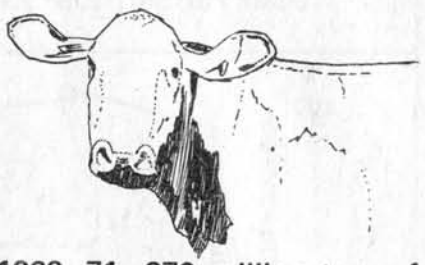
Climatic irregularities during the past several years reduced crop harvests in some of the world's major agricultural regions. In 1971, droughts affected crop production in parts of the Near East and Central America. In 1972, the failure of the monsoon season in the Far East, the disappearance of the anchoveta off the coast of Peru and the unfavourable crop growing weather in other parts of the world resulted in world food production falling for the first time since World War II. In 1973, drought and floods in parts of Africa, South America and the Far East limited agricultural production in these regions. Throughout 1974, poor crop growing weather in North America and the Far East resulted in world food production falling once again.



Droughts affected crop production.

Increased meat consumption in the developed world and particularly in the newly affluent nations led to more grain being fed to livestock. Between 1961-62 and 1969-71, the amount of grain fed to livestock in the developed world increased by 6.3 per cent per year. By 1969-71, 370 million tons of grain (amounting to 31 per cent of total world grain production) was being fed annually to livestock in the developed nations. In Japan, for example, meat consumption almost quadrupled between 1960 and 1973. Despite this large increase in meat consumption, Japan was able, by greatly increasing imports of cereals and other animal feedstuffs, to remain largely self-sufficient in meat production. Between 1960 and 1970, her imports of soyabeans more than tripled, while her imports of maize almost quadrupled.

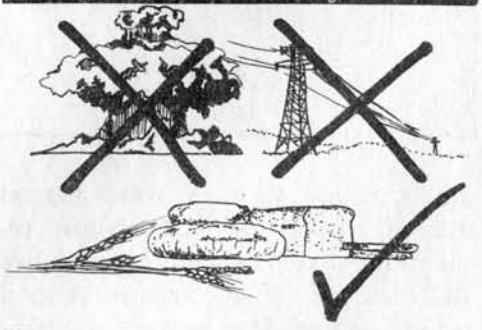
The combination of reduced harvests due to poor weather and the policies of grain producing nations, together with the increased consumption of grain-fed meat, led to an upward shift in world import demand for agricultural products, particularly cereals. The Russian grain deals in 1972 illustrate this point. Faced with reduced cereal production and a desire to increase livestock production, the USSR bought 20 million tons of wheat and 10 million tons of feed grain, much of it from the United States. While world import demand for cereals was shifting upwards, reduced harvest limited growth in the export availability of grain. As a consequence, the stocks of grain accumulated during the sixties were drawn upon. With supply and demand tightly balanced, world food prices began to rise even faster. Between 1970 and 1973, the UN export price index for food almost doubled from 113 to 220.



By 1969–71, 370 million tons of grain (31% of total world production) was being fed to livestock in the developed nations.

Higher world food prices adversely affected countries largely dependent on food imports for meeting domestic requirements. In the UK, the higher prices contributed to the deterioration in the country's terms of trade (the ratio of the price of exports to the price of imports), which fell from 100 in 1970 to 75 in the second quarter of 1974. They also contributed to the UK's worsening balance of trade, though their full impact was overshadowed and, as a consequence, largely hidden by the huge increases in the costs of fuel imports.

Rising world food prices eventually worked their way through to the British housewife. However the rapid rise in domestic retail prices during the past few years was not due solely to the increase in world food prices. Other major contributing factors included the growing rate of domestic inflation, the abandonment of the cheap food policy in 1970 and, possibly, the entry into the EEC in March 1972.



"The real power in the future will not be nuclear or even energy, but will belong to whoever possesses the sources of food."

PROSPECTS FOR THE FUTURE

Looking towards the future, two important questions must be answered. First, will the cost of food imports increase over the next few years and, second, will the UK be in a stronger or weaker position to pay for these and other imports?

World Food Prices

For several reasons it appears likely that the cost of UK food imports will continue to rise. World food prices cannot fail to increase during the first part of 1975 because of the shortfalls in production which occurred in 1974. Stocks are virtually exhausted. There are 76 million more mouths to feed than at this time last year.

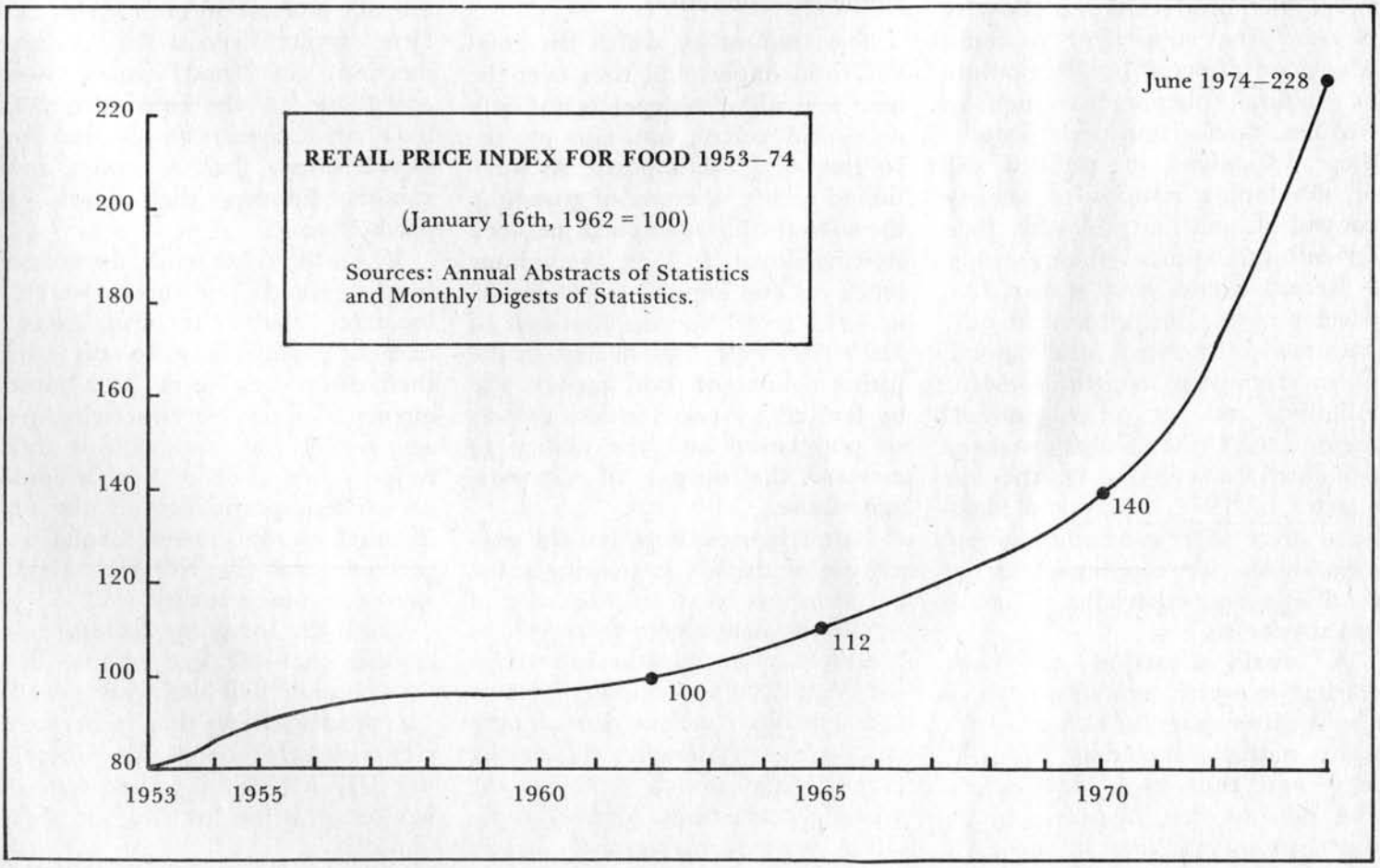
In the longer term, prospects that world food prices might stabilise and eventually fall are not good. The UN predicts that the demand for food in the developing world will increase at an annual rate of 3.6 per cent between now and 1985. It warns that, unless the rate of growth in agricultural production in developing nations does not increase faster than the 2.6 rate maintained for the past twelve years, shortfalls in domestic production of cereals in these nations will grow from the 1969-71 level of 16 million tons to 85-100 million tons by 1985. If their shortfalls in domestic production reach this magnitude, the nations concerned must either greatly increase their food imports or be faced with mass starvation.

The comprehensive UN proposals for a programme to accelerate agricultural production in the developing world call for a substantial increase in the level of inputs used by agriculture in developing nations (especially fertilizer and pesticides), the opening up of large areas of land for agricultural development in South America and Africa, the development of technology appropriate for agriculture in the Third World, and an increase in the level of foreign investment in agricultural projects in the developing nations from the current level of $1 billion to $5 billion per year by 1985.

Several constraints make it unlikely that the proposed programme will attain its objective of making the developing world once again largely self-sufficient in food. The UN itself predicts that there will be a shortfall in world production of fertilizers and pesticides over the next five to ten years. Shortfalls in fertilizer and pesticide production will particularly affect the developing world, which currently imports 52 per cent of its fertilizer and nearly all its pesticides from the developed world.

Apart from the two inputs mentioned, there are also indications that the vast capital investments needed to fulfil the UN programme may not be forthcoming. Western nations, currently beset with their own economic problems, are reluctant to make any large-scale financial commitments. While some of the Arab nations have indicated their willingness to provide part of the capital investment required, the funds have yet to materialize. Also, the willingness of governments in many countries to institute internal reforms, such as the improvement of income distribution, the implementation of land reforms and the generation of employment opportunities for rural populations, has yet to be demonstrated.

If the programme fails to reach its stated objective, shortfalls in agricultural production in the developing world will increase, with the result that world import demand for food will shift upwards. Unless



there is also a corresponding increase in the world export availability of food, prices will continue to rise. Already there are indications that the growth in export availability will not match the increase in import demand. The shortfalls in fertilizer production will affect the developed world as well as the developing world. With limited supplies of fertilizer and pesticides, crop yields in major food exporting nations are likely to fall, and may be reduced still further if the unfavourable crop-growing conditions predicted for the Northern Hemisphere by several leading climatologists become a reality. (See *The Ecologist* Vol.4. No.1. p.10.)

The increase in world food prices resulting from the tight balance between import demand and export availability will be even greater if agricultural producer-nations form cartels in an attempt to control prices. Already coffee producers have formed a cartel and sugar producers are thinking along the same lines. However, as seen in the case of coffee, producer cartels are difficult to operate successfully, particularly where agricultural products are concerned.

There are two major difficulties: how to allocate market shares between the producers, and how to regulate the supply of products which are affected by fluctuations in natural phenomena such as weather, disease and pests. Despite these difficulties, the political will of developing nations to achieve control of, and fair prices for, their agricultural exports remains strong.

Recent events have shown that developing nations are not the only ones ready to control food exports. In an attempt to control domestic inflation, and for other, political reasons, the United States restricted certain food exports in the last quarter of 1974. There is a likelihood that with continuing severe inflation she may once again restrict food exports, especially of maize and soyabeans.

A world situation has been reached in which food may become a political weapon, for lack of which many nations, including the UK, may find themselves defenceless. The position has been succinctly stated in an interview in the FAO journal *Ceres*, April 1974, by Mr Ismail Sabri Abdulla, Egyptian Minister of State and Director of the National Planning Institute, Cairo:

> "The real power in the future will not be nuclear or even energy, but will belong to whoever possesses the sources of food."

. . . there will be 3 million more mouths to feed by the year 2000 . . . Already population growth has caused almost a million acres of agricultural land to be withdrawn from production in the last 25 years . . .

Limits to the Expansion of Domestic Production

The amount by which the total UK food import bill rises over the next several years depends not only on world prices, but also on the volume of food imports. As mentioned earlier, the rate of growth in the volume of food imports has been slowing down. In fact, the volume index of food imports fell from 103 in 1973 to 97 for the first half of 1974. However, any decline in the future volume of food imports will be limited by two factors: growth in population and the ability to increase the output of domestic agriculture.

Latest figures show that the population of the UK is growing at 0.1 per cent per year. If this rate of growth is maintained, there will be 3 million more mouths to feed by the year 2000. Assuming present eating habits continue, British agriculture may experience difficulties in providing enough food for the growing population. Already population growth has caused almost 1 million acres of agricultural land to be withdrawn from production since 1953. While some of this land was undoubtedly marginal and unable to respond sufficiently to modern farming techniques to justify its being cropped, much of it was fertile and productive. With a growing population, more houses, roads and industry are inevitable and more land will be diverted to non-agricultural uses.

In addition to the loss of farmland, there are indications that future increases in domestic agricultural productivity may be limited. Given the cost/price relationship between fertilizers and arable crops, the optimum level of fertilizer use has been reached on many farms. Should farmers increase their fertilizer application rates with the intention of getting higher yields, they would almost certainly find that the cost of the additional fertilizer would exceed the revenue accruing from the higher yields. This situation could be altered if crop prices were to increase relative to the cost of fertilizers and other farm inputs. Since, however, the response of crops to higher fertilizer applications would be small, a substantial rise in crop prices would be necessary to bring about any significant increase in both yields and farm output. Even if the resultant increases in food prices were acceptable to the consumer, it is likely that farmers would find biological rather than economic constraints limiting their levels of production.

If, on the other hand, the cost of fertilizers and farm inputs were to increase relative to crop prices, farmers would have to cut back their use of fertilizers. As a consequence, overall productivity per acre would fall and with it total output. Any drop in output could be serious, particularly if the unfavourable crop growing conditions predicted for the Northern Hemisphere become a reality.

From the foregoing discussion, it appears that the size of the UK's food import bill will continue to rise, possibly faster than in the past. We must now determine whether the UK will be in a stronger or weaker position to pay for these imports.

Ability to Pay for Imports

Traditionally, the UK has paid for imports with the sale of manufactured goods and financial services. In recent years, however, our competitive position vis a vis the sale of manufactured goods has deteriorated.

Over the past twenty years, the value of manufactured goods exported by the UK has grown much more slowly than the value of manufactured goods imported. In fact, manufactured imports expressed as a percentage of manufactured exports has grown from 31 per cent in 1953 to 85 per cent in 1973. Possible explanations for this trend include the relatively outmoded capital equipment used by British industry (at least compared with that found in Japan and West Germany) and the growing rate of domestic inflation which makes UK goods less attractive on the world market. Certainly, unless strong measures are taken to reverse this trend, the UK's ability to pay for imports will continue to weaken.

While many agree with the above analysis, they admit no cause for concern; there is, of course, always North Sea oil. Certainly some cause for optimism is allowable, but this optimism must be tempered with a realisitc look at some of the problems involved. Because of the large capital investment required to extract North Sea oil, the unit cost is considerably higher than for oil from other sources. Since the prices of oil grades are uniform throughout the world, the consequences of a large cost differential could be serious for Britain in a world recessionary situation. The Arab nations, in particular, mindful of their markets and anxious to protect their foreign investments would probably move to support Western economies by reducing the price of their oil. The result would be a reduction in the already slender profit margin of North Sea oil. However, since the infrastructure of production platforms, pipelines, refineries and chemical works is already there, and many thousands of people are employed in oil-related activities, Britain could not afford to suspend extraction operations. Under such circumstances it is conceivable that North Sea oil would even be extracted at a loss and thus represent a drain on the economy.

As though this prosepct were not sobering enough, government statistics show that North Sea oil production will peak in 1979 and fall off after 1982-83. These figures are based on commercially significant discoveries up to April 5th 1974 and assume a total reserve of 1060 million tons. Taking into account further possible finds, the same source estimates a total extractable reserve of 2950 million tons. Given this upper level of reserves, a rough calculation shows that if demand for oil increases at 4 per cent per year, North Sea oil could meet all the UK's oil requirements from 1979 to 1989-90. However, if demand were to increase by 10 per cent per year, North Sea oil could only meet domestic requirements until 1985-86; its import-saving role, among other things, would be relatively shortlived.

In summary then, it is clear that the UK will find herself in a worsening situation. She will be faced with a rising food import bill at a time when her ability to pay is being continually weakened. Unless realistic measures designed to rectify this situation are introduced as a matter of urgency, then the outlook is a bleak one indeed.

Recommendations

In the light of conclusions reached, we urge the Government to make every effort to decrease the United Kingdom's reliance on imported food. A more nearly self-sufficient situation could lead to a reduction in the size of the import bill, thereby easing the tight balance of payments position. This would also lessen the UK's vulnerability to fluctuations in world food prices.

A word of caution is necessary, however. Any further attempt to approach self-sufficiency by encouraging domestic agriculture to adopt more capital – and energy – intensive methods of production may fail. The capability of such methods to significantly increase agricultural production is now open to doubt. Further, past experience has shown that these methods sometimes cause farmers to abandon sound husbandry, with disastrous results. Finally, with the rapidly rising cost of imported industrial inputs, any increase in output dependent on increasing levels of these inputs will inevitably limit growth in the import-saving role of domestic agriculture.

A New Approach

Given these difficulties, it becomes clear that we need an entirely new approach to the question of self-sufficiency; an approach that not only reduces our dependence on imported foods, but also encourages domestic agriculture to adopt sustainable methods of production. By sustainable we mean ecologically sound, rational in the use of energy, and less dependent on high levels of industrial inputs.

Such an approach must recognise that the degree of UK self-sufficiency in food is determined by two factors. The first of these is the level of output of domestic agriculture; in economic terms the *supply* side. The second is the level of domestic food consumption; the *demand* side. While in the past the level of domestic agricultural output has generally been recognised to be a major determinant of self-sufficiency, the role of consumption has largely been overlooked. By recognising that supply and demand jointly determine the degree of self-sufficiency, we contend that the objective of self-sufficiency can be approached by using sustainable methods of production.

National Food Requirements

On the demand side, our national food requirements are determined by what individual consumers choose to buy. Individual consumption patterns are themselves the product of many variables. These include the price, availability and convenience of different kinds of food as well as the income, background, regional residence and personal taste of the consumer. By manipulating some of these variables, the consumption patterns of individual consumers could be altered and the nation's food requirements changed.

Consider our present eating habits. In 1972, we consumed an average of 77.4 kg of meat per head. To do this we were obliged to import almost one third of the meat consumed, at a total cost of £715 million. In addition, we devoted one third of our arable acreage to growing grain for livestock and imported another 3.6 million tons of feed-grain from abroad.

Producing food through animals is not very efficient. Were we to reduce the proportion of our protein intake derived from animal sources (and in 1972, 57 per cent of our protein intake came from animal sources) and increase our intake from vegetable sources, we could lessen our dependency on imported meat and feed-grains, and in doing so increase our degree of self-sufficiency in food. Such a change in eating habits would also make a small, though worthy, contribution toward easing the present world food crisis.

Thus by altering our consumption patterns, we could increase our degree of self-sufficiency. However, before this can be done, it is of the utmost importance to determine what kinds of consumption patterns are desirable, and how consumers might effectively be encouraged to adopt them. The most desirable consumption patterns would be those where a relatively large proportion of the national diet comes from primary food sources. Note, we are not advocating the complete abandonment of animal sources of protein; rather we should like to see encouraged a reduction in what we deem to be their excessive consumption.

Fish farming.

Before attempting to change consumption patterns, we must assess the relative importance of the various factors influencing these patterns. Once this is done, the best method of changing consumption patterns can be determined. In all likelihood, the most effective and acceptable method would be to combine consumer education with financial incentive.

Modifying consumption patterns would not be the only way to lower the nation's food requirements. Another way would be to limit population growth with a view to stabilising and eventually reducing our numbers. Such an objective could be more readily attained if the Government were to adopt a population policy designed to bring about immediate zero population growth. This could be done by promoting the idea of the one or two child family as desirable and informing the public of the consequence which must be faced if the nation fails to curb population growth.

Domestic Food Production

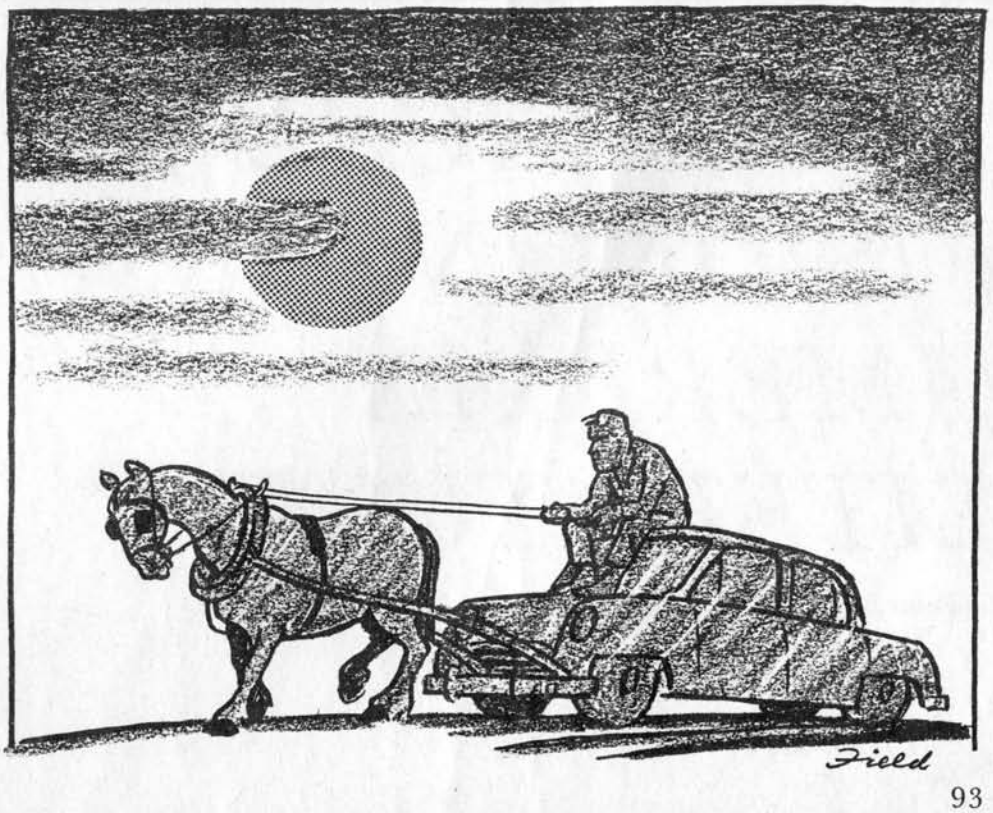
Turning to the supply side, we believe priority must be given to ensuring that domestic agriculture responds to changing patterns of consumption and produces the kinds of food required. In addition, ways must be found to increase the level of domestic food production. For reasons already noted, any attempt to increase production simply by raising the level of inputs may fail. We need a plan with two objectives: first, to restructure domestic agriculture and second, to investigate new and relatively untapped sources of food. Domestic agriculture could be restructured to encourage farmers to adopt sustainable methods of production and return to a more divers and, possibly, labour-intensive form of farming. The investigation of new sources of food would include fish farming and novel proteins.

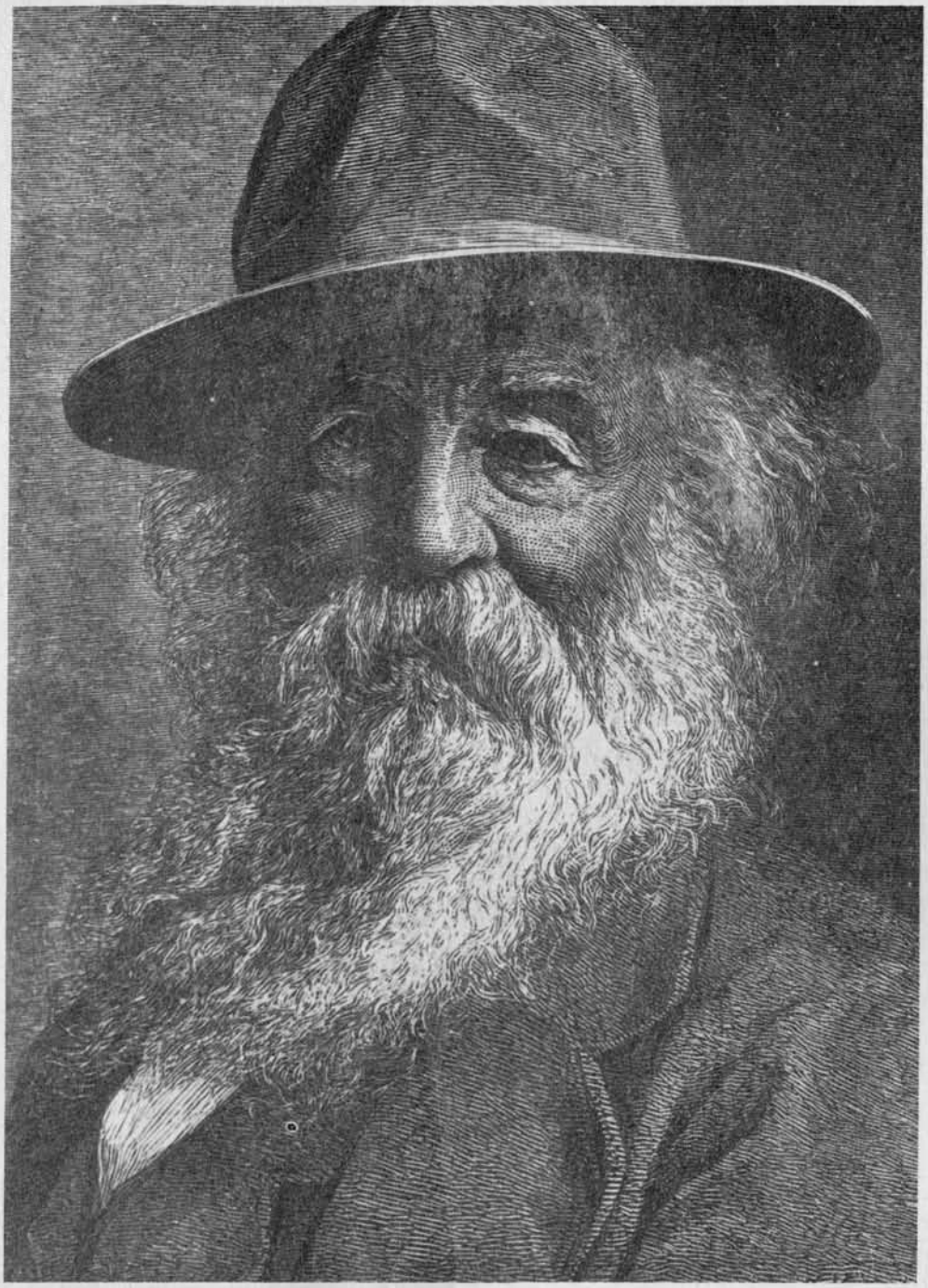
We shall leave a detailed examination of the proposed restructuring of food consumption. Before conpapers. Also to be discussed in another paper will be the role of new sources of food and possible ways of changing national patterns of food consumption. Beofre concluding, however, two points should be made. First, if the Government decides actively to encourage the restructuring of domestic agriculture (and we think this preferable to allowing agriculture to respond to haphazard market sources), then both short and long term effects of policy decisions must be evaluated. Neither farmer nor consumer wants to see surpluses of foods accumulating as the result of unwise decisions. Nor, we trust, do they want to see government agricultural policy unwittingly encourage farmers to abandon sound practices in favour of those that are merely profitable in the short term. Second, efforts must be made to ensure that *all* the food produced for sale reaches the consumer. According to Dr H.C. Pereira, FRS (Ministry of Agriculture, Fisheries and Food), 25 per cent of domestically produced food is wasted. A drastic reduction in food wasted would permit significant progress to be made towards self-sufficiency.

Summary of Recommendations

1. The Government should seriously consider how the UK might approach self-sufficiency in food. This must involve recognition that two main factors determine our ability to become self-sufficient: domestic food production and domestic food consumption, and that steps must be taken to influence *both* these determinants. On the demand side these steps would include:
   a) modifying national consumption patterns away from heavy dependence on animal proteins.
   b) instituting a population policy designed to bring about a stationary population followed by a decline in our numbers.

   On the supply side:
   a) encouraging domestic agriculture to respond to changing patterns of consumption.
   b) facilitating the restructuring of domestic agriculture along the lines that lead to the adoption of sustainable methods of production.
   c) conducting research on crops to suit changed climatic conditions and investigating the potential role for novel proteins, fish farming and other unconventional sources of food, and
   d) evaluating the role of underutilised resources, e.g. grassland.
2. It should be recognised that agriculture is the nation's most vital resource, and that steps must be taken to protect it from irreversible development and bad agricultural husbandry.





Walt Whitman

ECOLOGICAL VISION IN AMERICAN LITERATURE

by Peter E. Hartley

People tend to see themselves as separate from nature. Western European culture has carried this attitude to an extreme, with the ecological results now so depressingly familiar. We might expect that once people learned that nature is their life-support system, they would try to keep it in good order for their own benefit. But narrow self-interest is not as straightforward a motive as we think. Nor will simply defining man as part of nature solve anything, no matter how convincingly we demonstrate it as mere fact.

If man is merely part of the natural world that science now defines for us, man not only remains separate from nature, but he takes the last step in ensuring alienation from himself. For the scientific attitude has typically been the most extreme development of our separation from nature, priding itself on a detached and reductive objectivity. Worse, if we view ourselves as part of nature in any such naive and external way, we simply define all our activities as "natural" – *including the activities that are destroying the natural world.*[1]

Merely being part of nature provides no motive to save the rest of nature. Man will not stop destroying nature until he can value nature for itself. But he cannot do that if nature is a mere object separate from humanity, even if that object includes "man" in some reductive sense. The answer is inescapable: man must value nature literally as himself. As Norman C. Brown says in *Love's Body*, "the earth has no other refuge except to become invisible: in us."[2]

To be invisible is to be exterior no longer. Or rather it is to abandon the Cartesian distinction between interior and exterior. Brown tells us that the human body must become identical with the environment.[3] And our body is all our experiences. Not only must the earth, or nature become invisible in us; we must become invisible in nature. To heal the Cartesian split means to dissolve the boundaries that create a world of mere exteriors. Obviously discursive prose does not allow any approach to what such an experience would be like. But Alan Watts can at least tell us what it *entails.*

In an article called *"The Individual as Man/World"*, Watts applies the notion of a theoretical "field" to the total situation that we usually describe as an organism in an environment:

> "The individual is not a skin-encapsulated ego but an organism-environment field. The organism itself is a point at which the field is "focused", so that each individual is a unique expression of the behaviour of the whole field, which is ultimately the universe itself . . . The individual is . . . a process of behaviour which *is* the environment also.[4] "

Unfortunately, as Watts says, "to know this theoretically is not to feel it to be so."[5] That is, "we do not . . . experience ourselves as the behaviour of the field, but rather as a centre . . . which sometimes manages to control its environment, but at other times feels totally dominated by the environment."[6]

To stop destroying nature, man must value nature as himself. In Watts' terms, this would be to *feel* experience as the focus of an organism-environment field, and to *be that feeling*, abandoning entirely the sense of being an entity separate from the experience.

Clearly, whether man is separate from nature is not a fact we can determine, because we cannot reach any outside standpoint. If we try to make an "objective" decision about the question, we have simply chosen an answer . . . in being "objective" we have already chosen to be detached. Simply in adopting that standpoint we have created the separation. Just so would our union with nature be an active choice, a creation of our real situation as a choice we make. For in fact our real situation is the occurrence, the event, of whatever choice we happen to make. We make it, and it makes us.

The trouble is, "union with nature" is a pretty phrase, but we don't really know what it means. How can it be a possible choice? What is it like to be the individual as man/world, experiencing self as the behaviour of the biotic field?

When a question like that faces us, we can expect that our literary heritage surely will give us something to go on. Surely something like that experience lives somewhere in literature. For literature can make us fully aware of the quality of experience; through literature we become fully conscious.

I turn to American literature, because I feel I am more familiar with it than with any other. And I find that American literature not only contains works that deal with the union of man and nature, but contains that idea as a central theme running through the American literary tradition: the vision of man harmonious in nature.

Immediately we think of something like Natty Bumppo's life in the primeval forest. That's not really what I'm getting at, though Natty Bumppo is very much part of the central theme. But Cooper's hero seems rather a way of thinking about the possibility of man-in-nature, not a way of presenting the actuality. We are after a deeper insight.

Thoreau provides an obvious starting place. His life was a quest for the kind of harmony we are talking about, and his writing is a record of his quest. To Thoreau, being the individual as man/world was like this:

> "A man goes to the end of his garden, inverts his head, and does not know his own cottage. The novelty is in us, and it is also in nature . . . To a keen observer, objects do not twice present exactly the same appearance . . . The prospect is thus a constantly varying mirage, answering to the condition of our perceptive faculties and our fluctuating imaginations.[7] "

A constantly varying mirage, answering to the condition of our perceptive faculties and our fluctuating imaginations. This begins to give us an inkling of what living experience is like. This is true knowledge and true power – and true science: "The man of most science", says Thoreau, "is the man most alive, whose life is the greatest event."[8]

Having said this, I need hardly mention Emerson or Whitman. You will all instantly see the possibilities there. Emerson is crucial to the development of this theme in our literature, but I think he does not so much convey the experience as inspire others to do so. Others like Whitman, who gets to the living heart of it, as in these lines about watching a knife-grinder in the street:

> The scene and all its belongings, how they seize and affect me,
> The sad sharp-chinn'd old man with worn clothes and broad shoulder-band of leather,
> Myself effusing and fluid, a phantom curiously floating, now here absorb'd and arrested,
> The group, (an unminded point set in a vast surrounding),
> The attentive, quiet children, the loud, proud, restive base of the streets,
> The low hoarse purr of the whirling stone, the light-press'd blade,
> Diffusing, dropping, sideways-darting, in tiny showers of gold,
> Sparkles from the wheel.[9]

Myself effusing and fluid, indistinguishable from my living experience, whether a street scene or the titanic vastness that Robinson Jeffers loves to contemplate, as in these lines:

> and, I was the stream
> Draining the mountain wood; and I was the stag drinking;
> and I was the stars,
> Boiling with light, wandering alone, each one the lord of his own summit;
> and I was the darkness
> Outside the stars, I included them, they were a part of me. I was mankind also, a moving lichen
> On the cheek of the round stone . . . they have not made words for it,
> to go behind things, beyond hours and ages,
> And be all things in all time, in their returns and passages, in the motionless and timeless centre,
> In the white of the fire . . . how can I express the excellence I have found, that has no colour but clearness; . . .[10]

Perhaps the viewpoints in these two passages seem incommensurate. Here we have Whitman describing a mere street scene, and Jeffers expanding through intergalactic space. Certainly I could have chosen lines from Whitman that seem more cosmic in scope, or lines from Jeffers

that stay more within the bounds of localised experience. But my present choice is deliberate, for to the fluid living self these passages are not incommensurate at all. Every experience is vast, and takes in the cosmos of all life. Everything has cosmic experience. Elsewhere, Jeffers makes a comparison that fits Whitman's imagery of wheel and sparks very well. Jeffers calls the very Galaxy a "firewheel/On which we are pinned, the whirlwind of stars in which our sun is one dust-grain, one electron."[11] One spark. The sun itself a sparkle from the wheel.

Thoreau, Whitman, Jeffers – these are foremost among the names that inevitably occur to us as we begin to consider the theme of ecological vision in American literature. Yet there is another author who has gone beyond any of them in expressing human experience as a creative event in a living field of change. Most people would not consider him a "nature" poet at all, though his aim has always been to get at the essential nature of things, and though he uses a great deal of nature-imagery in doing so. I think that the poetry of Wallace Stevens is almost entirely an attempt to convey a sense of what Watts calls "the individual as man/world", and I think that Stevens succeeds even more consistently than Jeffers at reaching Jeffers' goal of seeing "without imagination, desire or dream."[12] For, paradoxically, it is just that transcendent detachment which is the most intimate involvement, and which perceives the greatest value in a world that is the very sensing, that constitutes the self.

Anyone who has read Wilson O. Clough's *The Necessary Earth* can easily appreciate what I am saying. A discussion of Stevens culminates Clough's revelatory exposition of "Nature and Solitude in American Literature", because Clough presents Stevens as the culmination of that theme. Clough gives us Stevens as the ultimate poet of nature, viewing nature as the one true source, insisting that "man is one with his universe, not apart from it."[13] Insisting that man, as Stevens said, is "the inhuman-making choice of a human self."[14]

To see and feel that is to see ecologically. It is to see reality in a way that combines "the philosopher's search/For an interior made exterior/And the poet's search for the same exterior made/Interior", . . . to combine them in a way that abandons the distinction between "interior" and "exterior".[15] To abandon that distinction is to make the world of *things* invisible.

To see ecologically is to see not a world of static ontological "things", but a world of living relationship, energy and change: "Of what is this house composed if not of the sun."[16] It is to see life as "the giant of nothingness . . . the giant ever changing, living in change."[17] It is to see the self as a seeming, an event – the little man who isn't there. Only the world, only the nothingness, the blazing wonder of the world.

As in *"The Sense of the Sleight-of-Hand Man"* which shows that our pompous attempts to be detached individuals, "tooting" our importance, also merely "occur as they occur", just as the clouds "occurred above the empty house and the leaves/Of the rhododendrons rattled their gold,/As if someone lived there."[18] But in fact, the house is *always* empty. Search as we may, we can never find anyone at home. There is no separate, detachable person alive; there is only aliveness, our life.

As in *"Tea at the Palaz of Hoon":*

Not less because in purple I descended,
The western day through what you called
The loneliest air, not less was I myself.

What was the ointment sprinkled on my beard?
What were the hymns that buzzed beside my ears?
What was the sea whose tide swept through me there?

Out of my mind the golden ointment rained,
And my ears made the blowing hymns they heard.
I was myself the compass of that sea:
I was the world in which I walked, and what I saw
Or heard or felt came not from myself;
And there I found myself more truly and more strange.[19]

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2. *Love's Body* (New York: Random House, 1966), p.259.
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4. Alan W. Watts, "The Individual as Man/World", in *The Subversive Science: Essays Toward an Ecology of Man*, p.140.
5. Watts, p.140.
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11. Jeffers, "De Rerum Virtute", in *Hungerfield and Other Poems* (New York: Random House, 1954) p.94.
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14. Wallace Stevens, "Of Ideal Time and Choice", in *Poems*, ed. Samuel French Morse (New York: Vintage, Alfred A. Knopf and Random House, 1959), p.140.
15. "An Ordinary Evening in New Haven", in *The Collected Poems of Wallace Stevens* (New York: Alfred A. Knopf, 1954), p.481.
16. "An Ordinary Evening in New Haven", p.465.
17. "A Primitive Like An Orb", in *The Collected Poems of Wallace Stevens*, p.443.
18. "The Sense of the Sleight-of-Hand Man", in *The Collected Poems of Wallace Stevens*, p.222.
19. *The Collected Poems of Wallace Stevens*, p.65.

"..ONLY, YOURS RUNS OUT IN 30 YEARS"

SUNSHINE ON WASTE

by Dr. Neiton Pilpel.

The Environment is being increasingly polluted by plastic and other waste materials. But by making use of trace amounts of chemicals known as photosensitizers it may be possible to harness some of the sun's energy and use it for disposing of this waste or converting it into useful new products.

According to archaeologist Dr. Louis Leakey, stone age man may have disposed of a good deal of his household rubbish by simply tossing it over his shoulder. Excavating in Africa, he recently uncovered circles of bones which he thinks were made a million years ago by hunters sitting round the carcasses of slain animals and piling up the bones they gnawed behind them.

Today it is not so easy to dispose of domestic rubbish. In the United Kingdom every member of the population generates about a third of a ton of waste a year. The total is 20 million tons — 25 dustbins full every second of the day and night. It comprises decaying food-stuffs, paper, plastic wrapping, wood, bones, tyres, bottles, ashes, tin cans, old clothes, carpets, and transistor radio sets. In addition, technological urban society produces almost incalculable quantities of sewage, dust and other wastes from mining and industrial processing and from periodic accidents like the Flixborough explosion in Lincolnshire and the stranding of the Torrey Canyon off the Scillies in 1967, when some 100,000 tons of crude oil was spilled on to the surface of the sea.

Waste oil from refineries and from leaks and accidental spillages elsewhere is constantly escaping into rivers – one estimate puts the amount at 2,000 tons a year. It causes considerable damage to installations as well as to the local flora and fauna and constitutes a continuous pollution threat to the environment.

Starting from April of this year, Waste Disposal Authorities, based on county or regional areas, have begun to take over the work of River Boards and Local Government Authorities in dealing with domestic, agricultural and industrial waste. There have been teething troubles and reports have appeared of unemptied dustbins and of rubbish in polythene bags accumulating in city streets. But once these have been overcome, the change should go some way towards solving the problems that are inherent in small scale operations where local conditions can materially affect decisions about salvaging, recycling and the choice of methods that should be adopted for disposing of waste.

In London and other urban centres with high population densities, land can cost £½ million an acre and there is usually a shortage of suitable sites on which to dump rubbish. Despite the high initial capital and maintenance costs involved, a strong case can usually be made for installing efficient rubbish sorting equipment and incinerators in towns for burning the organic content of the waste. In Nottingham, for example, a £7 million incinerating plant operated jointly by the City and the National Coal Board provides central heating and hot water for municipal buildings and housing estates. But in less densely populated areas of Durham or Cornwall, where millions of cubic metres of space are available from open cast or underground mining operations, it is usually more economical to tip the rubbish and ultimately to restore the land by covering the dumps with topsoil.

At the present time approximately 20% of all domestic rubbish in the U.K. is incinerated, about 5% being sorted to remove salvagable components like clean paper, wood, metals,s etc. The remaining 80%, amounting to about 40 million cubic metres in a year, is dumped in heaps or at sea, or is buried in quarries and disused mine shafts.

Decomposition of Plastics and Organic Waste

The ultimate fate of materials that have been dumped depends primarily on their chemical nature and rubbish may be broadly divided into

the organic portion – waste food, paper, wood and fabrics which are fairly rapidly decomposed by the action of bacteria, sunlight and chemical processes of oxidation – and the inorganic portion – glass china, ashes and metals – which persist for long periods. However, the division into these two categories is not as clear cut as might appear.

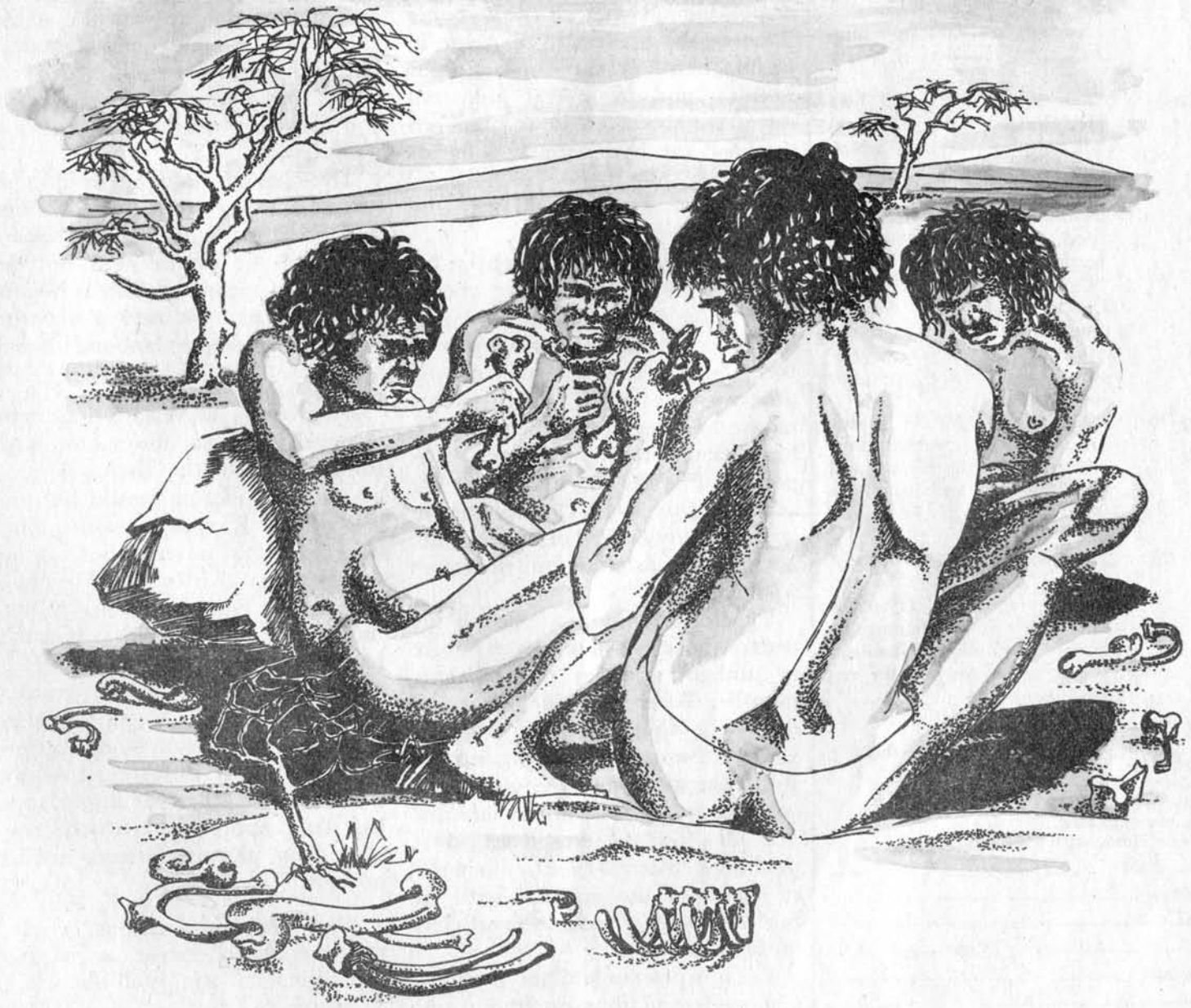
Wrought iron bolts from a bedstead will rust to powder quite rapidly in comparison with the lacquered brass knobs which may have been used to decorate the uprights of the bed. Furniture made from the heartwood of oak (which contains natural chemicals toxic to fungi) withstands decomposition much longer than furniture made from softwoods, like pine, which do not contain these natural toxins and which have a different composition of cellulose and lignin.

Under identical environmental conditions organic fabrics and foodstuffs both rot; but canvas rots faster than leather, bananas faster than onions.

The arbitrary nature of the division into organic and inorganic is particularly exemplified by plastics which last year accounted for approximately one million tons of all waste and rubbish in the U.K. Plastics such as acrylate, perspex, cellophane, polythene, polyvinyl chloride etc., are organic in the sense that their molecules are based on carbon, but in terms of stability some, though not all, are as indestructible as bone. This, of course, is one of the reasons why they have become popular as substitutes, where durability and lightness combined with relative cheapness are desired.

However, it is a widespread fallacy amongst the lay public subjected to sensational newspaper headlines, that all plastics are equally indestructible. While some of the commoner packaging materials that end up on the rubbish dump appear to be capable of withstanding the effects of sunlight and bacteria for decades, were it not for the fact that they contain certain chemical antioxidants and stabilizers which are incorporated during processing and fabrication, many of them would be quite useless. They would disintegrate under the combined action of air and sunlight as fast as any other rotting organic material.

The anti-fungal toxins in the oak furniture referred to above prolong its life in comparison with pine wood or paper, even though these are all substantially of the same chemical composition. Plastics resist bacteria, sunlight and oxygen from the air because they have been correctly formulated. During manufacture, small amounts of materials



LOW IMPACT LIVING

A series of lectures to explore the implications of low impact living is being organised at Havering Technical College. The lectures are open to anyone interested at a cost of £2.00 per head for the course payable on the first evening.
The programme is as follows:

April 8	"Reasons for Concern", Dr. G. Whitfield of Reading University will outline the present crisis in non-renewable resources.
April 15	"Modifications to the Home" Mr. E. Curtis (North London Polytechnic – Solar Energy Society) Heating with Solar Energy and Conserving Heat by insulation and double glazing.
April 22	"Alternative Building Materials", Mr. O. Cockell and Mr. C. Taylor (Architectural Association) will speak on rammed earth construction and soil cement.
April 29	"Organic Gardening", Mr. A. Gear (Henry Doubleday Research Association) will discuss home food production according to organic principles and their relations to wider issue.
May 6	"Self Health", Mr. Bill Tara (Self Health Centre – London) will outline ways in which individuals can take greater responsibility for their own health. Subjects include whole food, macrobiotic diet and natural childbirth.
May 13	"Cycling", Mr. E. Claxton, O.B.E. (British Cycling Bureau) will outline the implications of planned cycleways as exist in Stevenage, for local transport.
May 20	"Windpower", Mr. D. Taylor (Architectural Association) will speak on the history and possibility of harnessing the wind for projects, large and small.
May 27	"Implications of Low Impact Living" a discussion of the impact modified life styles could have on a wide range of issues including families, public amenities and the environment.

All the above from 7 p.m.–

APPLICATION FOR ENROLMENT

Mr. Shoop,
Havering Technical College,
Ardleigh Green Road,
Hornchurch, Essex.
(Phone: Hornchurch 55011)

Name .....

Address .....

.....

..... Phone .....

Signature .....

Date .....

Ecologist

like esters of phosphorous acid and dithiocarbamates are incorporated into them. Their function is to "mop up" hydroperoxides and various other organic radicals which would be formed in the initial stages of decomposition and which, by a variety of chain reactions, would otherwise cause the plastic to become brittle, discoloured and eventually crumble to powder.

The Role of Photosensitizers

It now seems that it may be possible by making relatively small changes in the formulation of plastics and replacing some of the current stabilizing agents by minute amounts of so called "photosensitizers" appreciably to reduce the stability of certain plastic packaging materials and thus speed up the rate at which they decompose when thrown or tipped on a rubbish dump. Work on the development of disposable plastics is now being done at the University of Aston in Birmingham, in the University of London and in several industrial research laboratories, in order to establish the best formulations for disposable polythene, p.v.c., polyvinyl acetate and other plastic wrapping.

Photosensitizers are chemicals which work by absorbing energy from sunlight and using it to "trigger off" decomposition in molecules of formulated plastics which would otherwise be stable. Provided the nature and amount of the sensitizer has been correctly chosen, it is possible literally to "tailor" the life of the plastic so that it will remain stable for any desired period of time, up to a year or more, but then start to decompose.

Plastic carrier bags are now being tested whose useful life on exposure to sunlight is about two to three months. After this they start to degrade, falling to fine particles which become indistinguishable from the surrounding environment within a period of about six months. The idea can be likened to incorporating a chemical time bomb in the structure of the material with its fuse set to go off when the article's useful life is over.

Because plastics and polymers are man-made and thus essentially unnatural to the environment, there are no bacteria or fungi capable of decomposing them. There have been numerous reports of plastic bottles floating far out in the oceans and of coloured plastic fragments – red, blue, orange and green – accumulating in estuaries and other marine waters. But once decomposition in a disposable plastic has been triggered off by the action of photosensitizers, the molecules split into smaller units which then become susceptible to normal processes of oxidation and decomposition by bacteria.

The routes followed during this decomposition are very complex. They depend both on environmental conditions like temperature, humidity, acidity, intensity of sunlight, availability of oxygen and nutrients, and on the nature of the plastic itself. The first stage usually involves the formation of peroxides and hydroperoxides. These are converted into a variety of organic acids, aldehydes, alcohols and ketones. With appropriate equipment and techniques, these could be recovered and used as a source of useful raw materials.

The final products would be methane, water and carbon dioxide, but synthesizing organisms supervene and the plastic ends up like any other organic rubbish as humus which can then be used as a source of food by various plant and animal species.

To give the impression that there is novelty in the observation that sunlight stimulates chemical processes of oxidation would be misleading. The Romans knew that olive oil goes rancid faster in hot, sunny weather than if it is stored in cool, dark cellars. The hardening of paints, the ripening of fruit, the fading and tenderinf fabrics, the pealing of a tyro sunbather's skin if he exposes himself excessively, are all examples of chemical oxidation being accelerated by sunlight. However, it is only quite recently that the importance has been appreciated of the role played by photosensitizers in this process.

Like the fungal toxins in oak, photosensitizers occur as natural constituents of almost all the organic materials that are dumped as rubbish. The amounts present vary

from one material to another. But because they rarely exceed a few tenths of a part per million of the material, it is necessary to employ sophisticated techniques of analysis to detect them. Even at these low concentrations, however, they are effective.

Just as one can extract the fungal toxins from oak wood and use them like a synthetic fungicide, e.g. Cuprinol, to protect pine wood from rotting, so, in principle, one could employ trace quantities of natural photosensitizers or, if preferred, of the same synthetic photosensitizers that are already proving effective in the formulation of disposable plastics, to speed up the rate at which paper, textiles, mineral oils and other organic wastes would be decomposed by sunlight and converted into other useful products.

Oil on the Sea

In general, the rate of decomposition depends on the amount of photosensitizer that has been employed and their possibilities seem particularly promising for mineral oils which have been spilled on the sea, because these are only rather slowly decomposed and, then not completely, by bacteria.

Bacterial species like Pseudomonas oleovorans and acenebacter occur in sea water and fairly rapidly consume certain fractions of split oil, particularly the paraffin constituents containing up to about 20 carbon atoms in their molecules.

Within a period of a year, some 20% of the oil will have been decomposed by bacteria. Some is also oxidised by sunlight, due to the presence in the oil of natural photosensitizers. The main ones appear to be derivatives of naphthalene and compounds of magnesium, nickel and vanadium and a typical crude contains about one part of photosensitizers to every 100,000 parts of oil.

They are removed from it as a sludge during the normal stages of refining and it has been found that as a result the oil becomes less susceptible to decomposition by sunlight. Conversely, if one takes pure paraffin or aromatic hydrocarbon and mixes in a few parts per million of the refinery residue, the oil becomes more susceptible to oxidation than it was before.

Similar work to that now in progress on the development of disposable plastics is being done in University and Government research laboratories to see whether photosensitizers could be used to assist nature in disposing of mineral oil that has been accidentally spilled into rivers and the sea. Just as detergents are used to accelerate the dispersion of the oil in water, so photosensitizers might accelerate its oxidation by sunlight.

Scientists at the Admiralty have estimated that if a patch of oil, one tenth of a mm thick and one km square, weighing about 100 metric tons is floating on the sea, possibly as much as 100 kg (or one tenth of 1% of the oil) is being decomposed every day by the action of sunlight. It is converted into volatile and soluble products, which then decompose further by one or other of the routes already described.

By adding a concentrate of the refinery residue to the oil to reinforce the action of its natural photosensitizers, the rate of oxidation might be increased, possibly tenfold. How feasible would this be in practice?

The answer, based on preliminary results, is that it should not be too difficult, in the event of an emergency, to consider metering the concentrate into a cargo at the rate of about one ton to every 10,000 tons of oil. Alternatively, one could spray it into a floating slick in much the same way as detergents are applied at present.

The advantage would be that because one was relying essentially on a natural process for disposing of the waste and using extremely low concentrations of reagents (in contrast to treatment with detergents) the effect of the treatment, as opposed to that of the waste itself on the environment would be minimal. On the other hand, it would still take months, or even years, for the oil to disappear completely.

The Outlook

Environmentalists and conservationists are justifiably concerned about the current attitudes of our "throw away" society towards so called waste and rubbish.

There are vast quantities of sewage, plastics, paper, straw, sawdust, etc., which if collected and properly recycled, would not only reduce pollution of the environment but provide a rich source of materials for further processing. A single factory making potato crisps produces about 400 tons a day of waste peelings. These could be converted by the action of bacteria and/or sunlight into valuable raw materials, such as alcohol.

Every day sunlight provides energy equivalent to about 5,000 tons of coal for every square mile of the earth's surface on which it falls. With the new discoveries now being made about the ways in which photosensitizers use sunlight to accelerate the processes of decomposition and synthesis, it would seem to be well within the competence of advanced technological society to use at least a proportion of the sun's energy for assisting in the disposal of waste and/or converting it into useful new products.

THE CENTRE OF LIVING

John Seymour, author of *Self Sufficiency* and *The Fat of The Land,* intends to establish a Centre of Living at and around his farm in Pembrokeshire. The object will be to provide a place where people who wish to master the skills needed for self-sufficiency in the countryside can come and do so. Such people will be able to stay for as long as it takes them to master the necessary techniques (a year seems reasonable for most people) and when they leave, if they desire, the Centre will try to help them establish themselves as peasant-craftsmen or peasant-food-producers or peasant-professional-men, or whatever they want to be.

Thereafter it is to be hoped that contact will be kept with those who want it – help will be given when necessary, and also it is hoped that those who have gone on will continue to support the centre and to give help to other free people who want to establish themselves in the countryside.

The main aim will be to train people to take a piece of their country and make it produce more food than it did before, with less input than it had before, and also to earn a good and honest living at some craft or profession. If a man cannot make his land produce more than it did before then he shouldn't have it!

Instruction in the various skills (which will have to be completely professional – not the blind leading the blind) will be provided partly by the "staff" – partly by experts paid to come in from outside. More buildings will be required (which involves buying at least another farm) and more stock and equipment although we have a pretty good collection already. It is therefore necessary to find a small number of people who are willing to come in as working partners and invest capital in the Centre. They will be assured of a good life and their capital will be secure, but money-making is not the object.

Learners may be expected to pay a fee at first if they can afford it. If not they will have to pay with very hard work! But the aim will be to produce all the food, power and fuel required, as far as possible using free material and our own labour.

It is intended that all the produce of the land of the Centre shall be brought to its final and most perfect form before being used or sold. For example wool will not be sold as wool but as clothes or blankets. Milk will be made into high quality cheese, butter, buttermilk, yoghourt etc. and the skim, whey and other by-products will not just be fed to pigs for the market, but the pigs will be turned into best quality ham and bacon and smoked sausage. There will be enough labour available to bring everything to its peak of excellence.

Research will be carried out on every aspect of self-sufficiency, not only in husbandry and food production – wood, wind, water, manure – and crafts and manufactury. The findings will be disseminated as widely as possible – perhaps in a Centre newsletter printed on the Centre press.

At present thousands of people are dropping out of the cities, finding bits of land and trying to "make a go". Hardly any succeed because they don't know how. The aim of the Centre will be to show them how to do it – and to do it well and *professionally*. If technological society is to break up, for God's sake let us start preparing people for something better.

If anyone is interested write to: John Seymour, Fachongle Isaf, Newport, Pembrokeshire, Wales enclosing a stamped addressed envelope.

This months authors

Brian Trenbath is a research fellow in the Department of Environmental Biology, Research School of Biological Sciences, Australian National University. Besides experimenting with crop mixtures he builds computer models of their growth and reaction to disease.

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Trudy West is a freelance journalist, and an architectural historian. Her book *The Timber Framed House in England* was published by David & Charles in 1971.

Dr. Neiton Pilpel is a reader in the Department of Pharmacy at Chelsea College of Science and a contributor to advances in *Pharmaceutical Sciences* (1971) and *Advances in Surface and Interfacial Sciences 1970* as well as large number of papers to technical Journals and to *Nature* and *New Scientist.* He was for ten years in Industry before going into research at King's College, Cambridge.

Michael Allaby, Colin Hines, Colin Blythe, Christopher Wendle. Are all Journalists working in the environmental field and Consultants to F.O.E.

Report

FIRST AID FOR A HALF DEAD SEA

Brochures issued by holiday resorts on the Federal German Baltic Sea coast still describe a perfect holiday scene. They promise "a bay glittering in the sunshine, sparkling, sea-green and crystal-clear water." In reality the tourists' holiday paradise has serious flaws. Every day two hundred rivers bring filth in their wake; waste water from sixty major cities along the 20,000 km coastline flows virtually unpurified into the "Adriatic of the North" and the 70,000 ships sailing in these waters annually – including over 3,000 tankers – burden the sea with their refuse. The result – the FAO, the World Food and Agricultural Organisation, has declared the Baltic to be one of the most heavily polluted seas in the world.

The "Convention for the Protection of the Baltic Sea's Environment", signed recently by the seven neighbouring countries and which will come into force in a few months, is not a moment too soon. Denmark, Sweden, Finland, the Soviet Union, Poland, the German Democratic Republic and the Federal Republic of Germany held laborious negotiations in order to act in unison as countries neighbouring the Baltic Sea regardless of differing political, military and economic interests.

None of the countries who began negotiations a year ago had a clean record. Everyone had contributed to a greater or lesser degree to the Baltic almost being "out of breath" due to lack of oxygen. It was threatened with a similar fate to that of other suffocated inland seas; it was rotting from its bed upwards. The upper layer of the water, rests like a lid on the one below so that an unsatisfactory exchange of water is achieved. It has so far been possible to limit but not to stop the salination and fertilisation of the upper layer of water and decay in the deeper regions caused by sulphuric hydrogen. Data have been collected by the "International Council for the Exploration of the Sea" by scientists at the Marine Research Institute from Kiel to Leningrad.

According to cautious estimates, ten per cent of the 4,000,000 sq.km. bed of the Baltic is already devastated and the situation is deteriorating daily. Poisons such as DDT contained in agricultural waste are destroying marine fauna. Organic substances present in waste water lead to the formation of blue algae. Broad slicks of oil lie on the beaches. First aid measures were urgently needed.

The agreement which has now been reached in Helsinki is the first convention between East and West which, so to speak, overrides systems and straddles frontiers in the cause of environmental conservation. It came about because the Baltic jibbed at its role as industrial sewer and struck back. Fish in the Baltic today contain ten times as much DDT as those from the North Sea. Large areas of the inland sea have been closed of because the marine animals were so full of quicksilver that the catches had to be destroyed.

Now the neighbouring countries intend to combat pollution jointly on the land, from the air and ships. It is the only agreement of its kind so far in the world. A High Seas Convention devised in London in October 1973 concerned ships only. In addition, it will probably not come into force until three years time. For this reason, the Baltic Sea countries blazed the trail with comprehensive and forward-looking controls.

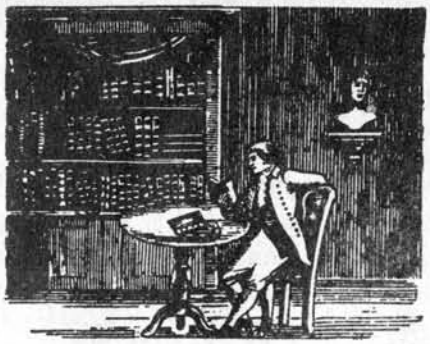
Everything prohibited or permitted is contained in thirty articles. The regulations mean new standards of cleanliness for industry, coastal towns and merchant shipping. In short, the Baltic Sea will no longer be a rubbish dump.

A warning is given in a 15-point list of especially harmful substances such as heavy metals, carbolic acid, cyanide, various insecticides, radioactive materials and plastics. Cadmium and quicksilver are well to the top of the list and DDT and PCB are to be prohibited in principle. The agreement obliges the partners to undertake all suitable measures necessary to control and reduce pollution of the marine environment caused by the country concerned. Of particular importance are regulations concerning industrial waste water and that of major communities. Stricter guidelines have also been created for cooling water from atomic reactors. Pollution caused by gases from the atmosphere also come under restrictive regulations.

The rule that oil tankers and other ships of 400 tons and above are no longer permitted to discharge oil and oil mixtures into the Baltic is particularly severe. Other rubbish and water for washing the tanks is also not to be dumped into the sea in future. When an oil slick is sighted behind a ship an investigation is to take place immediately. In future, no industrial waste is to be submerged in the Baltic.

A Secretariat with its headquarters in Helsinki is foreseen as the administrative organ for realising the agreement. It is subordinate to a "Marine Environmental Conservation Commission for the Baltic Sea" which meets at least once a year. Members are constantly to supervise the realisation of the agreement, recommend suitable measures and define criteria for control.

Trudy West



Books

FARMING WITH SCIENCE

INTENSIVE AGRICULTURE AND THE ENVIRONMENT, published by An Foras Taluntais, Dublin for the International Centre for Co-operation in Agricultural Research, £2.00.
INDUCED MUTATIONS IN VEGETATIVELY PROPOGATED PLANTS, published by the International Atomic Energy Agency, Vienna, £4.10.
INTRODUCTION TO THE SOIL ECOSYSTEM by B.N. Richards, Longman, £2.95.
WATER, SOIL AND THE PLANT by E.J. Winter, Macmillan in collaboration with the Royal Horticultural Society, £1.75.

I suppose the highest praise one can bestow upon a book is to steal it. In the course of a conversation with a French colleague, I produced my review copy of *Intensive Agriculture and the Environment.* He seized it, telling me that information of the kind it contained is not easily obtainable in France, and refused to let me have it back. I would have told him that information such as it contains is not all that easy to obtain here either, but my French failed me. So he paid me the price of a replacement copy. It was not quite theft, but high praise nevertheless.

The book is valuable partly for the information and data it contains, but even more for the light it throws on the relationship between agriculture and its wider environmental context. Agricultural scientists are becoming aware of the big, wide world that surrounds the experimental plots on which their eyes have been fixed for so long. This book contains 23 papers delivered at a symposium sponsored by the International Centre for Co-operation in Agricultural Research (CICRA), one of four symposia devoted to the study of ecosystems in Europe. Its aims were summarised by CICRA's President, Prof. R. Braconnier, in his opening address: "We might ask if our civilisation, which rests on the accelerated consumption of the goods put at our disposal, will not soon be confronted with cruel penury. Faced with these alarming prospects, agriculture has an important role to play. It cannot of itself disperse the clouds which darken our future, but it should contribute effectively towards making them disappear. However, agricultural techniques must be reviewed so that the resources we take from the biosphere can be used to the maximum in conserving its powers of production, and in avoiding all prejudicial pollution of the environment as well as of men themselves".

The symposium was divided into four sessions, dealing with the economic and technological limits to production, resources under pressure, the management of resources and the conservation and use of resources. It is important for the reader to take in the structure of the symposium as a whole before beginning to read, for some of the early papers, defining technological limits, sound curiously familiar. Ways are described of increasing livestock production and stocking rates with no mention of how the animals are to be fed. The assumption that the replacement of human labour by machines and chemicals leads of itself to increased food output is not challenged. Yet we should not be too hard: this is part of the accepted dogma of agricultural science and it is far less prominent in these papers than in most papers written even two years ago. Scientists – at least, these scientists – accept that there are resource and environmental constraints. It is when it moves on to discuss the pressures on soils, water, plants and animals, and the ways in which resources can be managed and conserved, that the symposium comes into its own, providing experimental and statistical support for views that environmentalists will find progressive.

No one disputes, of course, that food output has increased dramatically over the past quarter century. The increases have been brought about by a large number of factors acting on one another. Not least among them has been the development of improved crop varieties. Modern plant breeding relies heavily on the study of mutations, nowadays induced more rapidly and in larger numbers than they occur in nature. The International Atomic Energy Agency works closely with the FAO in this field, and published the proceedings of its conferences and symposia. *Induced Mutations in Vegetatively Propogated Plants* is one such publication, in which plant breeders from many countries discuss the techniques and effects of induced mutations in fruit trees, sugar cane, potatoes, cassava, bananas, cacao, tea and even roses. The techniques themselves are very crude: the worker exposes many specimens to radiation or chemical mutagens and waits to see what will happen. Among the strange plants that are produced, there may be one or two that possess desirable characteristics and that can be developed further by cross-breeding. The papers are very technical and intended for the specialist. Indeed, it is surprising just how technical a scientist can be as he describes the equivalent of bombarding an engineering works with high explosive to see what interesting metal shapes are produced. There are real problems that might, one day, be resolved by genetic punishment of this kind, especially that of the toxicity of cassava. Needless to say, cassava must remain poisonous for the time being. If it is of any consolation, you can obtain a red grapefruit. Before you dismiss the whole thing as absurd, however, you should glance at pages 195 to 202, which list the vegetatively propagated perennial plants in commercial use that were developed by utilising induced mutations.

Introduction to the Soil Ecosystem, in the words of its author, "is designed to give students of ecology an understanding of plant-microbe relationships in an ecosystem context". It is a textbook, written clearly and with sufficient detail to make it useful to the stu-

dent without making it incomprehensible to the general reader. In spite of his claim to be writing for students of ecology, Prof. Richards takes no chances. He assumes little or no knowledge of the theory of ecosystems or the methods by which they are studied, and is careful to explain both as he goes along. By the time the reader arrives at the final chapter, he will be familiar with many of the concepts of general systems theory, as well as with the life of the soil.

Water, Soil and the Plant is published in association with the Royal Horticultural Society as one of its Science in Horticulture Series. It begins with a fairly detailed examination of the hydrological cycle and the sources of water for horticulture, then moves on to consider the storage and movement of water in soils, into and through vascular plants, dealing in detail with the effects of water stress. Although it is written for horticulturalists, farmers have just as much interest in the water economy of their soils and crops and in the techniques and problems of irrigation. This book should be of value to them too.

Michael Allaby

DEMOCRACY AND THE ENVIRONMENT

CAMPAIGNING FOR THE ENVIRONMENT Richard Kimber & J.J. Richardson, editors. (Routledge & Kegan Paul) £4.95.
POLITICS BY PRESSURE, Patrick Rivers. (Harrap, £3.25).
REPRESENTATIVE GOVERNMENT AND ENVIRONMENTAL MANAGEMENT. Edwin T. Haefele. (John Hopkins University Press, £4.50)

These three books are about the failure of government in Western democracy to manage the environment. . .so far. All of them are well done by people fully qualified to write about their chosen subject, though Professor Haefele, who has written the most important book, suffers from the American passion for statistical and sociological jargon. His treatment of two party government as a game like roulette in which all possible combinations of votes can be traded and the trading calculated is above my head. It may be true that he has proved that two party government can do everything and can do it better than a parliament with many parties, but I find it hard to follow the proof. What is left of the book, when we remove that particular theme, provides a key to what is happening throughout Europe and America, as the people struggle to bring economic development under the control of representative government from which it has broken loose. On those grounds it cannot be too highly recommended.

The management of the environment is becoming the central issue of 20th century history. How can we reform the political structure so as to assure the survival of nature and natural resources without injustice to men and nations? Can it be done without a civil war? The problem is no less than that as various social forces, national and international, join in combat. These three books do not treat the international aspects, but their shadow lurks in the background. Fortunately the national and international obstructions to a solution are similar. In both cases they arise from undue despotism on the part of those with economic and political authority. The protestors demand the right to participate in decisions.

Campaigning for the Environment is an admirable record of eight outstanding environmental battles in England. I confess I had not realised the extent to which the power of the environmental lobby had increased with every battle, even when the battles were lost. *Politics by Pressure* supplements this book and the two books together give an immense amount of detailed information about how campaigns are waged. Patrick Rivers studies the various conservation movements and the campaigns incidentally; he has studied the forces opposed to conservation, in the broadest sense and including the proper conservation of urban property; his book becomes a tactical and strategic study of the pressure group warfare into which our society has degenerated. Like Haefele he sees that we are becoming a corporate state, a kind of democracy in which one functional interest balances another, or ideally might do so. All the authors would, I think, agree this is an unsatisfactory state of affairs and that it must lead to our political structure being severely tested.

Only Haefele begins from that position. After explaining why the environment has been wrested from the public control he goes on to discuss how development can be restored to a framework of representative government.

In the early fifties, he says, when dramatic economic developments were opening up after the end of the war and when new technology was supported by commercial and public enthusiasm, both the radicals and the conservatives agreed that development should as far as possible be taken out of the realm of parliamentary control as idealogical differences of opinion delayed execution of projects, and handed over to government agencies – the various authorities, water authorities, port authorities and so on. America had already experienced the Tennessee Valley Authority as a successful means of solving unemployment without realising how much personal liberty had been sacrificed to do it. The parallels with this country are very close. Mr. Wilson's 'white hot technology' had behind it the same philosophy, backed by the socialist preference for nationalisation and the unquestioned assumption that this increases personal liberty. The most powerful of these government agencies is now the Department of the Environment, originally intended, at least the public were deluded into thinking so, to protect the environment. In practice it too often protects industry against the environment, as the cynics suspected it would. The protecting agencies have been swallowed up by the Department, the Nature Conservancy Council for example, so that if their views differ from those of the Minister they may not publicly say so. They cannot for instance take a public stand against the construction of a motorway or against the positively tyrannical emergency measures taken by the government in Scotland where public inquiries into land taken over for oil installations are not allowed. (Even in

England they are only by the 'grace' of the Secretary of State. But would he dare to treat the English like we treat the Welsh and the Scots?) It is the right to speak up in public that is important. The creeping tentacles of departmental and bureaucratic control limit this more and more every day.

The result of this political delegation of representative power to government agencies, which is contrary to democratic principle, is the rise of pressure groups on every side, the most powerful to promote economic self-interest, others to defend the environment, urban and rural, and some in the middle that are in such a muddle they don't know what they are doing – as the people of Enfield who support the M16 motorway because it is assumed it will relieve their town of traffic, when it is more likely to increase it. All these groups are elbowing and scrapping with each other to break their way into the bureaucrats' offices. So far only the powerful ones like the monstrous British Road Federation have established a throne on the right hand of God (in return for services rendered in planning the motorway network). Patrick Rivers supported by the investigations of the Friends of the Earth describes all this so as to place it beyond doubt. However various footstools have now been edged into the corners and the bureaucrats are compelled to watch them out of the corner of their eyes and to devise new rules and regulations to keep the spokesmen seated on them from opening their mouths too wide and indulging in the unruly conduct reprimanded by the Secretary of State at the M16 inquiry. Poor man, did he think that Mr. George Dobry Q.C. author of the Dobry report on development control, commissioned by Parliament, had offered his services to hooligans when he appeared at the inquiry to request the Secretary of State to comply with the law?

Professor Haefele, who is on the staff of *Resources for the Future,* and who combines ecological knowledge with political philosophy, points out that this extra-parliamentary battle is no way to run a country and can't work in the long run. Development must be brought back into the democratic, representative framework of national and local government. The public's representatives, with their general purpose outlook, must be present when the decisions are taken so they can counter the single purpose aims of industry, for whom all roads are valuable wherever they are and irrespective of local conditions and alternative modes of solving transport problems. The public must have territorial representation.

All this will take a lot more consideration. But these three books provide an important foundation for working on an extended democratic structure that brings economic development under day-to-day public guidance and control. As it is we must work hard to strengthen the environmental lobby so that the government agencies do not think they can get away with their present powers and despotic practices. It is for example important to remember that when an inspector says at a road inquiry that Parliament is the right place to discuss general transport policy, this policy is not discussed there. All that Parliament does is to vote the funds and leave the details to the DoE; in other words the DoE creates the policy – with disastrous consequences. A powerful environmental lobby will compel the government to admit the need for reform. At the very least we must begin with accepting George Dobry's recommendations. In the legal field we should seriously consider Lord Justice Scarmen's recommendations. *The Lawyers' Ecology Group* has many sound proposals.

Let us hope the editors of *The Ecologist* will recognise the importance of these legal and constitutional developments and keep us up to date with all that is said and done of significance.

Robert Waller

FIELDS, FACTORIES AND WORKSHOPS TOMORROW by Peter Kropotkin. Edited by Colin Ward (George Allen and Unwin £1.95).

Peter Kropotkin's recently reissued *Fields, Factories and Workshops* was first published in 1889 and formed part of that eloquent 19th century protest against the squalor and inhumanity engendered by the Industrial Revolution; it can be seen as complementing the works of Ruskin and Morris and as foreshadowing the 20th century anarchists, particularly Lewis Mumford and Herbert Read, who were both indebted in various ways to Kropotkin. *Fields, Factories and Workshops* is an important book in this living tradition of alternative politics and its recent republication is to be warmly welcomed. Indeed, read in the context of the present moment, the book has an unmistakably prophetic ring, as the reader will be able to surmise from, for example, the following quotation:

> 'The scattering of industries over the country. . .will be rendered the more necessary when the great social movements which have now become unavoidable, come to disturb the present international trade, *and compel each nation to revert to her own resources* for her own maintenance. Humanity, as a whole, as well as each separate individual, will be gainers by the change, and the change will take place.'

If the prophetic note seemed unreal in 1889, now with our preoccupations about the squandering of non-renewable resources and with the somewhat dramatic emergence in this country of the Scottish and Welsh Nationalist parties, dedicated to the politics of the small-scale, the prophetic note rings out bold and clear. In contrast to the many socialist tracts of the late 19th and early 20th century, platitudinous and severely inadequate in their guiding assumptions about industrial growth, Kropotkin's book reads well and challenges the reader with a

sequence of ideas, countering the conventional thought of capitalist and Marxist alike, which has yet to be taken up and put to the test.

The opening chapter condemns the inhuman monotony of work in the factories and the dogmatic 'division of labour' principle upon which it was based. For Kropotkin, the industrial worker had been compelled to become a slave to the machine, to the abstract empire of unceasing mass production. The industrial worker had become, as still he remains, the 'mere flesh-and-bone parts of some immense machinery'. The artist and craftsman who had once experienced deep satisfaction in the act of production, had, under Industrialism, been turned into 'the human slave of an iron slave' destined to manufacture 'all day long and for a whole life, the same infinitesimal part of something'. Kropotkin's work, like William Morris's political writings, was an attempt to embody an alternative society in which work was no longer degrading but life-enhancing, in which a man would be free to engage in many kinds of labour, both industrial and artistic, both rural and scientific. A consumer society like ours based on the pleasure principle and on the endless manufacturing of synthetic fun would have struck him as abhorrent, for the desire to work, properly understood as the act of making and, hence, of increasing life, seemed to him an essential need of man. A certain vision of the human commonwealth drawn together through the power of mutual aid and the purposefulness of labour, informs *Fields, Factories and Workshops* and is worth quoting at some length:

> 'The greatest sum total of well-being can be obtained when a variety of agricultural, industrial and intellectual pursuits are combined in each community: and that man shows his best when he is in a position to apply his usually varied capacities to several pursuits in the farm, in the workshop, the factory, the study or the studio, instead of being rivetted for life, to one of these pursuits only.'

For Kropotkin, such a society was best realised within a federated network of largely autonomous communities, with their own farms, factories and schools, efficiently linked together by excellent systems of transport.

Kropotkin's argument is concerned to throw light on three primary activities, agriculture, industry and education and I would like now to briefly look at these areas in turn.

Agriculture: Kropotkin argues that 'the land continues to go out of culture, while the problem of the day is to render culture more and more intensive.' No country and no region can regard itself as independent when it depends on the massive important of food. For Kropotkin, each region, through a complex pattern of small and intensively cultivated market gardens and farms, should attempt to provide all its own needs, its own corn, milk, meat, vegetables and fruit. In Chapter 2 called *The Possibilities of Agriculture* he demonstrates, with all the stubborn thoroughness of a practical man, just how possible such an ideal is.

Industry: As with agriculture, so with industry, Kropotkin argues that each country should become its own producer and its own consumer. Instead of high specialisation and the massive concentration of production units in vast cities, London, Brussels, New York, Moscow, industry should be mixed and scattered across the globe. Against specialisation, Kropotkin advocates the integrated variety of small-scale trades and production units, demonstrating, with numerous 19th century examples, that there is *no inherent technical reason* for the scale of industry to be for ever expanding. Even on the grounds of increased efficiency, the small-scale factory has been proved superior to the large.

Education: In education Kropotkin argues for 'the integration of capacities, and, consequently, an end to the division between the academic and the practical, between head-work and hand-work.' He also argues all too briefly for what today I would call existential knowledge. 'It is obvious' he writes 'that each invention avails itself of the previously accumulated knowledge and modes of thought: but in most cases it makes a start in advance upon what is known; it makes a leap in the unknown, and thus opens a quite new series of facts for investigation.' The ideal education is one which heals the unnecessary split between theory and practice and which creates men not only endowed with knowledge but also the powers of inventive genius.

I agree wholeheartedly with Kropotkin's views on the true development of agriculture and industry. In every way they seem to offer desirable goals and are very much in accord with the best of contemporary thinking on such matters, with, for example, the political philosophy of Leopold Kohr, E. F. Schumacher and Lewis

Mumford. The short chapter on Education I find much less satisfactory for it fails lamentably to show any understanding of the crucial place of play, phantasy and imaginative recreation in the development of the child's identity. The objective universe of matter and motion is praised at the expense of the inner man. Quite falsely, technics is placed before culture. Indeed, the chapter reveals the failings of Kropotkin, failings which, ironically, were very much the failings of his age.

There is, first of all, a certain crass utilitarianism, a vulgar faith in facts, machines and science such as one encounters, for example in Bentham and later in H.G. Wells. Secondly, there is a crude optimism, a belief (which again was widespread and had been developing since the 18th century Enlightenment) that things would inevitably improve, that Progress had somehow been inscribed across the unfolding chart of History. In this respect, having seen the brutalities of Stalin and Hitler, we know better. There is no such thing as Progress. We have no certainty that the commonwealth of man, the ideal of a pattern of small-scale cultured communities, will come about. If it does come about it will not be as the outcome of any predetermined and unconscious process but as the result of the sustained and difficult efforts of individuals who, disillusioned with the present, seek to imagine and create a better future.

I wish, finally, to praise the careful editing of this book. Colin Ward has added a valuable introduction and postscript and at the end of each chapter has appended a series of notes relating Kropotkin's theories to present realities. In these fascinating notes the threads of an alternative tradition in political thinking are quietly drawn together: the works of Gandhi, Buber, Paul Goodman, Herbert Read, Lewis Mumford and many others are knitted into one coherent fabric. Here is a suppressed tradition of philosophy and politics, which as Marxist and capitalist ideology disintegrate or ossify, more and more people will be wanting to consider.

Peter Abbs

Letters

More Food for Thought

Dear Sir,

Robert Allen's admirable devotion to the hunter-gathering roots of modern man led him to overstate the case made by Dr. Michael Crawford for the consumption of meat (*Food for Thought.* Ecologist 5.1).

Fatty acids are not in themselves fats but are found combined in fats (i.e. lipids). It has often been shown that linoleic and linolenic acids are 'essential fatty acids' and that dietary lack of lipids containing these moieties causes various deficiency symptoms. But Allen implies that only herbivores are able to add to the chain length and increase the degree of unsaturation of these two acids whereas this ability to metabolically modify linoleic and linolenic acids has been demonstrated for a wide range of mammals, and it has not been shown to be absent in man.

Such organisms are able to synthesise the polyunsaturated fatty acids necessary, as Allen points out, for the elaboration of structural lipids. Nor are linoleic and linolenic acids restricted to seeds and leaves respectively, soy bean and ground nut oil, for example, contain respectable proportions of both. Moreover, if early man was a hunter-gatherer, modern man is a grower-storer, so that a wide range of seed and leaf material is available throughout the year.

Allen states that 'the herbivore's brain is smaller than the carnivore's possibly because it has to lengthen the parent acids from the plant itself.' This is surely putting the cart before the horse. If natural selection means anything it is that the carnivores evolved larger brains because such were required for hunting, and that herbivores didn't because small brains were adequate for grazing. In other words, the carnivore's brain was larger before it caught its prey and not after. The logical extension of Allen's argument is to claim that in order to maintain our superior brains we ought really to eat carnivores and not herbivores. This is obviously ridiculous.

In fact evidence from so-called primitive man points in the opposite direction. Allen fails to point out that the model of man as a hunter-gatherer is more accurately presented as one of man the gatherer-hunter. There is ample evidence that such people 'eat as much vegetable food as they need and as much meat as they can.' In practice this means that the majority of the Earth's hunting-gathering tribes provide most of their nutritional requirements from plant foods and eat meat only on a casual basis. The balance is tilted in the other direction only as one proceeds polewards beyond 40° N or S, when a suitable range of plant foods becomes less available. The general health of such people as Eskimos who depend almost entirely on meat is markedly inferior to that of such as the !Kung bushmen who eat mostly plant food in the equally harsh environment of the Kalahari desert (Lee and De Vore, *Man the Hunter).*

The fact is that consumption of a range of plant products provides adequate fatty acids upon which we are able to build. Allen is being alarmist when he says that 50–70% of the brain is fatty acid. Around 60% of the brain (dry weight) is lipid, e.g. sphingolipid, which contains just one fatty acid residue, contributing rather under one half of the total weight of the molecule.

So 'Food for Thought' should not deter any actual or potential non-meat eater. The social objections to meat eating are many, and whilst those related to the current devotion of British agriculture to mass production techniques can be met, this could not happen overnight. It is therefore quite wrong of your journal to permit woolly and inaccurate extrapolations of some controversial nutritional research to mislead the growing number of vegetarians.

This is particularly unfortunate as the individual can probably make a greater contribution to the restoration of global ecological stability (the avowed aim of *The Ecologist*) by becoming vegetarian, than by any other single act.
Yours faithfully,
P. Carter and R. Sheppard,
The Polytechnic,
Bristol.

Dear Sir,

In view of the subject matter of the editorial (January issue) i.e. criticism of 'boring trivial and largely irrelevant experiments' I am amazed and disappointed that it should be followed on the next page by Robert Allen's article *Food for Thought,* based largely on the research of Dr. Michael Crawford.

I have selected a number of points for criticism which follow:

1. There are in the region of 500,000 vegetarians in this country alone, a high proportion of whom have never eaten meat, flesh, or fowl and who live as highly active mental and physical lives as the rest of us.
2. Can we assume from the article that a vegetarian mother either does not produce milk containing the necessary polyunsaturated fat, their long chain derivatives and cerebrosides, or that she is draining her own brain?
3. We have in the past been told that it is necessary to eat meat for its essential protein and for the essential amino acids thought not to be obtainable from vegetable protein. Both hypotheses subsequently shown to be untrue.
4. Perhaps it is the poor carnivore who is at a disadvantage here, having to secure his long chain polyunsaturated fatty acids second hand from dead herbivores.

Yours faithfully,
E. J. Thompson,
London W.9.

Editor's note

We thank the many other readers who wrote following Robert Allen's article, and hope that the letters selected for publication cover most of the points made.

Ecological Living – The Only Alternative

Dear Sir,

What a rare pleasure to read Peter Bunyard's article (*Ecological Living – Dream or Reality*. January issue) – and instantly find a common link of common experience. The early high ideals, the gradual learning that to grow eggs and vegetables for the family is barely scratching the surface of self-sufficiency, the quarrels over principles, the work-work-work. How truly it all rings.

We began just two years ago, with an acre of land and a converted salvage vessel tied up to it, to try for the independence that living ought really to be all about. Fishing was to be the cash earner, but two years of gales and small catches have forced a re-think on that. As Peter Bunyard says just finding the money to finance your apparently low-cost way of life (it will be when we have the problems ironed out!) is a continuous headache.

But coming through this story of the problems is the conviction that this really *is* the way, and somehow it has to be made to work, no matter what it takes. Thanks for a really good, practical piece.
Yours faithfully,
David Bacon,
Woodbridge,
Suffolk.

Dear Sir,

In discussing his experiences in *Ecological Living – Dream or Reality* Peter Bunyard doesn't seem clear about the real justification for trying to live like that. As often in the Commune movement, there seems a muddle about priorities. He says that a certain crisis made them all try 'to work out in our own minds what were the aims of our farm as well as of our own existence . . .', and his conclusion was: '. . . all the rules we create for ourselves, all the taboos, are not based on real facts or fundamental truths, but are rationalizations in order that we can bind ourselves in a framework and give ourselves identity'. The impression this gives is that people who are trying to live 'ecologically' are merely pursuing arbitrary notions, that they choose one way of life rather than another on personal whim, and that one can invent for oneself whatever rules one likes. But this is to miss the point entirely. Of course, there are matters of personal choice and whim, such as the extent to which a small community tries to be self-sufficient, or whether a farm is to be run as a commune – but these are hobbies, side issues; they should not be confused with the essential and serious reason for living ecologically – which is that one must live in a way which doesn't involve exploiting other people. One needn't be a vegan but one should not eat animals fed on human food because to do so is to exploit the poor of the world. To farm in ways which impoverish the land is to exploit the future; so, though one needn't be a purist and condemn all chemicals, one should avoid those which impair the soil and pollute rivers. For the same reason one should try to use only renewable sources of energy. This test is surely the most important: is this activity exploitive? Beyond this people can search for their own identity, bind themselves to frameworks, commune with nature, and play whatever games they like – but these pursuits must be distinguished (particularly in a journal like *The Ecologist*) from the element which gives 'ecological living' real moral and political significance: it is the only way of life that doesn't cause others – in the third world and in the future – to starve; it is the only alternative to neo-colonialism, facism and war.
Yours faithfully,
Nicholas Parsons,
Burrington,
Ludlow.

Alienation from Nature

Dear Sir,

I read with gread interest the letter of Anton Stanislaus in Vol. 5. 1. and I substantially agree with him. I think that the eastern religions particularly Buddhism are much more relevant to our current ecological crisis than any new messianic movement is likely to be. The Old and New Testaments are concerned with man; the 'beasts of the Earth' are there for man to dominate as he sees fit. There is no positive teaching

concerning animals and nature in the Bible and it is likely that because of this Christianity has contributed in no small way to the spiritual impoverishment of our time. From the little that is known it would appear that the religion of the British Isles at the time of the Roman Conquest encouraged a far greater reverence for nature, and was more meaningful to the average citizen than Christianity has ever been. It makes harrowing reading to discover how Christianity gradually persecuted the adherents of the old pagan nature religion over many centuries, finally culminating in the witch mania of the middle ages.

Mr. Stanislaus is right, I believe, when he says that we need a religious consciousness of nature without a God. Some people can experience a joyful sense of union with nature spontaneously. Most of us however are not so lucky (or virtuous) and need practical help. The practices which can be most easily learnt and which produce the most benefit are those of yoga and meditation. Meditation in particular, besides providing a reliable means to religious experience, profoundly relaxes our mind/bodies thus acting as a powerful antidote to stress. Yoga may be regarded as a kind of physical method of meditation. These and other kinds of spiritual practice are greatly needed in our alienated and stress ridden society.

Yours faithfully,
Chris Ward,
Shipley,
W. Yorks.

Dear Sir,

In his letter Dr. Stanislaus has argued that man has separated himself from nature by 'projecting' its omnipotence, mysteriousness and performance onto something outside it, something alien to it, namely God. In so doing man has, as it were, broken the magic circle of monism and set up the discontinuities within the single system of which his own alienation from nature is a conspicuous example.

Leaving aside the contention that nature is omnipotent and eternal, I would suggest that the existence of a being outside of nature and superior to it does not in itself imply a radical disharmony of the sort Dr. Stanislaus sees as a consequence. An analogy could illustrate this: the totality of all natural systems on the earth make up a unity. But the fact of their unity as a great earth system does not make them self-sufficient. The biosphere, supported by the hydrosphere, the atmosphere and the lithosphere, would cease to exist without the input of solar energy from outside the earth system. Does this fact reduce the 'organic wholeness' of the biosphere? Man is part of the biosphere, but the biosphere, by itself, is incapable of supporting human life. Does this fact reduce his allegiance to the biosphere? Does the necessity of 'alien' sunlight make us hostile to our environmental home?

For Freud the super-ego was, indeed, a perverse projection of the natural id, an alienating and alienated super structure. The branches and roots of a tree bear a certain resemblance to each other. But the branches are not mere phantom projections of the roots, projections by which it uproots itself, as it were, in the act of growing branches. I think there is still much exploration to be done in the fascinating but complex area of the relation between religion and ecology.

Yours sincerely,
Tom Merriam,
Basingstoke.

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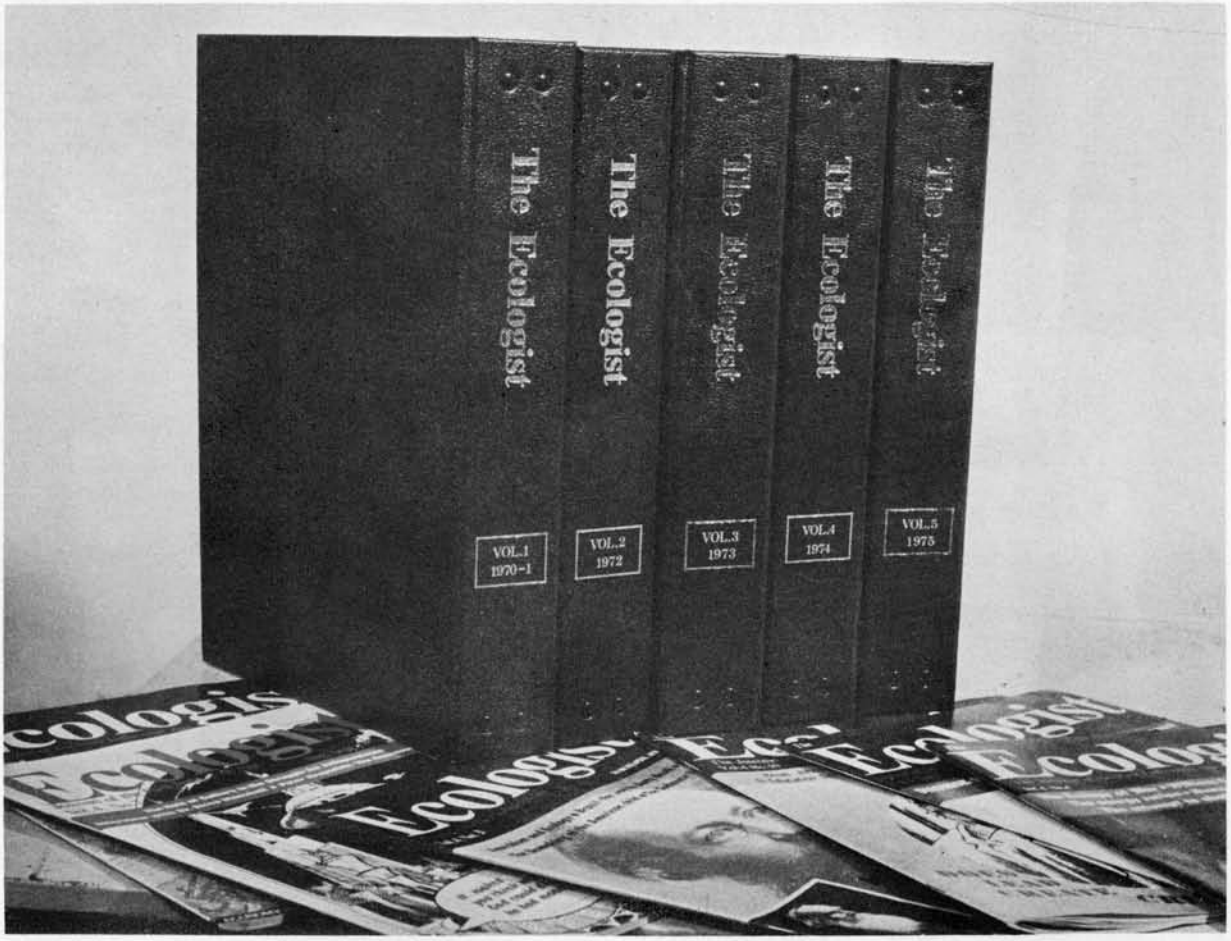

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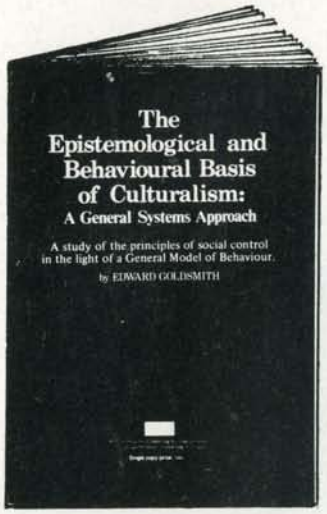

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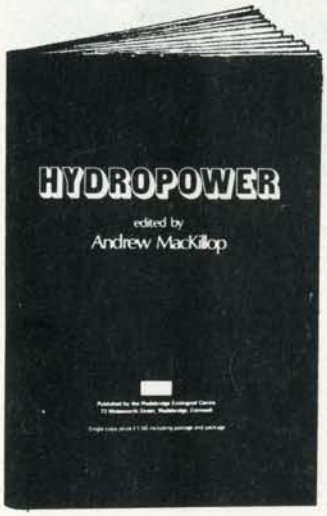

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