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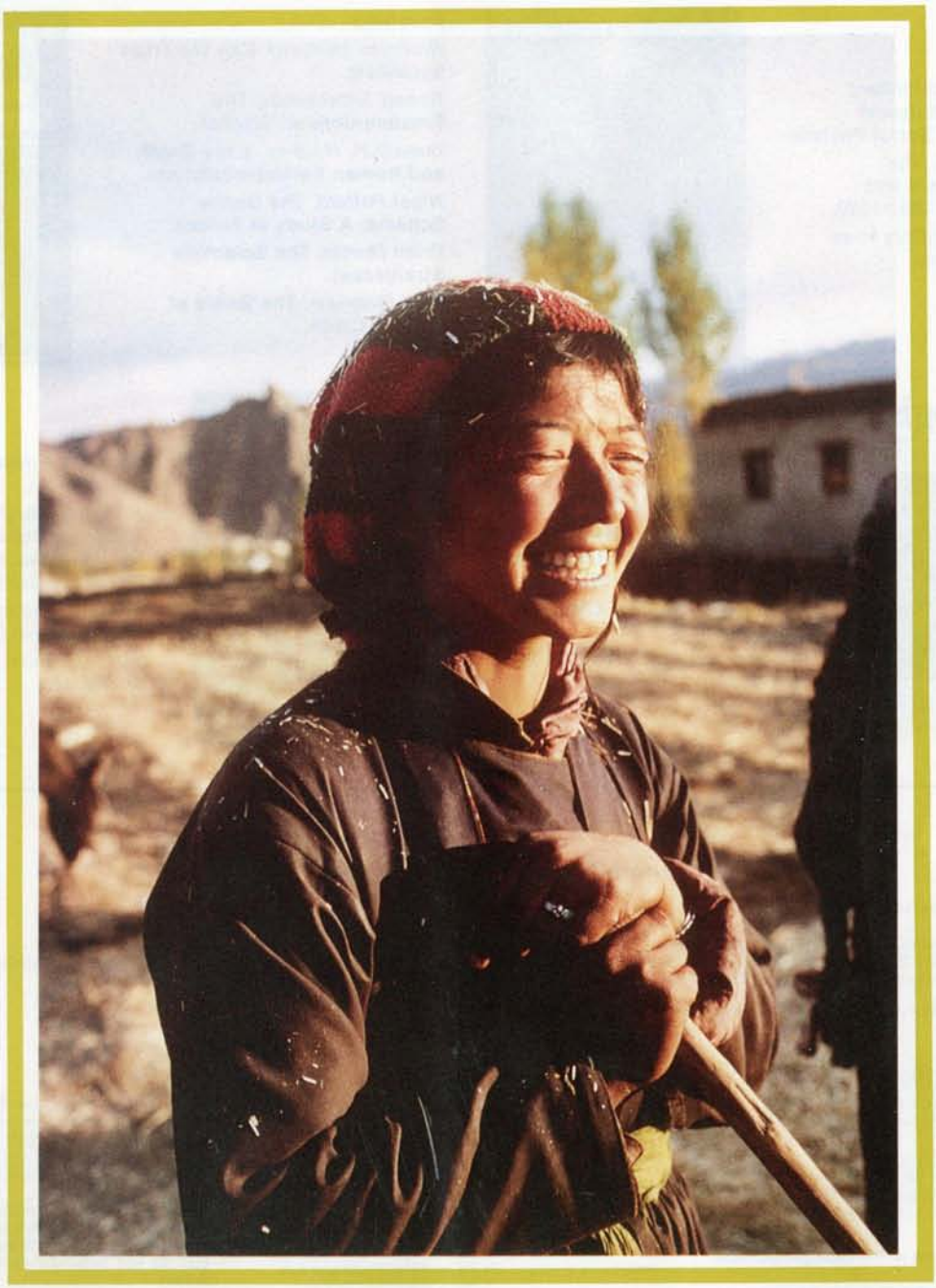

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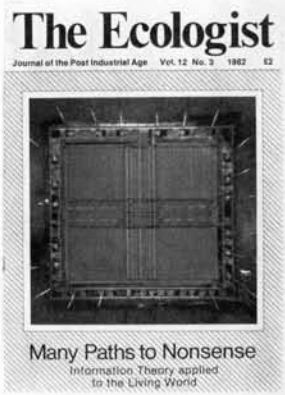

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Editorial

Feature Articles

Cover picture: A Ladakhi girl, Photo by Helena Norberg-Hodge.

Cover layout: Steve Womersley.

Can Self-sufficient Communities survive the onslaught of Development?

While the Amazon falls to the axe, Ladakh in India remains a stronghold of Buddhist economics.

by Peter Bunyard

Ecologist readers hardly need telling that as each day passes the world becomes a poorer place. Animal and plant species vanish forever, their demise hastened, if not actually brought about, by the hand of man, and entire environments are destroyed, the delicate richness of their life bulldozed and eroded away to make room for modern man's brand of civilization. Adrian Cowell's stark TV documentary of the tragic destruction of the Amazon forest in the state of Rodonia in the western part of Brazil, makes all the more bitter viewing because everything happening there has been utterly predictable. Indeed some ten years have passed since we published "Brazil — the Way to Dusty Death" (*The Ecologist,* Vol. 4, No. 3). And despite the warnings of ecologists, of men such as Jose Lutzemberger (*The Ecologist,* Vol. 12, No. 6), that the soils beneath the thick canopy of trees, so seemingly rich, are among the poorest in the world and incapable of sustaining a temperate style sedentary agriculture, the Brazilian Government continues to carve up the land into a grid of rectangular holdings, irrespective of soil, topography and climate, and promises it to the landless poor, who in their desperate attempts to scrape a living, pass on from one site to another, leaving in their wake a totally destroyed environment where nothing much will grow.

That there are Indians living in the forest, who since the beginning of time have survived very nicely on their hunting and their slash and burn cultivation, is simply an embarrassment. To a government dealing with demography and development a vast acreage populated by a handful of Indians is an intolerable waste and one that has to be filled, heedless it seems of the consequences for the Indians and equally for the environment. But then, the Indians are given the option of becoming civilized, if they can adapt quickly enough and survive the epidemics that strike so rapidly after contact with the colonists.

The message from Cowell's film is that the slightest incision into the forest turns quickly into a massive festering wound, despite assurances that development will be controlled and the Indians protected, and one cannot help feeling that the entire Amazon region is doomed, to be hacked to pieces for its wood, ripped apart for minerals, flooded for hydroelectric plants and what is left of its meagre topsoil washed and blown away when the poor peasants and rich landowners have finished with it. To see the sky filled with smoke as thousands of hectares of forest are made to burn, to see the dust swirl in the heat, obscuring the sun, is to be filled with foreboding. One's sense of outrage increases when one learns that behind much of the destruction is money from the World Bank.

The people flooding into the Amazon are for the most part seeking nothing more than a means to survive, and with the government and its henchmen behind them neither the Indian nor the forest stands a chance. But whereas in Brazil the Indian is not asked whether he wants himself and his environment transformed, in other parts of the world peoples whose traditional way of life has hardly changed in centuries will often, when exposed to the trappings of the industrial society, fall for what appear to be its obvious benefits without seeing the drawbacks. For the past nine years Helena Norberg-Hodge has spent much of her time in Ladakh, that outpost of India, north of Jammu, wedged between China, Tibet and Pakistan across the Himalayas. She first went to Ladakh in the Spring of 1975, just a few months after the Indian Government had opened the border to tourists for the first time since Independence, and was soon so captivated by the place and its people that after spending an initial six weeks there with the German film crew with whom she was working as a linguist, decided to return. Over the years she has witnessed a slow transformation in Ladakh from a way of life that was

totally selfsufficient to one increasingly dependent on the outside world, for cash, for fuel, for education and for technological gadgetry including pumps and electricity. She is convinced that as dependence grows and as more and more of Ladakh's 100,000 population get drawn into the cash economy so will the ancient traditions crumble, leaving a society, once happy and self-sustaining, vulnerable and disintegrating.

Just as the Amazon Indians blended their way of life to fit in with the forest, not threatening the intricate balance of the ecosystem, the Ladakhis have adapted themselves to a harsh, difficult environment. About the size of Austria much of the land is barren, arid desert with an annual rainfall of some four inches on average. During the winter months night temperatures can fall to −40°C. Most of the villages, with clusters of up to some 300 houses, are at around 11,000 feet, the houses being built of thick stone walls and adobe. Crops, barley being the main staple, are grown at the same altitude, using water brought down from the glaciers in small irrigation canals, made of mud and stone, running along the mountain slopes, and traversing the occasional gap by means of carved-out logs. The pasture for goats, sheep, donkeys, yaks, cows, mules and the yak-cow cross—the dzo—is high, up at 15,000 feet or higher, and provides winter feed for the animals. The Ladakhis also grow apricots and walnuts for food and willow and poplar for construction purposes, coppicing and replanting so as always to have a supply. Wood is too valuable to use as fuel, and instead the Ladakhis traditionally burn animal dung. All human waste is composted and goes back on the land.

As Helena came quickly to appreciate, the Ladakhi way of life, at least up until 1975, was completely self-contained and sustainable. The population too, appears to have been remarkably stable, a feature of the social system which combines flexibility with an intuitive sense of environmental limits. Under traditional inheritance laws, land is passed on undivided, from father to son the eldest inheriting. In the absence of a son, the eldest daughter inherits. Nevertheless, depending on the size of the inheritance and the amount of work to be done, more than one son may stay on, marrying the same woman as is married to the eldest brother., Although polyandry is the preferred form of marriage, both polygamy and monogamy may be practised, depending on the particular context and its requirements.

As a result many women do not marry, instead becoming nuns. Meanwhile, men, whose services are not required on the land or in the villages go to monasteries, where they are cared for by the community and relatives. With a high proportion of the population remaining unmarried the monastic system, aside from its important religious role, provides a benign way of caring for people.

Overall the health of the Ladakhis is good, the worst problem if anything being smoke from the burning of dung inside the houses and its effects on the eyes and lungs. The Ladakhi medical system is based mainly on herbal medicines, the tradition being a blend of Chinese and Indian that goes back to the 8th century, with a sound recognition of the importance of mind in the cause and cure of disease.

Ladakhis were the first to appreciate how fortunate they were to be part of India when the Chinese invaded Tibet in the late 1950s destroying some 1,500 monasteries, wiping out villages and eradicating all vestiges of the Tibetan way of life. Ladakh, although a separate kingdom from Tibet, having had its own monarch until the country was invaded and conquered by Dogras from Jammu in 1834, has always looked to Tibet and to the Dalai Lama for its religious traditions and culture. All books and writings were traditionally in Tibetan, using the classical Tibetan alphabet—the alphabet being originally derived from India. The spoken language, Ladakhi, is actually a dialect of Tibetan.

Helena, who learnt to speak Ladakhi on her visits to the country, helped compile the first-ever dictionary of the language, writing the words out in the letters of the Tibetan alphabet. "The language has a complex, very elusive grammar," she says, "absolutely nothing is considered to have an existence on its own, and for a Ladakhi to think of himself as 'independent' of the rest of creation is an absurd illusion. All life is a matter of 'oneness' and the

Photo: Helena Norberg-Hodge

Ladakh: Ploughing at 12,000 feet with the yak-cow cross.

language reflects that interdependence. For instance the Ladakhi has more than twenty different ways of saying the word 'to be'. How he says it is dependent on his relationship with the objects and situation around."

With Ladakh now severed from Tibet and Tibetan culture virtually destroyed, the Ladakhi language has gained in importance; indeed Ladakh has increasingly become the centre of Tibetan Buddhist studies, foremost Buddhist scholars like Tashi Rabgyas, being based in Leh, the capital of Ladakh.

India's interest in Ladakh was triggered in part by the Chinese invasion of Tibet, and India quickly sent in troops to protect the border. Roads began to be laid, with labour and materials from India and a small airport built to accommodate the increasing flood of tourists and supplies coming in by air from Delhi. Tourism has now become a major industry in Ladakh, as many as 15,000, the majority European, making their way across the Himalayas each year. Some hike their way around, by all accounts leaving a trail of debris behind, including tins, paper and plastic, none of which breaks down quickly in that dry environment. Many tourists now fly in and then take buses along the newly built roads, rushing from one monastery to the next. The tourists in particular have had an unsettling effect on Ladakhis, especially on the young, who get a false notion of modern life as one of riches and of not having to work. They see more money being spent by an individual tourist in a week than they would normally get through in a lifetime. The tourist comes with his modern gadgets, his camera and watch, with his seeming leisure, expects to be fed food that he is used to, and to live in a hotel that can provide some of the conveniences of modern life, including running water and a flush toilet. Some new hotels are owned and run by outsiders but most are run as family guest houses, and in the capital Leh, it is not unusual to see young boys clambering onto the roof to pour water into a tank. Pumps are increasingly used to get water in the houses.

Development comes to Ladakh

India meanwhile is carrying out its own slow, development of Ladakh. More and more vehicles are to be seen on the roads, especially in the capital, and mass manufactured goods are now beginning to replace traditional ones. New houses are being built of concrete blocks and are provided with kerosene heating, while on the land agrochemicals are increasingly used. The demands for more water are being met through the construction of concrete irrigation pipes, despite problems with frost cracking in winter, and through pumping water from bore holes. Tractors are now being imported although most Ladakhis still plough, till and harvest using their traditional beast of burden, the dzo.

"Greater changes have taken place in the last twenty years than have during the last thousand" says Helena, "undoubtedly the most dramatic being the way that Ladakh is being drawn into the cash economy with all the growing dependence that goes with that kind of development. The problem is that once development starts almost everyone wants to get on the band-wagon with a subsequent breakdown of communal ties and cooperation. And whereas in the past everyone participated in the maintenance and construction of irrigation canals, today Ladakhis see the government constructing permanent structures out of concrete and bringing in more water to increase productivity in the fields. On the face of things the new imported ideas appear better and it is not surprising that Ladakhis from one village, seeing the improvements carried out in a neighbouring village, want similar treatment.

"The paradox is that life in Ladakh has been totally free; it has cost no money to live; whereas the slightest development in the modern sense requires money and creates a value for activities that previously have been taken wholly for granted. Ironically too, Ladakhis will only remain in control of their own lives while they are outside the cash economy. Once in, despite the illusion that money confers freedom of choice, they will in fact find themselves on a treadmill."

The notion of poverty hardly existed before, today it has become part of the language. When visiting an outlying village some eight years ago, Helena asked a young Ladakhi where were the poorest houses. "We have no poor houses in our village," was the proud reply. Recently Helena saw the same Ladakhi talking to an American tourist and overheard him say "If only you could do something for us. We are so poor."

The most damaging aspect of tourism has therefore been its psychological impact in giving young Ladakhis in particular a deep sense of the inferiority of their own culture and way of life. To redress the balance, Helena has started using the local radio and bringing in books and literature from the outside world to show Ladakhis that the reason tourists come to their country is because they hope to find there the very values that they have lost in their own societies and have come to cherish. She therefore tells Ladakhis how in the industrialised western world people are trying to create close-knit communities that are basically self-reliant; how they are looking for non-polluting technologies such as composting lavatories, and solar heating systems; how brown bread and other whole foods are now increasingly being consumed, and that people actually pay a lot of money to get exercise. All of those things, community, wholesome food, are freely part of the Ladakhi heritage.

Much of what Helena has said and campaigned for in Ladakh ties in well with Buddhist beliefs concerning the relationship between individuals and a sustainable, life-enhancing, economy. A Ladakhi Ecological Development Group now exists and the local government has given a prime plot of land in the centre of Leh for a centre to be built. Work on the site has begun and the building is to have a library, restaurant, and exhibition of low impact technologies with working examples. Tourists are expected to come, and the hope is that encounters between tourists and Ladakhis will reinforce mutual respect and make Ladakhis come fully to realise the value of their own culture.

Ladakh has never been completely closed off from the rest of the world. On the contrary Leh used to be on the silk route between China and India and a certain amount of trading always went on. Helena is well aware that it would be both impossible and impractical to try to stop all outside influence, but she hopes that any future development in Ladakh can be coaxed along lines that cause minimum

disruption to the traditional structure of Ladakhi society. Without doubt, the bitter winter cold is one of the harshest aspects of life in Ladakh, and Helena realised that any means of heating that could be easily afforded would make a considerable improvement in living conditions. The quick answer is to get in kerosene stoves, with all the resulting dependence on imported fuels. Instead Helena, through the Ecological Development Group, showed the Ladakhis how to build a Trombe wall. Such a structure consists basically of a sheet of glass held a few inches away from the south-facing blackened wall of the house, with vents at top and bottom to allow the sun-heated air to circulate. Already proven in France, where it was originally designed, the wall is particularly effective in the Ladakh winter, with its high altitude, dry climate and high level of insolation. The cost of the wall is no more than the purchase of a dzo beast of burden; moreover the wall can easily be erected by Ladakhi craftsmen and already some sixty have been built, twenty of them under the instigation of the Ecological Development Group. In addition the group has designed simple solar ovens working on the same principle of a blackened surface covered by a sheet of glass.

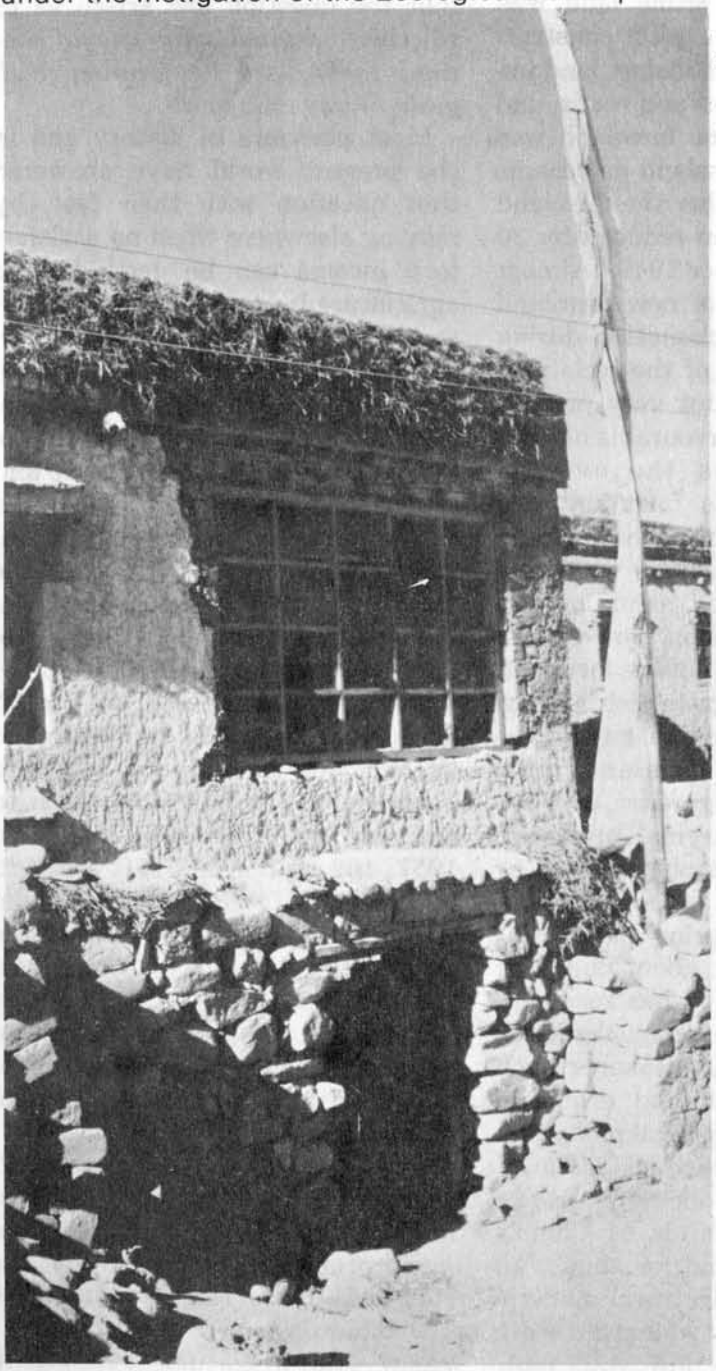

Photo: Helena Norberg-Hodge

A trombe wall, for passive solar heating, built by local craftsmen, fits in well with the traditional Ladakhi house.

Through such simple technologies, the Ladakhis have less need to burn animal dung inside the houses for cooking and warmth, and the dung can therefore go back to the soil; a far better alternative than importing artificial fertiliser.

From her observations of Ladakhi society, Helena believes that certain principles have to be adhered to if a society is to be sustainable from the use of its own resources. According to her the principles are as follows:

1. All basic needs must be met at the local level. Self-reliance is essential, although that principle need not be exclusive of importing and trade. Much of the colourful stones and corals used as decoration by Ladakhi women have been imported over the centuries from Italy.
2. Decisions affecting the community should be made at the household level and not be delegated to some distant representative. In general in Ladakh some twenty households are involved in decision-making and organising their affairs. Boundaries themselves do not appear to be important. Indeed village size and therefore the number of households reflects the resources available in the vicinity. In that respect the countryside can be divided into bioregions, each with its own group of decision-makers.
3. Small-scale units are essential for self-sufficiency. They allow a truly spontaneous and flexible efficiency. In such communities there is no waste, life close to nature being the only true efficiency.
4. Everything in a self-reliant community is for free, and self-sufficiency can only exist outside the cash economy. Yet toil under such circumstances is not drudgery. Indeed no rigid distinction is evident in such communities between work and play. In Ladakh the truth of that is demonstrated in the fundamental inner contentment of the people.
5. Finally the decentralisation found in self-sufficient communities must be associated with a strong binding culture that is completely accepted, and respected by the people involved. That way any decisions taken are likely to be to the benefit of all.

For Helena, one of the most striking aspects of life in Ladakh is the overall happiness of the people. Ladakhis seem to spend most of their lives with humour and laughter derived from an extraordinary peace of mind. "That happiness is deep-rooted and sincere, and such a contrast to the way our own lives are ridden with stress and anxiety," says Helena. Compared to many other peoples in the world suddenly faced with development, Helena believes the Ladakhis have as good a chance as any in accepting only those aspects that can be incorporated into the culture without destroying it. Traditional beliefs, with their inherent respect for nature, are a great help. One of the activities of the Ecological Development Group will be to sponsor work that shows the relationship between ecology and Ladakhi culture. With the scholar, Tashi Rabgyas writing in Ladakhi, Ladakhis are in the fortunate position of being both an integral part of a basically self-sufficient country and of spearheading new, workable ideas and technologies that can be incorporated into such societies without destroying the basis of their existence.

Agriculture in China— A deteriorating Situation

by E.B. Vermeer

Despite general impressions in the Western world that China has made remarkable strides in solving its food production problems, the indications are that China's agricultural policies, in particular those pertaining to the bringing into production of marginal lands, have been environmentally disastrous. Erosion, salinisation, deforestation, dessication as well as contamination of shrinking water supplies are all serious problems besetting China. New policies are called for, most important of which are the restoration of marginal land, to act as a buffer between man's activities and a vulnerable environment.

Most of China's 9.6 million square kilometres are of little or no use for agriculture. Extreme coldness or altitude, such as on the Qinghai-Tibet plateau, extreme dryness, such as in the deserts of Xinjiang and inner Mongolia and steepness of slopes are major factors limiting habitation or agriculture. According to present statistics, the cultivated area is 100 million hectares, or only 10 per cent or so of China's total land surface.[1] However, as with most statistics on China, that figure is dubious. Local surveys show the cultivated area to be in the region of 120 million hectares.

The Chinese themselves have expressed similar doubts concerning the official figure for China's forest area: 122 million hectares, or 13 per cent of China's total land surface. In reality, satellite pictures show that China's forest cover is only about half that size, 5 per cent according to some, 8 per cent according to others.[2] Obviously, a matter of definition is involved. At present, we have little choice but to follow the Chinese official figures, but with reservations.

While the rural population doubled between 1949 and 1980, from 425 million to more than 800 million,[3] the size of total farmland area remained surprisingly stable. However, its composition changed a great deal. Much prime land was taken up by state capital construction projects, rural housing, land improvement measures and roads, and indeed still is. Some farmland was converted into grassland or became wasteland. Altogether the farmland area may have been reduced by 30 million hectares since 1949.[4] Almost the same amount of new farmland was created by reclamation during that period.[5] Most of the reclaimed land, however, is not very productive because of unfavourable natural conditions.[6] Thus the average quality of China's farmland has changed considerably over the past 30 years: marginal areas which are either saline, marshy, sandy or subject to serious erosion, now constitute about one-third of the farmland area with average grain yields below 1.1 ton per ha.[7] Likewise, an average one-third of the farmland area, probably for a large part overlapping with the marginal one-third, was struck by disaster each year during 1972-1977, a considerably larger area than during the 1950s.[8] On the other hand, about one-third of the total farmland has seen considerable capital investment including infra-structural measures such as pump irrigation and drainage, land levelling, mechanical ploughing and high levels of chemical fertilizer application. That one-third is responsible for two-thirds of China's grain production and for almost all of its cotton.[9] Agricultural modernization has actually widened the differentials between low- and high-production areas[10] to such an extent that the question has arisen as to whether *marginal areas should continue to be used for farming food-grain or any crop at all.*

Most peasants in history and in the present world have answered that question with their feet, by moving elsewhere when no satisfactory income can be derived from agriculture in marginal areas. However, the Chinese example is different for two reasons: first, that already before China's industrialization, all easily accessible and promising land had been opened up and taken into cultivation under the heavy pressure of population increase; and second, that since the formation of the People's Communes in 1958 members of the production teams are tied to the soil of their native village and are not allowed to move. That limitation of the peasants' mobility has served to keep the city populations down to the very low levels of 99 million in 1957, 102 million in 1970, and 129 million in 1980.[11] By 1978 industrial employment, inclusive of industries operated by People's Communes, was no larger than 50 million, as against 295 million agricultural labourers.[12] Thus, almost all rural population growth has been accommodated within the villages.

Furthermore, over the past 30 years, a considerable amount of capital has been invested in the development of agriculture, both by the state and by the local communities: 120 billion *yuan** in water conservancy and irrigation, 100 billion

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* Yuan = US $0.5

yuan by the state alone in agriculture, and an as yet unquantified amount in tractors, and the chemical fertilizer industry.[13] According to a recent estimate, agricultural modernization—along the lines previously suggested by Hua Guofeng's 1978-85 Plan—would require a tremendous amount of capital; as much as 200 million yuan for half a million people.[14] Thus, the Chinese population as a whole would take some 300 billion *yuan*—three times the *total* annual state budget, and therefore an unrealistic figure. As it is, most of China's marginal and poor agricultural areas will have to do without much state investment in the near future. Hence the recurring question: should marginal areas continue to cultivate foodgrain or any crop at all?

Marginal Area Cultivation or Not?

The question has several angles: production, productivity, employment, capital requirement and last but not least that concerned with ecological and long-term conservation of resources. There is no easy answer, and the question 'if not agriculture, then what?' must be asked as well. Only very recently has the problem been recognized as such in China. With accessibility and official data being what they are, I am in no position to give more than a preliminary answer with regard to certain areas, based on available literature, satellite pictures and visitors' reports. Satellite pictures are especially useful in identifying natural vegetation and crops, in indicating surface water resources, in classification of soils, and in expanding data based on field work and published in the literature. They facilitate the drawing of demarcation lines between different crop zones and the making of interregional comparisons. In the following, I discuss six areas in different parts of China, from which I draw some conclusions on agriculture, forestry and possible measures to protect the environment.

New Oases in Xinjiang and Secondary Salinization

The arid Northwest of China used to be inhabited by nomads, who tended their cattle on the mountain slopes and desert fringes. Generally, precipitation in the area is only 50-100 mm a year and evaporation about 2,000 mm; therefore agriculture is possible and feasible only in some areas with access to water from mountain streams or from underground water resources. Since 1949 the reclamation corps of the People's Liberation Army has undertaken a major effort in reclamation and grain production, in the face of extremely adverse natural conditions. Soils are sandy and irrigation water seeps away quickly; strong winds in spring and heat in summer cause high evaporation; the few rivers have a very irregular regime. All those factors contribute to easy alkalization of the soil.[15] The oases in the Tarim river area—the northern fringe of the Taklemakan desert—have a history of agriculture dating back to the Han dynasty, but they never seemed very promising. Nevertheless, the Chinese authorities have decided that 262,000 hectares along the lower reaches of the Tarim river are suitable for reclamation.[16]

Irrigation—a deteriorating Ecology

Since 1949, the old irrigation areas were expanded, and new State Farms were built. In the past 20 years and more, over 70,000 hectares have been reclaimed, and new oases created. With the increase of the irrigated area, the water of the Tarim river dwindled, and the quality of lake, reservoir and river water deteriorated. In the non-reclaimed grasslands near the river the water table dropped, and plant cover declined from 10 to 15 per cent in the past to 2 to 4 per cent now; thus grass stands became very poor, falling precipitously from 1200-2250 kg/ha to 270-375 kg/ha. Similarly the forest cover in the upper reaches decreased to one-third of what it was before reclamation. Without question the ecological balance had been seriously disturbed.

Along the Tarim river total dissolved salts constituted no more than one per cent of total water weight in the late 'fifties and early 'sixties. By the mid-seventies, salinity had increased 5-8 times during the spring flow (April-June), and after 15 years of cultivation ground water in the belt with a width of about 10 km. along the Tarim River rose from 4-6 metres below the surface (3-8 m. in the lower reaches) to 1-3 metres below the surface. Salinity rose from the original 1-3 g/l. to 3-10 g/l. Groundwater rose because of irrigation without sufficient drainage, thereby bringing salts up to the crop root zone. Commenting on those facts, a Chinese author concluded that: a) irrigation should be used in a more rational and sparing way; b) drainage should be improved; c) forests and pastures should be protected.[17]

Indeed the salt levels threaten the very survival of the oases themselves. Moreover, the desiccation of the pastures is taking away the economic basis of the native nomad population and bringing the desert and sand storms down to the agricultural fields. From a purely economic point of view, only high-quality cotton with its capacity to resist fairly high levels of salinity seems a rewarding staple crop. In addition the establishment of a Han-Chinese presence and a food base for the People's Liberation Army in that interior area does not have the same strategic validity as it may have for the Northern Xinjiang border. Consequently, many good reasons can be found for reducing the area under agriculture in Xinjiang.

The Loess Plateau and Water and Soil Erosion

How to manage the serious water and soil erosion problems of the 580,000 sq. km loess plateau in Gansu, Shaanxi and Shanxi provinces has been the subject of a continuous debate during this century. Initially focus was mainly on the reduction of the extremely heavy silt load of the Yellow River, which created problems for containment of the river in the North China Plain, and for the construction of reservoirs.[18] Later, the inevitability of a high silt content was recognized and more attention was given to the economic and ecological problems of the loess plateau itself. The population in the area had increased to 60 millions by 1980[19], and today the area is extremely poor.[20] Northern Shaanxi was once rich in water and natural vegetation. At the end of the 15th century, reclamation started and grain was sown. After five centuries

of cultivation, most of the area turned into a semi-desert and suffers from droughts and sandstorms. Indeed, for every hectare of land taken into cultivation, three hectares of grassland are turned into desert; moreover, since 1949 management of pastures has not been undertaken. As people wanted only such products as meat, wool and hide, the best pastureland was put to the plough while over-grazing of the remaining pastures became an ever-growing problem.[21]

Guyan County in Gansu is a case in point. It is a mountainous, dry and seriously eroded area and if anything, should have been devoted to animal husbandry. Notwithstanding, after 1949 the area was instead developed for grain production. Between 1949 and 1979, the population increased by 133 per cent, and 82,000 hectares were reclaimed, so that the cultivated area rose from 203,000 to 285,000 hectares or 0.57 hectare per person by 1980. The average foodgrain yield, however, was only 315 kg/ha., so that per capita grain production in 1978 was less than half the amount in 1949, hence 178 kg. in 1978 as against 414 kg. three decades earlier. The quantities of pork, meat and edible oil sold to the state declined greatly, and during the 1970s the area has been dependent on state relief.

Chinese plans for the loess area stress the development of animal husbandry and forestry with a reduction in the food grain acreage. That is a realistic option only if a long-term commitment is made to provide the area with extra food grain during years of drought (such as happened in 1980). Meanwhile, communications and transport facilities must also be improved, in order to be able to move grain in and meat, wool, fruit and other products out to Xi'an, Lanzhou, Baotou and other cities. Green manuring has already shown its value and provincial authorities are now urging peasants to sow green fertilizer crops immediately after the wheat harvest or autumn harvest to improve soil structure and fertility, as well as to serve as fodder for pigs. One suggestion is to try 'unpopular' crops such as Irish potatoes and promote other economic activities such as coal mining. Indeed provincial authorities told me when I visited Shaanxi Province in 1979, that climate and soil were probably suitable for growing potatoes, but there was a lot of resistance from the peasants to growing the crop, as they were unaccustomed to eating potatoes. Moreover, Irish potatoes still count as a vegetable crop and not as a food grain crop, which has implications for fixing official targets for food grain production. Developing coal mining would need considerable investment and improvement of existing railways. Local officials are in favour, but they are not very optimistic about the prospects for getting the necessary funds. Finally, the drawing of underground water from depths of over 70-100 metres for irrigation purposes is increasingly uneconomical given rising energy prices. Consequently, agriculture does not seem to have much of a future in this area. On the other hand, should the government want to promote a major reforestation effort along the middle reaches of the Huanghe so as to support agriculture downstream, it should subsidize the local peasants for such a scheme, or move labourers in from outside. However, the latter should be unnecessary, as the area is clearly overpopulated, with serious unemployment. The problem is that nature seems to have the upper hand in the area, and it is doubtful whether large-scale afforestation would be possible under the dry climatic conditions which characterized the 'seventies, or whether the continuing process of erosion can be slowed down.

Photo: Ambio

A deforested, windswept China.

The Sanjiang Plain and the Drying up of Marshes and Pastures

Recently an article in *Dili Xuebao* drew attention to the reclamation of marshland area in the extreme Northeast of China.[23] The Sanjiang—three rivers—plain, at the confluence of the Heilong river and the Wusuli river, is an alluvial marshland covering a surface of 51,300 sq. km. During the early 'fifties some 25 per cent of the area was marshland, 30 per cent fluctuated between marshland and grassland, over 30 per cent was grassland, 8 per cent forest and 3 per cent bodies of water. Previously the marshes contained many small lakes, while the forest area consisted mainly of shrubs, with abundant wildlife, including bears, deer, otters and foxes. Today the wildlife is much reduced owing to the retraction of the marshy environment.

In 1949, farmland comprised only 3 per cent of the area, but 30 years later, by 1979 it had been expanded to 36 per cent of the total area, thus to 1,800,000 hectares. According to

official estimates a further 2,900,000 hectares of wasteland is reclaimable in the long run.[24] Located in a strategic position on the Soviet border, the Sanjiang plain has become one of China's prime granaries selling more than half its grain production to the state.

But the reclamation plan had no unity of purpose. North of the Sungari, 30,000 hectares of reclaimed sandy soil turned into a sand desert, and the forests were almost entirely destroyed, merely covering 5 per cent of the area in 1974. Marshes then covered 1,160,000 hectares and fluctuating marsh/grassland 1,120,000 hectares with the marshes altogether covering 47 per cent of the total area. Over the past few years the marsh/-grassland area has decreased by a further 53,000 hectares per year. Thus, animal life has been considerably affected and fish production in 1979 plummetted to only 17 per cent of that in 1960.

The Dessication of the Marshes

Meanwhile, the average amount of rainfall decreased from 600-700 mm. in the early 'fifties to 400-450 mm. in the second half of the 'seventies.[25] Surface water flow decreased, and the water table fell. Wind and sand affected soil fertility, leading to desertification, while salinization affected over 60,000 hectares and water and soil erosion became more serious. Thus, agriculture suffered as well.

The author of the article in *Dili Xuebao* proposed several measures to be taken for the rational use of natural resources:

a) Protective forests should be planted, and forest renewal promoted. Animal husbandry as well as fisheries should be developed.
   The tilled land should be limited to 45-50 per cent,and grassland for animal husbandry to 20 per cent. Meanwhile forest cover should be no less than 10-15 per cent, and an equivalent area kept for sideline production and protected marshes. Waterbodies should be at least 3 per cent of the total.
b) Water management should be comprehensive, with underground water being exploited as well. The region has experience with rice growing—85,000 hectares in 1980—and more rice should be planted, both because it is highly productive and because it helps maintain an ecological balance.
c) Soil should not just be exploited, it should also be nourished to raise its fertility. Green fertilizer should be planted, and stalks and ashes put back on the land as well as other organic fertilizer.
d) A certain area of marshes should be protected as a necessary factor in the ecological balance. They should be designated as such.

In the absence of data on land and water resources in the area, as well as on economic and demographic developments, it is hard to comment on those proposals. The picture of ecological losses that have occurred is much more in evidence, than that of possible economic gains from agriculture or forestry. The development of the area seems to be bound up with the presence of the Peoples Liberation Army and its economic demands.

Tianjin Water Supply

The northernmost part of the North China Plain, with the two large cities of Beijing and Tianjin, has a severe water shortage.[26] Precipitation is only 500 to 550 mm per year, three-quarters of which falls during the summer months between June and September. Tianjin now has a population of 9 million. Its water consumption is 65 times higher than that of 1950 because of increases in industrial, human and agricultural consumption. Its traditional water source, the Haihe river, has been increasingly tapped upstream for irrigation purposes. Since 1958 over 20 large reservoirs have been built on the upper reaches of the Haihe river tributaries, with the result that Tianjin receives less and less water. In 1980 only 0.7 billion cubic metres of water entered the sea, or 8.5 per cent of the pre-1958 amount. In the drought year of 1972, when precipitation was only 314 mm., water was let in from the Huanghe via the Grand Canal. In 1975 and again during 1980 and 1981, the water shortage in Tianjin was very serious.

Tianjin's city districts draw more than 0.1 billion cubic metres of underground water per year. But the water table is steadily falling, so that pumping costs have increased both for city and for agricultural users. Indeed over an area of 7,000 square kilometres the water table is now 60 metres lower than in the surrounding areas. The surface of Tianjin has sunk by 80 cm. during the past 20 years, and in one place by as much as 150 cm.[27]

Not only is surface water getting scarcer, but also dirtier because of factory discharges.[28] In addition the seawater entering the Haihe river is making the water more saline. To solve that problem, reservoirs have been built on the plains, some very large, but they depend on water from upstream and also tend to get saline.[29] Two reservoirs are under construction as a part of the Luan river control scheme. These will be able to provide the cities of Tangshan and Tianjin as well as the countryside with an estimated two billion cubic metres of water per year. A diversion project to supply Tianjin with Huanghe river water was completed in 1982.[30] Together, the reservoirs and the diversions will ease somewhat the present situation, which is representative of all East coast cities from Beijing to Shanghai. Especially in the Beijing-Tianjin area, the competing demands for water for industrial, urban and agricultural uses are bringing about a permanent shortage of surface water, which can no longer be made up by underground water. In all likelihood agriculture will have to give way.

Reclamation of Lakes—"Draining the Pond to catch the Fish"?

Since 1949, China's lake surface has decreased by 1.3 million hectares, most of that shrinkage along the middle reaches of the Yangzi river. The silting up and reclamation of lakes has occurred throughout China's history, but speeded up considerably after 1949.[31] Over the past 30 years, the Dongting lake has shrunk from 435,000 to 282,000 hectares[32] and many smaller lakes in Hubei have been reclaimed[33] with the result that their total surface has diminished by three-quarters.

Thus at least 87,000 hectares of the Poyang lake in Jiangzi have been reclaimed.[34] Meanwhile the flood danger along the middle reaches of the Yangzi river has increased considerably because of the loss of flood water storage capacity, a fact which became painfully clear during the 1980 floods.[35]

Generally speaking, the drainage and reclamation of lakes lowers their water retention capacity, so that in dry periods the more elevated surrounding areas are unable to receive irrigation water any more from the lake. Furthermore heavy rainfall brings about waterlogging, and the costs of pumping water out may be very high. A recent article also pointed to other negative effects: after the surface of the Chaohu lake in Anhui had been reduced the frost free period in that area was considerably shortened by as much as twenty to forty days, with subsequent bad effects on production. To prove the point a decision to maintain the water level of the Baiyangding lake (near Baoding, south of Eijing) at 1.7 metres has favourably tempered the climate in that region.[36]

Less Fish

Drainage has also had negative effects on fisheries. Thus fresh water fish production went down from 500,000 tons during the 1950s to 300,000 tons during the 1970s.[37] Meanwhile the Taihu lake in Jiangsu, which lost 20,000 hectares through reclamation, did not fall off in overall production of fish, only that fewer and fewer large fish were caught,[38] the reason being overfishing and that large fish are more vulnerable to water pollution.

In spite of those negative effects, reclamation of lakes in the Yangzi river basin appears to be profitable. The reclaimed land is very productive, and situated in densely populated areas with good communications. The surrounding fields can usually make up the loss of irrigation water supply by using underground water close to the surface. The loss of fish can be compensated by meat from animal husbandry. Because of the danger of flooding, the suggestion is that the reclaimed areas should still serve as flood diversion areas whenever necessary and therefore might be best devoted to raising cattle. Meat has a ready market in nearby Wuhan and can be exported via the Yangzi river. Hence cattle raising should be more profitable than the alternative of wheat followed by green fertilizer crops and safer and less costly than fully-fledged farming behind high dikes.

Hainan Island—Slash and Burn

Hainan has a rich variety of plant and tree species, and many valuable varieties of timber and medicinal herbs. However, because of the indiscriminate felling of trees since the 1950s the ecological balance has been seriously disturbed. The natural forest decreased from 863,000 hectares to 245,000 hectares in 1980, therefore a decrease of 72 per cent and the overall forest cover from 25 per cent in 1954 to 13.6 per cent in 1980, with an additional 7.8 per cent of rubber trees or protective forests. A Chinese visitor noted that during the year 1979-80 forest destruction had increased considerably.

> "During a cross-country drive in April of this year we saw much destruction along the road. Although there are many notices to protect the forest and forbid fires, slash-and-burn farming continues; moreover burning the mountain slopes to catch the "Money Tortoise", which is sold at high prices to Hongkong merchants is still on the increase. On the mountains everywhere you see smoke, and the remains of destruction caused by forest fires are a sad sight. The protective tree belts along the road have been plundered terribly at many places."[39]

He attributed forest destruction to four causes: 1) the policy of grain growing as the key to agricultural development, 2) primitive slash-and-burn methods, 3) the expansion of state farms, from an area of 27,000 hectares in 1960 to 35,000 hectares in 1979, most of which have very low grain yields: Hainan still has to import 225,000 tons of grain each year, 4) the lack of coal, which leads to the use of wood as fuel. On average each person burns 1.5 kg per day, and with a population of 5 million people, that means that 2.7 billion kg of wood is burnt every year—which corresponds to 4,000 hectares of forest.

The average grain yield is only slightly more than 2.250 kg/ha. But investments are extremely high (15,000 *Yuan* per hectare) for the clearing of mountain slopes and production is very low (in 1979 the rice yield was only 2,600 kg/ha). Yu Dechang's proposals for improving the ecological balance are:

a) new tropical forests. Protective forest belts should be set up on mountains, plains and around cities and villages.
b) new rubber plantations, to be carefully established; with regard to water and soil conservation it is necessary to construct level fields.
c) peppers, tea or coffee should be planted between the rubber trees because those crops are profitable (especially pepper) and the work provides employment.[40]

At the conference on the use of China's tropical resources it was suggested that the area of rubber plantations in Hainan be extended from the present 200,000 hectares to 350,000 or even 400,000 hectares for China to become self-sufficient in natural rubber. However, opponents of the scheme stressed the negative effects on plantlife and wildlife and said that the wood of tropical forests might be more valuable than rubber trees.[41]

It seems that until now the natural advantages of Hainan have not been exploited, especially in view of the successful experiences of the neighbouring Leizhou Peninsular with regard to reforestation.[42] Instead of cultivating low-yield food grain, the tropical resources of wood, rubber and medicinal herbs promise to be more rewarding both now and in the future. Labour-intensive crops such as tea could be expanded, and processed for export. Hainan should follow the Taiwan example, and use its geographical location for developing harbours, industry and trade. Employment could then be found along the coast and slash-and-burn farming in the interior stopped. If China was unable to provide the capital and skilled manpower needed for such a qualitative change, foreign participation might be brought in. The present exploitation of the interior threatens to damage agricultural undertakings of the

future because of soil erosion, loss of humidity, and increased vulnerability to droughts and floods.[43]

Conclusion

What should be the extent of foodgrain cultivation has been answered differently for the six areas. In general it appears that the most sensible strategy would be to reduce the acreage of such cultivation in marginal areas as much as possible. By comparison reforestation, green fertilizer crops and animal husbandry seem to be, even if not in the short term, both more beneficial and economical in the long term. From the national point of view, the overall grain shortage, which is made up by imports of about ten million tons a year—is seen to be a serious drain on foreign exchange. But animal husbandry is underdeveloped in China, and has good export potential.[44] Moreover, the shortage of timber and fuel is just as serious as the grain shortage, if not more so, and the denudation of upstream areas has been shown to have extremely negative and costly effects downstream.[45] Furthermore, timber prices are expected to rise in the future, both within China and in the international market.[46]

Generally timber stands in China are poor. Of the forestry reserves only one-half to one-third is considered usable. Since 1977 the average yearly decrease of forest resources has been 100 million cubic metres, almost 40 million cubic metres more than annual growth. About half of the decrease is on account of regular timber exploitation.[47] Furthermore, the pace of felling is quickening, giving rise to a real crisis of resources. A major cause is the energy shortage; there being insufficient fuel for household use or for village factories, with the result that the villagers are forced to go out and log trees as well as cut grass, and use plant stalks as fuel. Such practices reduce soil fertility. According to a recent article:

> "The rural population needs 540 million tons of plant fuel a year, equivalent to almost 300 million tons of standard coal—half of our country's production. But the stalks and wood are also needed as fodder, fertilizer or industrial material leaving just 300 million tons of stalks to be used as fuel. The state delivers some coal to the villages, but very little and 40 per cent of the peasants suffer a serious fuel shortage. The only short-term solution seems to be *biogas*. In 1979, there were 6.6 million biogas tanks, but only half were really usable. They had been produced too fast, without regard for quality or good management. That should be a lesson!
>
> Furthermore, the peasants should plant forests for fuel, while the state should plan to supply more coal. In 1985 we should reach the minimum standard of each peasant having hot meals every day. In 1990 we should reach the level of 100 kg. of coal per peasant."[48]

For other uses, such as paper, the future need for timber will also grow rapidly. The government, however, has not given enough support to the maintenance of forests. Both the general shortage of coal and the closing down of many small coalmines, especially in South China, during recent years has had the foreseeable effect of aggravating the onslaught on forests. In fact these small coal

mines were closed down because of their high production costs which were approximately double those of large mines. However, external costs were not taken into consideration, and the decision was an example of departmental planning disregarding the needs of other sectors. Nor has the increased supply of rural electricity from small hydroelectric power stations, and biogas, made any substantial contribution to solving the shortage.[49] State investments in forestry went down from 2 per cent of total state investments during the 1966-1970 period to 1.35 per cent during 1976-1980, and to only 1 per cent in the 1981-1985 plan.[50] In 1979 the Ministry of Forestry was re-established, and a Forestry Law promulgated with overly strict stipulations, for example, Article 29, stating that "*If collectives want to fell more than 10 cubic metres of timber a year, they have to ask permission from the county . . .*" but with no sanctions nor organs of control, so that since then the situation has gone completely out of control. According to the same law, "whether owned by the state or owned by a collective, scenic forests, protective forests, water and soil erosion protection forests, old forests and precious forests must all be managed by the state in a unified manner." However in most instances management of forests was essentially handed over to the production teams, with different provinces making different regulations. No-one seems to have bothered much about the law since then. Indiscriminate felling had been very serious in 1958, after the formation of the People's Communes; in the period after 1968, when food grain cultivation and self-sufficiency were stressed; and since 1978;[51] Indeed, the individualization of production under the new responsibility systems introduced recently by the Government cannot but weaken control and management of forest resources further.

Much more successful has been the Government's policy of stimulating tree planting along roads and near villages—a common goal is 100 trees per inhabitant. Although trees often compete to some extent with agricultural crops, they also serve to reduce wind velocity, improve the micro-climate, supply fuel to the villagers and strengthen embankments of roads and canals. The most extensive but only partially successful effort has been the creation of a shelterbelt along the Southern edge of the Inner Mongolian desert, the purpose being to stop the desert sand from encroaching on the pastures and farmland of the loess plateau and other parts of Northwest China. Altogether China has planted eight million hectares of protective forest belts.[52]

Apart from the forests for timber, fuel and protective forest belts, the greater economic freedom granted to farmers over the past few years has stimulated a considerable planting of orchards.

Plantations of chestnuts, walnuts, tea oil, tong oil, mulberry, and tea, do not or hardly compete with foodgrain or other crops, as they are usually planted on hillsides. The total area of orchards now amounts to 8.3 million hectares, and will certainly be expanded further in as much as they provide cash income to the farmer. Intercropping of those plantations with low crops or, in chestnut plantations, with grass, which cover the bare soil, may help to improve water and soil conservation as well as improve the microclimate, such as discussed in the Hainan island example. Care, however, is needed when removing the original vegetation. In particular the coastal areas in Southeast and South China, with their good climatic conditions, much unused hilly land, and access to foreign markets, should develop export crops.

Official data state that during the three years (1978-1981) the area sown to grain decreased by seven million hectares, yet grain output rose by fifteen million tons.[53] That suggests grain cultivation was abandoned primarily on low-yield fields or under disadvantageous conditions. For the last few years, official policy has supported diversification of production instead of a one-sided stress on grains. Thus the policy formulation reads: "Comprehensive development of agriculture, forestry, animal husbandry, sidelines and fishery." How long the trend will continue is ultimately dependent on foodgrain output and the national or local demands for self-sufficiency in grain. It is not easy to see, however, how local governments can influence grain output directly, as decisions on crop allocation have been taken out of their hands and the manipulation of grain prices remains a prerogative of the national government. The margin from moving away from self-sufficiency in grain is often very small, as there is little commodity grain for instance available, no more in 1979 than 14.7 per cent of total

Photo: Tiofoto/Stig Karlsson

The Changchun region of Kirin province: The land has been opened up to agriculture and trees planted along the roads.

production. Most of that does not enter the national market.

> "As for grain, the provinces must be the units. They must be largely self-supporting. Only Hunan province exports 3 per cent of its grain production, other provinces just 1 per cent. We must import from other countries grain, cotton and oil crops. It is rational to import grain and to raise cotton and edible oil production."[54]

That view was prevalent in 1980 but has since been called into question. An interesting proposal was made to concentrate state investments and efforts on China's "middle zone" of farmland consisting of some 23 million hectares of plain areas with irrigation facilities but which still had mediocre and unstable grain yields. Meanwhile in the Northwest the focus should be mainly on "state ecological capital construction"; while in the South, forestry and tropical crops should be developed.[55] The State Agricultural Commission proposed to strive for a foodgrain output of about 400 kg. per capita in the year 2,000, and to build large commodity grain bases in the Northeastern provinces, the middle and lower Yangzi river region, and to transform the Huang-Huai-Hai region into a cotton/oil crops/foodgrain production centre. Others saw solving the problem of grain shortage and the establishment of a socialist modernized agriculture as opposite goals in the short-term. A more orthodox Maoist position was that "China is backward and cannot change quickly . . . problems facing China are insufficient grain, energy shortage, a deteriorated environment, and unemployment"—the order seems significant.[56]

Such policy statements may be good enough for planners in Beijing, but they do not come to grips with many of the problems described in this article. If anything, one would hope that a socialist planned economy would have the ability to foresee and protect the long-term interests of its population and economy, and to act on them. However, the political system seems incapable of stopping the continuing destruction of the natural environment, through the activities of short-sighted farmers. The laws enacted recently for forest and environmental protection have been ineffective not only because of the lack of penalties for individuals and village authorities, and because of the lack of government control, but also because of objective factors: thus peasants have to live off too small an acreage of farmland in a very vulnerable natural environment.

Notes:

1. *Zhongguo Nongye Nianjian 1980*, Nongye Chubanshe, Beijing 1981, p.2. The under-reporting of farmland is due to several factors: evasion of rules concerning the extension of private plots, the tendency to strive after high unit yields in reports to higher authorities, laxity or wilful delay in reporting reclamation of wasteland and clearing of forests. Also, the distinction between farmland used for fodder or green fertilizer crops and pastures may not always have been clearly made.
2. *'The Ecological Balance and Agricultural Development'*, by Wang Gengjin, *Nongye Jingji Wenti* 1981 no.6.
3. The number of commune members was 807 million. State farm workers totalled another 4.8 million, and State forestry workers 0.5 million, *Zhongguo Nongye Nianjian 1980*. The *total* agricultural population constituted 84.6 per cent of China's population (in 1978), *Jingji Kexue* 1980 no.1, p.8.
4. During the period 1949-1977, 13.3 million ha. were used up for State capital construction projects, 10 million ha. for rural construction, and 3.3 million ha. became wasteland or pasture; altogether the farmland area was reduced by 31.1 million ha., according to *Nongye Jingji Wenti* 1981 no.1, p.47. Reservoirs have taken up 2 million ha., *ibidem* 1980 no.9, p.61.
5. *Nongye Jingji Wenti* 1981 no.1, p.47.
6. This shows in the low yields of State farms, which produced 3 per cent of China's grain output in 1980. A notable exception are the 1.9 million ha. of reclaimed lake areas along the Yangzi river, which are highly productive, Ma Hong and Sun Shangqing (ed.), *Zhongguo Jingji Jiegou Wenti Yanjiu*, Shijiazhuang 1981, p.151.
7. In 1980, 4 million ha. of farmland were marshy, 6.7 million ha. saline, 9.3 million ha. desertified and desiccated, 6.7 million ha. subject to serious water and soil erosion; 12 million ha. were low-productive red soil, *Zhongguo Nongye Nianjian* 1980, p.2. China had about 35 million ha. of farmland with grain yields below 1,125 kg/ha., *Nongye Jingji Wenti* 1981 no.6. In 1977, 40 per cent of China's farmland was deemed low productive, *Nongye Jingji Wenti* 1981 no.1, p.47.
8. According to *Zhongguo Jingji Nianjian 1980* from 1950 to 1959, each year less than 20 million ha. was struck by disaster; and during the six years 1972-1977 each year an average of more than 33 million ha. was struck. Disaster is usually defined as output being lower than 70 per cent of normal.
9. 32 per cent of China's farmland was considered to be highly productive in 1977, *Nongye Jingji Wenti* 1981 no.1, p.47. There are 25.3 million ha. of wet rice fields, and 22.4 million ha. of irrigated fields, *Zhongguo Nongye Dili Zonglun*, Beijing 1980, p.75-79. Of the latter, 4.5 million ha. are irrigated by pump wells, the remainder by surface water, *NCNA* Chinese July 27, 1978. 42 per cent is mechanically ploughed, but only 10% mechanically sown, *Beijing Home Service* Oct. 14, 1979. If we assume that chemical fertilizers are only used in irrigated areas, then the level of application almost tripled between 1972 and 1979, to some 1,200 kg. (20% N) per ha., *Zhongguo Nongye Nianjian* 1980. Cotton is grown almost exclusively in the irrigated areas of North China and of the Middle and Lower Yangzi Region. For the productivity of grain areas, see the map of county averages in 1971, *Zhongguo Nongye Dili Zonglun*, map 4-1, and E. B. Vermeer, *China*, Koninklyk Instituet voor de Tropen (Royal Tropical Institute), Amsterdam 1982, p.56.
10. See e.g. E.B. Vermeer, *'Comment'*, *China Quarterly* no. 81 (March 1980) on grain yields in Shandong in 1956 and 1978.
11. Ma Hong and Sun Shangqing (eds.), *Zhongguo Jingji Jiegou Wenti Yanjui*, p.500.
12. *Ibidem*, p.526. Capital construction, communications and utilities employed 5.8 million people; commerce, finance, science and culture 7.8 million people.
13. The State invested 47.3 billion *yuan* (1 yuan equals about US$ 0.50) in water conservancy work expenditure during 1949-1979, *Zhongguo Nongye Nianjian* 1980, p.25. Local self-paid investments in water conservancy were 50 billion yuan, Nongye Jingji Wenti 1981 no.2, p.4. State agricultural investment figure from *Nongye Jingji Wenti* 1980 no.8.
14. The estimate was made by Wang Renzhong for the average county of Wugong in the Wei River plain, Shaanxi, *Zhongguo Nongye Nianjian* 1980 p.172.
15. For reclamation and salinization problems in Xinjiang since 1949 see E. B. Vermeer, *Water Conservancy and Irrigation in China; social, economic and agrotechnical aspects*, Leiden 1977, p.206-210.
16. Zhu Zhenda, *'Problems Concerning the Development and Utilization Of the Interior Of the Great Taklamakan Desert'*, *Dili* 1961 no.4, p.156-157, 192; Nongye Chubanshe, *Zhongguo Nongye Dili Zonglun*, Beijing 1980, p.96.
17. Hang Qing, *'On the Deterioration Of the Water Quality In the Tarim Basin and Its Control After Reclamation'*, *Dili Xuebao* vol. 35 no.3., Sept. 1980.
18. See. O. J. Todd, *Two Decades in China*, Peking 1938; Huang Wenxi, *Soil and water conservation of the Yellow River Basin*, Yellow River Consulting Board, Studies on the Yellow River Project no.5., 1947; Teng Tzu-hui, *Multi-purpose Plan For Controlling the Yellow River and Exploiting Its Water Resources*, Beijing, FLP, 1955, for the early period. The average annual silt content of the Yellow River (Huanghe) is 36.5 kg. per

cubic metre at Shanxian, which is located where the Yellow River enters the North China Plain (i.e. upstream seen from Nanluohe). This is about 100 times the average silt load of the Xijiang in Guangdong.

19. Li Xueceng, *Huangtu Gaoyuan*, Beijing 1960; *Huanghe Zhongyou Dichu Shuitu Baochi Shouce*, Beijing 1959; Zhao Mingfu's comments on the Yellow River Middle Reaches Water and Soil Conservation Conference, *Shuili yu Dianli*, 1965 no.6 (Dec.) p.6-11; and articles in Renmin Ribao Nov. 26, 1978 and *Guangming Ribao* Jan. 3, 1979.
20. E. B. Vermeer, '*Income Differentials In Rural China*', *China Quarterly* no.89, March 1982, p.1-33.
21. Wang Gengjin, '*The Ecological Balance and Agricultural Development*', *Nongye Jingji Wenti* 1981 no.6.
22. From 1970 till 1976, the State provided 13 million *yuan* in relief funds, and bank debts amounted to 10 million *yuan*. In 1978, per capita collective income was only 29 *yuan*. From 1970 to 1977 a total of 600,000 tons of grain should have been paid in tax; instead, the State had to supply the county with 250,000 tons of grain. Wang Gengjin, 'The Ecological balance . . .', and *Guangming Ribao* Jan. 3, 1979.
23. . . . '*Changes In the Natural Environment Of the Sanjiang Plain, and Its Rational Exploitation*', *Dili Xuebao* Vol. 36 no.1, March 1981, p.33-45.
24. Nongye Chubanshe, *Zhongguo Nongye Dili Zonglun*, Beijing 1980, p.92-93.
25. According to *Zhongguo Nongye Nianjian* 1980, p.289-290, which uses a larger definition of the Sanjiang Plain, yearly precipitation during the 1975-1980 period went down to an average of only 300-400 mm. per year. But for the remainder of China this was a dry period as well, and there is no connection between reclamation and dry weather. As the Sanjing is a rather wet confluence, there is no danger of its becoming a 'dustbowl'. It is, nevertheless, concluded that the forests should be protected and increased to the Heilongjian average, because forests reduce wind velocity and improve the microclimate.
26. In Beijing, ground water resources amount to about 3 billion tons annually, of which 2.6 billion are tapped near saturation, Li Weiyao, '*Broad Prospects For the Development Of China's Ground Water*', *Renmin Ribao* Nov. 28, 1981.
27. Zhu Laidong, '*The Water Of Tianjin*', *Dili Zhishi* 1982 no.
28. The Northern half of the North China plain has the most severely polluted surface water in the whole of China, Zhang Li Cheng and Dong Wenjiang, *Huanjing Kexue* Vol.2 no.5 (Oct. 1981) p.71-74, map.
29. Zhu Laidong, op. cit.
30. *NCNA* Aug. 21, 1978; *Shandong Provincial Station*, Jan. 15, 1982. There are no details on how the silt problem will be handled.
31. Hubei originally had 870,000 ha. of lakes, but only 200,000 ha. were left in 1980, *Zhongguo Nongye Nianjian* 1980, p.213. The Dongtinghu Lake in Hunan was reduced from 700,000 ha. in 1870 to 435,000 ha. during the 'fifties. According to Ma Hong and Sun Shangqing, op.cit. p.151, in the six provinces along the Yangzi river 1.9 million ha. of lake surface were reclaimed until 1980.
32. *Renmin Ribao* April 5, 1979.
33. T. Woldai and W. B. Vermeer, '*Geomorphology and Land Use Of the Jianghan Plain and Surroundings, From Landsat Imagery*', *ITC Journal* 1979 no.4.
34. '*Reclamation Of Lakes, More Losses Than Profits*', *Zhongguo Nongye Nianjian* 1980, p.238-239. But other sources indicated a larger acreage, *NCNA* May 4, Nov. 9 and Dec. 23, 1961.
35. See E. B. Vermeer, *Water Conservancy . . .*, p.311-314; '*Has the Silt Load Of the Yangzi River Increased Or Not?*', *Nongye Jingji Wenti* 1980 no.12; *Xinhua* Sept. 19, 1980.
36. '*Reclamation Of Lakes, More Losses Than Profits*', *Zhongguo Nongye Nianjian* 1980, p.238-239.
37. *Ibidem* p.27-29. This was due also to newly built dams, industrial water pollution, agricultural pesticides etc.
38. *Dili Zhishi* 1982 no.3, p.14.
39. Yu Dechang, '*Some Ideas On the Control Of the Deterioration Of the Ecology Of Hainan Island and the Establishment Of a New Ecological System*', *Nongye Jingji Wenti* 1981 no.11, p.49-53.
40. *Ibidem.*
41. *Zhongguo Nongye Nianjian* 1980, p.283. Together with the expansion of rubber trees in Xishuangbanna and elsewhere to a total of 230,000 ha., China might then produce 550,000 to 700,000 tons per year. For a short description and map of China's natural rubber see *Dili Zhishi* 1982 no.7, p.4-6.
42. Since the 'fifties Leizhou Peninsula almost tripled its forest cover, to 23 per cent of its surface area in 1980, *Dili Zhishi* 1982 no.1, p.25. This had favourable effects on climate and production. Li Keliang, '*Forest Construction In Leizhou Peninsula*', *Nongye Jingji Wenti* 1982, no.8, p.23-25.
43. For present developments in Hainan, see *China Trader* March 1981, p.50-73.
44. Foreign exchange earnings in 1979 from exports of livestock products totalled 1.53 billion *yuan*, *Nongye Jingji Wenti* 1981 no.11, p.10-17; *Zhongguo Nongye Zianjian* 1980, p.331-332.
45. This point has been stressed recently, after the serious floods in the Yangzi river basin in 1980 and in Sichuan and Shaanxi in 1981, by He Xiwei. '*Has the Siltload Of the Yangzi River Increased Or Not?*', *Nongye Jingji Wenti* 1980 no.12, p.49-52, and '*A Discussion Of the Relation Between Forests and Water Conservancy, After the Flood Damage in Sichuan*', *ibidem*, 1981, no.12, p.3-8. It is shown that districts with a good forests cover suffer much less damage from rainstorms than those with little forest. In a controlled experiment, reforestation of a barren mountain led to a reduction of run-off by 70 per cent, and of silt by 99 per cent. Lowest and highest flow of the Minjiang river in Sichuan became much more extreme since the forest cover of its basin was reduced after 1949 by almost one-half, to 19 per cent now. During the 1975 floods in Henan two major reservoirs with a very weak forest cover in their upper reaches collapsed, while other reservoirs stood. Part of He's arguments were refuted in *Dili Zhishi* 1982 no.5.
46. Kong Fanwen, '*A Discussion On Forest Value and the Theoretic Price of Timber in China*', *Linye Kexue* 1982 no.2, p.177-184.
47. Timber stands average 79m³/ha. in China, as against a world average of 110m³/ha. Of its forestry reserves of 9.5 billion m³, only 3.5 billion m³ is considered to be usable. Yearly timber exploitation is 50 million m³, according to *Zhongguo Nongye Nianjian* 1980, p.16. Another source states that the volume of foret resources is 8.6 billion m³, of which one-half is available for logging, and that the actual logging volume comes to over 200 million m³ per year. Per inhabitant China has only one-eighth of an hectare of forest, against a world average of 1 ha. Timber growth per ha. is only 1.84 cubic metres, as against 3.1 in Japan, and 5.5 in West-Germany, Wang Gengjin, '*The Ecological Balance and Agricultural Development*', *Nongje Jingji Wenti* 1981 no.6.
48. Ma Hong and Sun Shangqin (ed.), *op. cit.* p.286. In 1978 the level of coal consumption for household use was 61 kg. per capita in rural China, and 409 kg. per capita in urban China, *ibidem* p.277. See also Rong Donggu '*The Relation Between Energy Consumption and National Development*', *Jingji Yanjiu* 1980 no.6, p.49-55.
49. Small hydroelectric power stations have been under political attack since 1979. In 1980, they supplied 11.9 billion kWh, or 37 per cent of total rural use. Half of their capacity was created during 1975-1979, at a State investment of 1.3 billion *yuan*, *Renmin Ribao* Feb. 17, 1981.
50. Li Zhankui e. a., '*Quickly Change the Passive Situation Of Concentrated Over-felling Of the Forests In Our Country's Main Forest Areas*', *Nongye Jingji Wenti* 1982 no.1, p.9-12.
51. 'The changeover from large collectives to small collectives may fit the present level of agricultural production forces, but after the authority over forests was turned over to the production teams . . . again the forests suffered large-scale destruction', *Nongye Jingji Wenti* 1981 no.1, p.7. In some provinces such as Yunnan, a premium of 750 *yuan* per hectare was give for reclamation of forest or wasteland. For each hectare which was afforested a premium of 3 to 15 *yuan* was given, *Zhongguo Nongye Nianjian*, 1980, p.217.
52. *Zhongguo Nongye Nianjian* 1980, p.2, 162-163.
53. *Xinhua* Domestic Service Dec. 31, 1981.
54. Ma Hong and Sun Shangqing, *op. cit.*, p.143, 159.
55. Weng Yongxi e. a. '*Views On Strategic Problems In China's Agricultural Development*', *Jingji Yanjiu* 1981, no.11, p.13-22.
56. '*A Discussion About Agricultural Development Strategy At the Beijing Conference Of the Chinese Agronomy Society (Feb. 26, 1982)*', *Nongye Jingji Wenti* 1982 no.4, p.50-54. The last view was put forward by Liu Zhideng of the Academy of Agricultural Sciences.

Dissident Science in West Germany

by Helmut Hirsch

Within the last five or six years, a new phenomenon has appeared in the scientific arena in West Germany. Whereas, "critical science" used to be a matter of discussion for theoreticians, who reflected on the shortcomings of traditional science and on possible alternatives, a number of institutes and groups have come into being, consisting mainly of comparatively young natural scientists who do not just reflect in their armchairs on 'critical', 'alternative', 'ecologically oriented' science, but who actually set out to practice their science in a way that is obviously different from established science.

Many of those institutes are members of an umbrella organisation, the AGÖF (Arbeitsgemeinschaft Ökologischer Forschungsinstitute), which has been in existence since 1980. With about 40 member institutes, AGÖF today represents about 1000 scientists. Roughly speaking, membership can be divided into three categories: Institutes in the strict sense of the word, carrying out research and public information work; associations of engineers, with a more technical orientation; and groups connected with universities.

The following account gives some idea of the activities of AGÖF members. Particular emphasis is put on the concept of science and on how science should be practised. Such ideas have grown out of the practical work of the institutes and are subject to continuous discussions within AGÖF. As AGÖF is genuinely undogmatic in its structure and aims, there is no rigid programme to which all the members have strictly to adhere. The outline given here is an account of the present state of development, and not as something final and determined.

The coming into being of most AGÖF member institutes was (and is) closely connected with the great social controversies concerning technological development, such controversies themselves strongly influencing the way in which scientists working in these institutes developed their concept of science. Many ecologically oriented scientists therefore became critical of established science when they realized that science often plays a considerable part in the conceptualisation, realisation and justification of large industrial projects. Thus at the political level, criticism and protest are silenced with scientific studies and reviews, which are presented as pure truth that stands above all criticism. At the scientific level, although shortcomings, errors and omissions may be found in those same studies, that discovery does not make any difference inasmuch as an open, fair discussion is generally impossible, well-founded arguments being countered through discrediting the person or the institute who utters them. Many AGÖF-institutes could tell dismal stories in this regard, as for example, when the Institut fur Energie und Umweltforschung in Heidelberg was once attacked as being 'scientifically criminal' for its work on the effects of low-level radiation.

Ecologically oriented scientists thus strongly reject that corruption of science as an instrument of political power, as equally they do the claim for absolute truth of established science. In effect ecologically oriented scientists regard science as an instrument, a tool, for enabling people, faced with concrete questions, to come to conclusions that can be usefully applied in a concrete situation. Without question the new science, as a tool, must be perfectly mastered—but even then with the realisation that 'objective truth' is possible only in isolated, relatively well-defined sub-areas of science.

In dealing with questions that include larger areas of natural science, the concept of truth must be seen as relative, scientific 'truth' in such instances being no more than a consensus of scientists working in the respective field. But wherever such a consensus does not exist and cannot be created in an open, rational discussion, it is often seemingly achieved, or rather forced, through discrediting certain opinions. It would be better for the development of science—as well as more honest—to accept, when the situation arises, the existence of different standpoints (different 'truths', if one likes to call them that) and to live with them until the controversy can be resolved.

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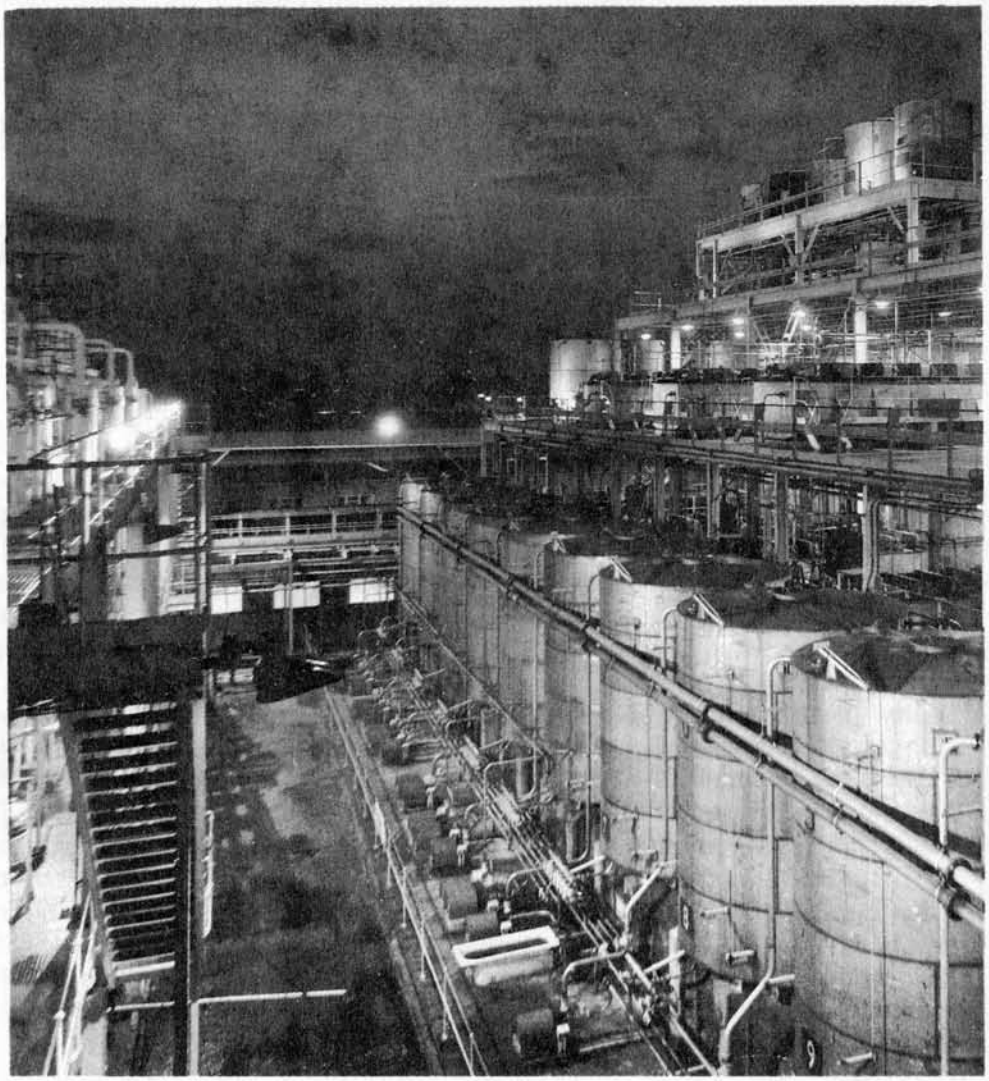
Indeed both in 'established' as well as in 'ecologically oriented' science, which methods to apply, which questions to deal with and which decisions to make, are determined not only by purely 'inner-scientific' motivations and considerations, they are also influenced by the personal history, interests, general philosophy and political conviction of the scientist and, last but by no means least, the institution in which he or she works, its structure, history, and ways of financing. Established science conceals this face behind its claim for absolute truth, and behind its claim, that its statements contain a 'better' truth than statements emanating from the non-scientific sphere of life. Ecologically oriented scientists, on the other hand, must always take the problem of relative truth into consideration openly and publicly.

In particular, ecologically oriented scientists recognize the limited validity of scientific results. They do not demand that their results must become the sole basis of action. They are willing to consider everyday-knowledge, which has not been gained by a scientific process, together with 'scientific' knowledge in their studies. Most important knowledge from everyday experience is not considered inferior to knowledge gained by scientific methods.

Meanwhile conventional scientists, whose aim is primarily to own, control and dominate nature, tend to divide reality in small sub-systems, which they then regard as closed systems, and to find out steering mechanisms. When applied to the social and natural reality, this tendency leads to deficits and negative effects, which through their appearance have finally contributed to the coming into being of ecologically oriented science and the ecological movement in general.

In ecologically oriented science, on the other hand, the tendency, in case of doubt, is to consider rather a larger, than a smaller part of reality as the system to be studied, and to overestimate, rather than underestimate, its interactions with its environment. The paradigm of ecologically oriented science is the open system. In that way, the importance of each individual case is increased, while the importance of general rules is decreased.



Nuclear Power—a dead-end technology

Topics and Methodology of ecologically oriented Science

The areas of work of AGÖF-institutes may roughly be divided into three parts: first, 'constructive' work, the development and study of concrete alternatives to existing technologies and plans; examples include the development of alternative energy technologies, and of new farming methods where artificial fertilizers and pesticides are avoided.

Second, 'conditionally critical' work, dealing with technologies which are not considered as wholly ecologically unsuitable, but which need considerable modifications and improvements to become acceptable; one part of such work is to study the effects of such technologies. Examples include the use of coal for electricity generation, where questions of unit size, advanced technology and sufficient off-gas cleaning arise; and the protection of ground water from contamination by certain household or industrial wastes where there is some difficulty in avoiding discharge.

Third, 'unconditionally critical' work, dealing with 'dead-end technologies' (Sackgassentechnologien), where every compromise would be an unacceptable compromise, and the aim must be to bring certain developments to an end. Nuclear power is a prime example of such a development: being not only one of the earliest topics on which ecologically oriented scientists were working, but one which, alas, will still keep many occupied. Large parts of the chemical industry can also be categorised as 'Sackgassentechnologie'.

In essence AGÖF is a very heterogenous association. Clearly, an engineer working on the development of simple but efficient solar collectors is in a very different situation from that of a physicist analysing potential radioactivity release sequences in a nuclear fuel reprocessing plant. Apart from sharing the same general goals, the two persons described will have little in common with regard to their work. In the 'critical' field—and in particular in the

scientific criticism of nuclear energy—the working methodology is rather academic, and not so dissimilar to that of established science. Consequently the situation is potentially dangerous inasmuch as ecological scientists may be pressed into the role of 'counter-experts', having to answer the other side's arguments in a highly detailed manner and thereby risking a contradiction with their own, alternative understanding of science.

The old, nigh on religious belief in science may live on in this way—fixed on a new team of scientists, but still based on the old claim of being in possession of an absolute, 'better' truth. So as to prevent a corruption of that sort, ecologically-oriented scientists working, for instance on nuclear energy problems, have to transcend the frame set by established science. In a way, they need a two-fold qualification: they must know their counterparts' area of expertise at least as well as they do; and, in addition, they must constantly take into consideration the limits of the scientific method; those very limits which established scientists generally like to forget.

In the nuclear controversy, the discussion is often centred around the question of whether certain technologies can be safely used or not—given the state of scientific knowledge available. Such a controversy is an obvious example of a question of both scientific and political character. In established science, where the basic desire is to see technology develop and flourish, scientists implicitly assume that an exact, mathematical description of the systems under study is possible with sufficient accuracy, and ask only *how* to do it. Ecologically oriented scientists in considering the complexity of real systems, ask first whether such an exact description is at all possible, usually coming to the answer 'no'. The thinking thus follows different basic patterns.

In many instances established science all too often displays unjustified optimism. Take, for example, radionuclide migration in a geologic formation. To date, no-one has been able to prove conclusively that the multiplicity of geochemical and physical processes occurring in the course of radionuclide interaction with the geologic medium can all be described by one single number—the absorption-distribution-coefficient. Nevertheless, that coefficient is used—for the simple reason that otherwise, calculations with mathematical models, where this coefficient plays a rather important role, would be impossible. Furthermore, ecologically oriented scientists are well aware that questions of a political nature should be explicitly included in their considerations. For instance questions of sabotage and war damage are usually omitted—an extremely weak point of official risk assessment studies.

Ecologically oriented scientists recognise the limited validity of scientific results and do not demand that their results become the sole basis of action

Despite criticisms of conventional science, increasingly the 'alternative scientists' working in the 'critical' area are establishing analytical chemical laboratories which have the equipment and necessary qualification to measure such pollutants as chlorinated hydrocarbons in human milk, heavy metals in soil samples, and nitrites and nitrates in drinking water. Depending on the source of the pollution, the criticism may be unconditional, as for instance concerning organic poisons discharged by the chemical industry, or may aim at lower limits being set for the concentration of certain substances, nitrates being a case in point. In 1981 the Bremer Umwelt-Institut thus launched its 'Rhine-Action' on account of alarmingly high concentrations of chlorinated hydrocarbons being found not only in the river itself, but also in ground water in supposedly protected areas, where the ground water was used for drinking water.

The approach used in the working method in the 'constructive' field is quite different. Theoretical studies, are of great importance here, such as that on soft energy paths for West Germany (Energiewende) carried out in the Öko-Institute in Freiburg. At least equally important on a daily basis, are projects realised in direct cooperation with interested and concerned citizens.

Ideally, the aim is for research work and practical projects to be in complete harmony with each other. A good example is a project at present under way in the author's institute, Gruppe Ökologie in Hanover The project has a scientific component—a doctoral thesis on the topic "Perspectives for Agricultural Development as Part of Ecologically-Oriented Regional Development"—and a practical component entailing the organisation of a cooperative with farmers from a peripheral rural area Luchow-Dannenberg, or 'Wendland', (a place marked out by the nuclear industry for its expansion) and consumers from the city of Hanover. Both parts supplement each other, and together form one project. Thus the theoretical idea of improving marketing conditions for agricultural products, while stimulating the conversion of farms to ecological farming, is actually being put into practice by the 'Wendland-Kooperative'.

A Citizens' Science

Most important to the concept is the active role of directly concerned citizens. Conventional planning science includes concepts of 'endogenous regional development'; thus embracing the notion of development of a region without an 'overpowering' influence from outside; an exception where outside influence is paramount entails the construction of large nuclear plants. But conventional planning science strongly emphasises the clear division of work between the planners and those who have to live according to those plans. Moreover it does not recognise the close union between researcher and concerned citizen, a process which is developing in AGÖF and becoming manifest in the engagement of scientists in the practical side of the work.

Meanwhile, another AGÖF-institute, IBEK in Karlsruhe has been developing concepts for household waste recycling and management. Although large industrial firms are

today active in this field, their approach is different from that of the ecologically oriented scientists and engineers who began by examining critically the amounts of wastes to be handled, and whose intention is to develop concepts whereby generation of waste is minimised. In contrast conventional engineers are more likely to find themselves working for an enterprise which needs to sell as many large plants as it possibly can. Indeed in the alternative system problems of waste partitioning, transport to central collecting stations are not seen as purely technological ones. Rather, the active cooperation of the citizens concerned, brought in at the design stage of the system, can give rise to solutions which are efficient, economic and give everyone an active role—rather than mindlessly forcing him/her along a way rigidly planned by technocrats.

Organisation of Work

Established science is usually organised into hierarchical and centralistic structures with a high degree of division of labour, leading to a veritable 'class system' entailing managers, scientists (with an intricate class system of their own), technical assistants, secretaries, skilled and unskilled labourers, and student helpers. Without doubt a strong 'structural sympathy' exists between such a system and the political and economic system it serves. Indeed, such a repressive environment, one that is hostile to many forms of creative initiative, may have provided motivation for many ecologically-oriented scientists to leave the system, in addition to their criticism of the way the results of science are used. Both points are closely linked: a scientist working increasingly as little more than a wage earner in a hierarchical system will obviously feel less and less responsible for his results and their application.

In a way, ecologically oriented science is not only supporting certain new social movements; it has also come to represent a new social movement within science. An ecologically oriented scientist regards questions of 'what is science' and 'how scientific work should be organised' as inseparably linked. Thus externally, science must not be used as an instrument of repression; and accordingly, institutes and working groups should be organised in a non-hierarchical way and be free of domination internally. Taking over 'technical' work such as cleaning equipment, typing and copying can help a scientist derive a more healthy and conscious awareness towards his or her work. Different personal histories, different degrees of knowledge and different psychic make-ups can make it extremely difficult for a group of scientific workers to develop ways of joint decision-making and problem-solving. However experience shows that it is possible to solve such problems, as long as there is sufficient readiness to take the task seriously and to invest time and energy. The end result is worth the effort as when a group gives support and security to each member, without restricting the individual's creativity or suppressing her or him in any other way, and where communication can take place and conflicts can be resolved without fear. Yet it must be emphasised, that the organisational structures of AGÖF member institutes vary greatly. Apart from relatively far developed alternative structures, models still exist that are very close to conventional hierarchies. In order that new models are developed it is essential for some personal continuity to exist over long periods of time. Problems can also arise if very different areas of work are combined in one institute. In particular, tensions can arise between 'constructive' and 'critical' workers; the former tending by the nature of their work to a great 'structural sympathy' for non-hierarchical organisation, whereas that of the latter tends more towards conventional structures.

Partners of ecologically oriented Science

By now it should be clear that ecologically oriented scientists have a rather different relationship to interested and concerned citizens, than those in established science. It is important for ecologically oriented science to deal with topics where citizens are engaged and in need of scientific expertise. The development of science is necessarily influenced by the interests of those for whom the situation works; and 'pure' science can, at best, exist in small, specialised fields. The important point is to make those influences clear to oneself and to others; with the consequence that the work becomes more transparent and more honest. Established science, on the other hand, tries to hide its links with political and economic interests. Indeed its partners include people from industry, politics and official institutions, including among the latter, those concerned with 'defence' and not, as for ecologically oriented science, those 'ordinary' people suffering under Industry and State projects.

Active cooperation of citizens can give rise to solutions which are efficient and economic rather than mindlessly forcing them along a way rigidly planned by technocrats.

Ecologically oriented scientists often make their findings known in ways that are considered unsuitable by those in established science: for example by press conferences or booklets and journals with large circulations, and not just in scientific journals read only by a small elite. That approach is one way of establishing and keeping contact with the general population. Yet AGÖF is not merely an 'appendix' of the ecological or peace movement. Those scientific studies, in which the results are predetermined according to the intentions of whatever group or institution, are not acceptable under any circumstances—regardless as to whether they are produced for an industrial enterprise or a citizen's group. Nevertheless inasmuch as the societal partners of ecological science are numerically strong, but economically rather weak, the danger of becoming corrupted by their interests is negligible.

Cooperation between ecologically oriented scientists and citizen's groups takes place daily, in many different ways, such as providing expertise for a law suit, holding lec-

tures, supporting the citizen's case in panel debates and hearings, but also giving advice for and taking part in 'constructive' projects.

Increasingly 'alternative' scientists are cooperating with political parties, and supporting their parliamentary work, in particular the Green Party, which is now represented in the Bundestag as well as most Landtage. AGÖF-institutes thus have the facilities to provide members of parliament with data and facts to use in their work, while in return MPs can use parliament to ensure that AGÖF's findings are made public. In addition one of AGÖF's tasks should be critically to evaluate parliamentary policy, pointing out important questions that have been neglected. Parliament can also be, for AGÖF-institutes, a means of getting information from the government.

In principle AGÖF is ready to cooperate with all parties. However, the readiness of the parties of the right (today, that includes F.D.P.) for such cooperation is practically nil. On the other hand contacts with individual social democrat politicians of high personal integrity are fairly well established. Nevertheless the party as a whole was rather unsympathetic towards AGÖF while it was in power, a situation that applied particularly to the social-liberal government. Since the end of 1982, the party has suddenly discovered the importance of 'ecology'. Therefore not surprisingly many ecologically oriented scientists view that sudden change of opinion with a certain suspicion.

AGÖF and public Opinion

With regard to public opinion, AGÖF chooses ways that are more direct than those of established science. Corresponding to the wide range of different working areas, the possibilities are many. For instance in the 'constructive' field, studies of a general nature often have a far-reaching echo in the media and even in state-institutions, as with the study by the Öko-Institute on soft energy parths, mentioned above, which was included in the work of the Enquete-Commission 'Future Nuclear Energy Policy' of the Bundestag. Projects like the 'Wendland-Kooperative' founded by Gruppe Ökologie on the other hand, first became known on a local basis, got publicity in local newspapers and by mouth-to-mouth communication, as well as by advertisements. In the 'critical' area, an effective way of reaching the public is to make known the scandalous situation prevailing at particular sites, as, for example when the Arbeitsgemeinschaft Hydrogeologie und Umweltschutz, Aachen, gave the results of its analysis of ground water pollution by a poisonous waste storage facility at Munchehagen near Hanover.

An important part of the work but one that is often extremely difficult to get across, pertains to providing soundly-based criticism of official programmes which have been set up ostensibly to solve problems but which, in fact, are often little more than diversionary activities. In that respect several AGÖF-institutes, are at present active, together with BBU (Bundesverband Burgerinitiativen Umweltschutz), in formulating radical measures to be taken against the dying of German forests, and in criticising the often less than half-hearted official efforts.

Concerning criticism of nuclear energy, AGÖF-institutes have had some spectacular successes with their studies on reactor safety, final disposal, reprocessing and the costs of nuclear electricity. The problem there, however, is that people tend to get tired of the debate which appears to go on and on. Moreover, since the factual problems to a large extent remain the same, so do the arguments, the result being a somewhat repetitive discussion. Thus, the interest of the press, the general public, even of some Green parliamentarians, and certain BBU-chairmen, is less than expected and hoped for. Still, the struggle obviously has to be carried on, at both the scientific and political level, as long as the nuclear programme continues.

Financial Problems

In principle, most members of AGÖF try to be as independent as possible of official funds. That situation may be achieved by several means; most important are studies and reviews that are paid for by citizen groups or environmental organizations and parties, as well as through donations (preferably in the form of a small regularly paid sum) from individual concerned citizens. That way of financing guarantees a maximum of independence and ties in well with the general principle of close cooperation with citizens. On the other hand, such an arrangement necessitates the readiness to work long hours for little money, with citizen groups often expecting miracles from ecological research institutes, such as the production of a full-scale risk analysis for a nuclear installation for DM 1,000 within one month. It is sometimes difficult to explain to such groups how scientific work is done and which resources are needed for a certain task. On the other hand, it is up to the institutes to consider how large a scientific infrastructure the ecological movement needs and can pay for; and to be careful not to create self-interested structures which then follow their own dynamics.

The sale of publications provides another source of funds, on the other hand those institutes that are more oriented to engineering work have the capability to carry out commercial projects, such as the planning of bio-gas-plants. Similarly certain

Planning and constructing a biogas plant is UTEC's chief work.

analytical laboratories, can perform analyses for customers, including small industrial firms. Such commercial work gives rise to problems inasmuch as potential buyers and customers are not always ecologically-minded and compromises may become necessary: for example should ecologically oriented engineers take on the contract to design a bio-gas-plant for a large farm, on which animals are kept in industrial feedlots, which is against the principles of those same engineers?

In addition, most AGÖF-institutes try to get financial support for projects from federal, state and communal funds. Yet the basic financing of the institute should never depend on such sources, and the conditions—regarding access to information, absence of influence on the results, and the freedom to publish—must be acceptable. With those conditions in mind, the expectation that taxpayer's money should go in part on ecologically oriented research is a justified one and one that should be regarded as an element in the democratic struggle for a research policy in the people's interest. Often, 'parallel research' is aimed at; that is the commissioning of two working groups, one belonging to established science, the other to AGÖF. If however equal access to information is not guaranteed, as is often the case, another approach is for a group of ecologically oriented scientists to analyse a study critically after its completion by an 'established' institution.

Those concepts—parallel research, and review—apply primarily to 'critical' work. In the constructive area, the first demand must be that sufficient funds are made available; thus federal spending on soft energy and conservation, which was never adequate, is actually decreasing under the new government. Important too, people must be made aware of the dangers of having the responsibility to organize alternative energy research placed in the hands of nuclear research centres, as has already happened, and that in other fields, too, the wolf is not appointed shepherd.

In the past few years, AGÖF institutes have had increasing difficulty in obtaining federal financing. That trend had already begun under the social-liberal government, but has become still more marked under the present conservative one.

Official research policy is characterised by cutting back on basic funds to institutions such as universities—where a small degree of freedom of choice in the work undertaken still exists—and increasing the project funding of institutions and research laboratories (Drittmittel-Finanzierung) where the scientists have no freedom at all. Furthermore, a megalomaniac technology also leads to gigantic long-term research and development efforts, as in the nuclear sector, so that funds are committed for a long time in advance and flexibility is greatly reduced. All that goes contrary to AGÖF's ideas of research policy. The presence of the Green party in the Bundestag at least provides an opportunity for discussions on this point to be forced in parliament and to obtain more information on the inner workings of the apparatus of research policy. It is doubtful, however, whether it will be possible really to achieve basic changes through parliamentary activity under present conditions.

A scientist working as a wage-earner in a hierarchical system will obviously feel less and less responsible for his results and their application.

Only a wide ranging coalition of AGÖF, of ecological and peace movements together with all their organizations, of the Green party and ecological forces in the other parties (as far as they can be taken seriously), of trade unions (contacts with which are gradually growing, but are still in a very early stage) and of churches will be of sufficient impact to bring about radical change. And such a coalition is hardly likely under present circumstances.

In short, the main characteristics of ecologically oriented research are as follows:

A highly critical attitude towards the concept of 'science'; in which models of thinking are partly different from those of established science, for instance with regard to paradigms of the open system, and having a sceptical attitude towards mathematical models.

Close cooperation and conscious partnership with the concerned population and its organisations.

A connection between the content of work and organisational structure, based on non-hierarchical models.

Taking up politically sensitive topics; and in particular the role of a controlling body where because of their close links with industry official institutions can no longer fulfill their role.

Note:
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AGÖF has no permanent office nor staff. The member institutes in turn take over the function of AGÖF-office, it being IBEK for 1984 and 1985. AGÖF publishes a newsletter five or six times per year which gives information on current activities, projects, publications, conferences, and serves as a forum for discussion. The newsletter (in German) can be ordered from the AGÖF-office. (see above)

Quinua: Grain of the Incas

by David F. Cusack

Quinua has long been shrouded in mystery, intimately connected with the land, the farming communities, and cultures of the descendants of the once mighty Inca Empire which ruled the Andes mountains prior to the arrival of the Spanish. It has been "discovered" and "rediscovered" many times in the intervening centuries by curious outsiders fascinated by its nutritional qualities, its hardiness, and brilliant colours that stand out against the bleak landscape and clear skies of the highest continuously farmed region of the earth, yet it has never been successfully propagated outside of the Andes.

It has survived four centuries of neglect and pressures against it, yet it is still an essential food crop for millions. Only recently have South American scientists, working with international support, begun to learn about quinua from the indigenous farmers and to study ways to improve its production and processing technology. It is now also recognized as a potentially important underutilized plant resource, especially for marginal Third World areas that are not food self-sufficient.

The author and several members of Sierra Blanca have known and appreciated quinua for many years. They decided in 1982 that now was the time to devote their talents to the study and propagation of this remarkable plant in close collaboration with South American scientists. They have successfully grown it in the Colorado Rockies where previous attempts had failed, their mission being to make the ancient grain of the Incas better known, to help its revival in the Andes, and to make it a viable alternative crop for farmers in the Rockies and other mountainous, cool, and semi-arid regions of the globe.

Quinua (or Quinoa, as it is often spelled in English) is the seed of the plant *Chenopodium quinoa* Willd. Quinua is called 'the Mother Grain' by the natives of the Andean altiplano. It is an annual herb of the goosefoot family and is related to the grain amaranth and lambsquarter or 'pigweed' of North America. It is most commonly grown at high altitudes throughout the Andes of South America especially in the altiplano and mountain valleys of Bolivia and southern Peru. Closely related Chenopods used for human and animal consumption are Canihua *(Chenopodium palidacuale)*, known as Kaniwa in Peru, which grows at even higher altitudes on the altiplano than quinua; and huauzontle *(Chenopodium nuttaliae)* which was grown extensively by the Aztecs in central Mexico but which has almost disappeared from modern day Mexico.

Quinua was a staple food of the Inca Empire. Figures 1 and 2 show the extent of the Inca Empire at its peak of power and the modern range of quinua production in South America. The two almost exactly coincide. The Inca, Garcilaso de la Vega, in his *Royal Commentaries on the Incas* (1609) writes that "Second place among the cereals which are grown on the surface of the earth (after maize) is given to what they call quinua"[1]. The descendants of the Inca Empire—eight to ten million Quechua and Aymara-speaking natives of the Andes from southern Colombia to northern Chile and Argentina—still use quinua as an important component of their daily diet and in some regions it is the principal staple.

Quinua plants vary in height from half to over two metres tall and come in a variety of colour pigments

from white, yellow, and pink to the darker reds, purples, and black. It has thick, strong, woody stalks and wide leaves that resemble—in shape—the foot of a goose (thus its name). The seed is small, round, and somewhat flat (similar to millet) and is produced in large clusters on the head of the plant (Figure 3).

The root system consists of many branches and capillaries off a central tap root approximately 12 inches long. It is a strong, extensive system rarely overturned by the wind and varies in depth according to the variety and height of the plant commonly reaching more than 24 inches and up to 48 inches on taller plants. This hardy plant can grow under harsh ecological conditions—high altitudes, relatively poor soils, low rainfall, and cold temperatures—which other major cereal grains cannot tolerate. For this reason quinua has remained the principal grain in regions of South America where corn and wheat do not grow well.

The seed is from two to three mm in diameter, there being between 250 to 500 seeds per gram. The pericarp of the seed of most varieties is covered with a resin containing two to six per cent saponin—a bitter substance with an unpleasant taste—which must be removed prior to human consumption. The traditional difficulties involved in the removal of this saponin plus the apparent ecological limitations to its cultivation and the nearly total lack of knowledge (until recently) of its agronomic qualities have long hampered quinua production and marketing.

Source: National Geographic Magazine, Cartographic Division, ed. Wilbur E. Garrett (National Geographic Society, Washington, D.C., March 1982).

FIGURE 1 The Inca Empire at its peak of power in the 16th Century.

Source: Based on Mario Tapia, et. al., Quinua y Kañiwa, Cultivos Andinos (Bogotá, CIID, Oficina Regional para la America Latina, 1979), pg. 16.

FIGURE 2 Distribution of quinua in South America (cultivated areas).

Nutritional Value

Quinua's nutritional qualities are well-documented. The Incas and their modern descendants honoured it because it gave strength for arduous work at high altitudes. Thanks to a number of nutritional analyses in recent years we now know why.

Because the seed of quinua (and other Chenopods) is not a true grain but rather a fruit it has been called a pseudo-cereal and even a pseudo-oilseed. This is because of its unusual composition and exceptional balance between oil, protein, and fat. Cereals store energy mainly as starch and protein; oilseeds store energy as fat and starch.

Table 1 compares the nutritional content of quinua with other common cereal grains.

The protein content of quinua is high, from two to six per cent above most wheats and even higher when compared to other cereals like barley, corn, and rice. More important than the percentage of protein however, is the *quality* of protein. In terms of amino acid balance, the quality determines what portion of the protein is fully utilised by the human or animal organism which consumes it. The essential amino acids

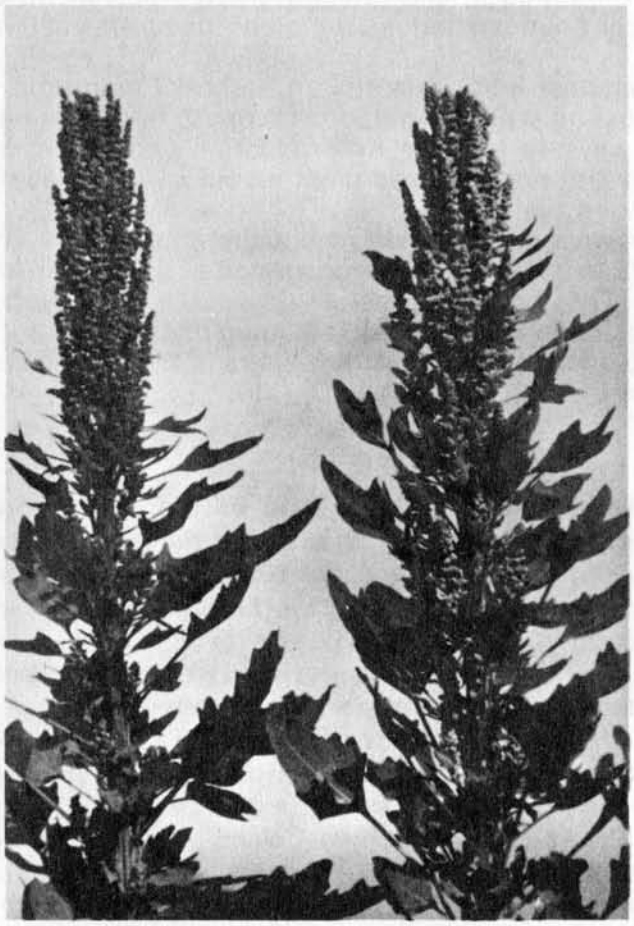

Photo: David F. Cusack

Fig.3. Quinua growing in San Luis Valley of South Central Colorado, USA.

Quinua originally had many different generic names in South America, depending on the tribal region. When the Spanish first arrived, the tribes of Quechua-speaking central Peru close to the Inca capital of Cuzco called it *quina*. Owing to the difficulty of pronunciation, the Spanish changed it to *quinua*. To this day, the natives of regions more distant from Cuzco still use their own names in addition to the hispanicized quinua. In Colombia, it is called *suba* and in some parts of northern Peru *chancas*. The Aymara-speaking inhabitants of the Lake Titicaca region call it *jupa*, and some of the Quechua speakers from central Bolivia to northern Chile *jiura*. In southern Chile, at the edge of the former Inca empire, the native mapuches call it *quingua*. To the Indians of the Altiplano, quinua has always been *la chisiya mama*, the Mother Grain. The German scientist Willdenow, the first person to classify it under the *Chenopodium* genus, latinized the original Spanish in giving it its scientific name *quinoa*. Generally the English-speaking world (and modern Chile) use the scientific 'o' spelling although the Spanish generic 'u' is being used with increasing frequency in the US and Great Britain.

are those that cannot be synthesised by the human organism and thus must be obtained from food sources. These are especially important for children in the early years of growth.

Table 2 compares quinua to wheat, soy, and to the Food and Agriculture Organisation of the United Nations (FAO) ideal reference pattern for evaluating proteins. Quinua is closer to the FAO ideal balance than any other common cereal grain and even compares favourably with soy which is valued for its high lysine content. Quinua is exceptionally high in lysine—a key essential amino acid—which is one of the most scarce in the vegetable kingdom. It is clearly superior in lysine than other cereal grains and comparable to major animal food sources. Most quinua varieties are also unusually high in the essential sulphur-bearing amino acids, methionine and cystine, which are particularly important for vegetarian diets as well as correcting deficiencies in legume diets.

Quinua is also very high in phosphorous, calcium, and iron in comparison to wheat and other cereals (Table 3). It is also high in Vitamin E and several of the B-complex vitamins.

TABLE 1. Nutritional Analysis Comparisons (%).

	Water	Protein	Fat	Carbo-hydrate	Fibre	Ash
Barley	11.1	8.2	1.0	78.8	0.5	0.9
Buckwheat	11.0	11.7	2.4	72.9	9.9	2.0
Corn	72.7	3.5	1.0	22.1	0.7	0.7
Millet	11.8	9.9	2.9	72.9	3.2	2.5
Oats	12.5	13.0	5.4	66.1	10.6	3.0
Quinua	11.4	16.2	6.9	63.9	3.5	3.3
Rice	12.0	7.5	1.9	77.4	0.9	1.2
Rye	11.0	9.4	1.0	77.9	0.4	0.7
Wheat	13.0	14.0	2.2	69.1	2.3	1.7

Source: After "Fact Sheet" by Stephen L. Gorad quoting U.S. Department of Agriculture figures compared to average figures for quinua (Boulder, Colorado, 1975). Unpublished.

TABLE 2. Essential Amino Acid Pattern (g/16g N) of Quinua compared to Wheat, Soy, and FAO Reference Pattern for Evaluating Proteins.

	Quinua	Wheat	Soy	FAO*
Isoleucine	4.0	3.8	4.7	4.0
Leucine	6.8	6.6	7.0	7.0
Lysine	5.1	2.5	6.3	5.5
Phenylalanine	4.6	4.5	4.6	
Tyrosine	3.8) 7.4	3.0) 7.5	3.6) 8.2	) 6.0
Cystine	2.4	2.2	1.4	
Methionine	2.2) 4.6	1.7) 3.9	1.4) 2.8	) 3.5
Threonine	3.7	2.9	3.9	4.0
Tryptophan	1.2	1.3	1.2	1.0
Valine	4.8	4.7	4.9	5.0
				*(1973)

Source: Johnson and Aguilera, *Processing Varieties of Oilseeds (Lupine and Quinoa)*, Table 6 (Report to Natural Fibres and Foods Commission of Texas, 1979-80).

TABLE 3. Comparative Mineral Values of Selected Cereals Per 100 Grams of Weight.

	Quinua	Wheat	Yellow Corn	White Rice
Calcium, mgr.	141.0	36.0	6.0	8.0
Phosphorus, mgr.	449.0	224.0	207.0	143.0
Iron, mgr.	6.6	4.6	3.7	—

Source: *Recetas a Base de Quinua*, 2nd ed., Ministerio de Agricultura, Servicio Cooperativo Inter-Americano de Produccion de Alimentos, October 1953.

All of these figures indicate that quinua is an excellent source of nutrition for humans and animals. While no single food can supply all of the essential life-sustaining nutrients, quinua comes as close as any other in the vegetable or animal kingdoms. White *et al.*[2] hold that the value of quinua protein for humans and experimental animals is at least equal to that of milk—one of the most highly valued food sources. It holds exceptional promise as a weaning food for infants, especially in nutritionally-deficient Third World areas.

The quality of quinua protein means that a higher percentage of it is absorbed by the human body and its high quantity means that more of its essential ingredients are supplied to the human diet. As put by Cardozo and Tapia[3], "If we take into account that quinua has a larger percentage of protein, . . . We can see that quinua offers a larger quantity of the essential amino acids than any other of the four most important cereals in the world (wheat, barley, oats, and corn)." Johnson and Aguilera[4] conclude that: "The unusually good balance of amino acids make quinua extremely attractive as a source of protein, and for use as a food ingredient."

Key advantages of quinua as a human food source are that its taste is good, it is easy to prepare, and it is versatile. A clean grain boiled for 20 minutes in two to one proportions of water to quinua produces an excellent dish with a light, distinctive flavour and a texture similar to barley or wild rice. In the Andes it is used in soups and mixed grain dishes and to make biscuits, compotes, and a popular drink called 'chicha blanca.' A Bolivian woman has put together a recipe book entitled *A Thousand Delicacies of Quinua*[5].

As Johnson and Aguilera[4] have shown unusual qualities of the tiny and cohesive quinua starch granule have been identified which may have important industrial uses. Even the bitter saponin which is discarded when the quinua is washed may have pharmaceutical and industrial uses which have not yet been discovered. In fact Andean women use the washwater as a hair cleanser and conditioner.

New Knowledge

As a result of investigations that have taken place over the past decade, researchers have identified at least 17 races and over 200 varieties of quinua in Peru, Bolivia, and Ecuador not taking into account southern Chile, Argentina, and some of the more isolated inter-Andean valleys. Since 1979, germ plasm-collecting expeditions have produced seed banks in Peru and Bolivia with over 1800 ecotype samples and related information on variety characteristics. These collections are the basic material for any future work with quinua. Small germ plasm collections also exist in Chile and have recently been established in Ecuador. With the support of the National Science Foundation, University of Texas, A & M biologist Dr Hugh Wilson is putting together an extensive US-based seed bank.

Gandarillas[6] has grouped quinua varieties according to their botanical characteristics and place of origin in the different inter-Andean valleys. Tapia[7] groups quinua varieties according to the four major

VALLEY QUINUA: These varieties were originally developed in the high Andean valleys of Peru, Ecuador, eastern Bolivia, and southern Colombia, at an altitude which varies from 7,000 to 13,000 feet. Most Andean valleys have a relatively long frost-free period (6-9 months), with 35 to 79cm of annual rainfall. This environment has produced varieties that are large (up to 2.5 metres in height) and slow-maturing (5 to 7 months). At lower elevations quinua competes with and is grown in association with corn, and at higher elevations with potatoes and barley.

ALTIPLANO QUINUA: These varieties were developed on and are adapted to the high mountain plains of southern Peru, western Bolivia, and northern Chile and Argentina, which are almost all above 12,000 feet altitude. Frost is a constant danger and the frost-free period is relatively short. Rainfall varies from a low of 10cm in the arid southern altiplano to 50cm around Lake Titicaca. This environment has produced varieties that are smaller (1 to 1.8 metres), mature relatively rapidly (4 to 5 months), have smaller, more compact seed heads, and are the most tolerant of cold temperatures, drought, and poor soils. Corn does not grow in this environment, and few other food crop competitors are as well adapted as quinua.

SALTFLAT QUINUA: These varieties are specially adapted to the extremely alkaline soils and arid conditions of the salt deposit areas of southern Bolivia, at altitudes of 10,000 to 12,000 feet. These varieties are slightly larger in size than Altiplano quinua, higher in saponin content and generally slower to mature, but equally tolerant to drought and cold. They are also very hardy, relatively salt tolerant, and usually high in protein content. No other food crop can compete with quinua in this harsh environment.

SEALEVEL QUINUA: These are varieties adapted to the cool, rainy, forested regions of southern Chile, where they were first observed by the Spanish conquerors. Unlike the quinua of the central Andes, these varieties grow well at close to sealevel and are adapted to the long summer daylength of high latitude. They have a medium maturing time, are similar in size and yield to most Altiplano varieties, and probably have relatively lower tolerance to cold and drought.

A possible fifth category in Tapia's system is SUBTROPICAL QUINUA, based on a recently discovered variety in the tropical low-altitude Yungas zone of Bolivia.

ecosystems centres of domestication (see box). His is a valuable classification system for growers and for those interested in transplanting to other regions of the world because of the different adaptive characteristics that have been developed over time in those distinct eco-regions. Wilson of Texas A & M is developing yet another classification system based on careful laboratory analysis and comparison with wild weed varieties and the Mexican huauzontle relative. Gandarillas[6] has further established that each altiplano zone requires certain varieties adapted to its particular environmental conditions for optimal productivity. Based on that principle, South American scientists are now orienting much of their work toward identifying and improving the yields of varieties adapted to specific conditions rather than to developing one or two high-yield varieties designed to replace traditional strains. The last few years have seen a notable increase in Spanish language publications on quinua and in the number of university departments and experimental stations that are dedicating resources to testing and improving quinua and its production technology.

Yields usually low under traditional farming conditions are improving considerably at experimental stations and on some farms (from 400-800 up to 2000-3000 lbs/acre or more). Significant improvements are being made to the costly and time-consuming traditional harvesting and processing technology.

The problems and myths that have led to the image of quinua as a crop inherently restricted to the South American Andes will be explored later on. What is clear is that quinua is well-adapted to the Andes where a tremendous need for more food and better nutritional balance already exists. Peruvian and Bolivian scientists agree that the total area of quinua production can be expanded many times in both countries, yet production has decreased notably since the 1940s and has barely held its own in the 1970s. While it has never lost its importance in subsistence farming communities it has not been able to compete in commercial markets.

Neither the shrinking range of quinua cultivation in this century nor the lack of strong commercial markets in the Andean countries reflect lack of production *potential* or deficient nutritional and culinary qualities of the grain.

The History of Quinua in South America: From the Incas to the Modern Era.

Quinua has been utilised as a food source in the Andes since 3000 BC and possibly longer.[7] Originally altiplano region of Peru and Bolivia was believed to be the centre of origin of quinua. While some researchers still believe in the specific-point-of-origin theory[6], others believe that the numerous finds at different archeological sites throughout the Andes from southern Colombia to southern Chile indicate that quinua may originally have been domesticated at many different sites[7].

Whatever its origin, it became identified with the expansion of the Inca Empire which dominated the Andes prior to the arrival of the Spaniards in 1532. Quinua was the pre-eminent food crop in the altiplano region because corn and other crops could not compete with it. Quinua's special adaptability to that high and harsh region has enabled it to maintain its comparative advantage during the four centuries since the Spanish conquest.

The power of the Incas was based on their army, their organisational talents, and one of the most productive agricultural systems in the ancient world which amply fed eight to ten million people. The exceptional agricultural productivity of the Inca system is attributed to several factors: 1, an elaborate terracing

system throughout the high mountain valleys; 2, a sophisticated irrigation and cultivation technology; 3, the development of a great variety of crops and subspecies each adapted to a specific ecological niche; and 4, an apparently highly accurate system of weather prediction based on extensive meteorological, astrological, and biological observations.[8]

The chroniclers of Francisco Pizarro's small army noted in their first campaign of conquest in 1532 that Inca storehouses were full all along their route. Potatoes, maize, and quinua were the three primary staple foods of the populations they encountered. The hundreds of varieties and subspecies of quinua that exist today are indications of the extent to which it was cultivated under the Incas' system and adapted to the many micro-climates of their mountain empire. The Inca himself with a golden-spaded *chaqui-taclla* (the principal cultivating tool of the Incas and of many modern-day indigenous Andean farmers) broke the soil and planted the first row of quinua at the start of each new season.[1,9]

From the moment of the Spanish conquest, the production of quinua and other Andean food crops began to decline. The Spaniards were interested in gold, silver, domination, and Catholicism but not in agriculture. To some degree quinua like amaranth—the religious ceremonial grain of the Aztecs—may have been actively suppressed because of its honoured position in the Incan society and religion.

The new Spanish landlords took over the fertile valley floors and the best grazing lands for their European livestock. They developed an irrigated agriculture on the arid coast near Lima and near other European population centres. Corn and potatoes were cultivated, improved, and exported but quinua—less known and less widely adaptable—was not. The indigenous farmers were relegated to the rocky, less fertile hillsides of the Andes and to the open plains of the altiplano where they continue to dominate agriculture to this day. They were forced to pay their masters with free labour and large portions of their meagre harvests.

Photo: David F. Cusack

An Inca instructor gives advice on proper cultivation techniques in Pre-Columbian agriculture.

From the time of independence from Spain in the 1820s until the 1940s, quinua and other Andean food crops held their own. While Andean farmers accepted and integrated into their farming systems European barley, cattle, sheep, and other crops and animals, they continued to maintain their native animals (llama, alpaca, vicuna) and well-adapted native strains of corn, potato, quinua, and other traditional crops which provided security and nutritional variety. Even today over ten million people from northern Chile and Argentina to southern Colombia still speak primarily their own non-Spanish languages and live by subsistence agriculture that is largely outside of the national economies.

After the 1930s the economic importance of Andean crops began to deteriorate further owing to factors external to the producing countries. Improved transportation and the advent on the world market of significant wheat production excesses in North America heralded the beginning of massive wheat importation into the Andean countries. The largely white upper and middle class urban populations quickly shifted to imported cereals and processed foods in preference to the unprestigious 'Indian food' of the Andes. Even now, quinua is still associated in the public's mind with the bitter saponin taste of the poorly cleaned open-market quinua.

During the late 1950s and 1960s Andean crops—particularly quinua—were further undermined by 'foreign aid' efforts to 'modernise' the traditional agricultural societies of Third World countries. The US Public Law 480 Program (Food for Peace) began to flood the 'underdeveloped' Andean countries with cheap, surplus US government-subsidised white flour, undercutting the still significant production of quinua and native wheat.[10]

The much-heralded Green Revolution and coincidental international drive to "modernise agriculture and increase productivity in the Third World" brought new pressures. Andean farmers were 'encouraged', often put under pressure, to abandon traditional crops in favour of high-yielding 'super crops' which would supposedly give them increased yields and bring them into the national cash-crop economies. A high price was paid for this move to 'modernisation' including loss of security because new crops were more vulnerable to climatic variation and disease; loss of land owing to small farmers' lack of capital to cultivate, fertilise, and manage the new crops; and loss of a way of life in the traditional Andean communities. Many areas also suffered a significant loss of genetic resource material owing to the replacement of traditional native crops with the new hybrids.

The Revival of Andean Food Crops and Farming Communities

Some of the failures of the Green Revolution have spurred a new orientation toward the food production problems of the developing countries. There is a new interest in identifying and preserving the genetic diversity of our planet's agricultural resource base, especially with regard to crops or varieties which are little known or in danger of disappearing. Many of the


Photo: David F. Cusack

Bolivian girls re-enact the sacred ritual of offering the fruits of the Quinua harvest to the Inca.

new high-yield hybrids have not worked well under environmental conditions different from those for which they were originally developed. In response to this many researchers are now placing new emphasis on improving crop adaptability to local agroclimatic environmental conditions. This has often meant working to improve the yields of traditional well-adapted native varieties rather than replacing them with new hybrids, especially in areas of great ecological diversity such as the tropic highlands. Climatic information and climate-defensive technologies as well as genetic and biological disease/pest resistance have also received renewed interest now that petrochemical fertilisers and pesticides are becoming more expensive and their often negative side-effects better known. These developments may give hardy food plants like quinua an important role in future agriculture.[11,12]

Such new thinking has coincided with the re-emergence of a large small-farm peasant-owned agricultural sector in the Andes as a result of agrarian reforms which began in Bolivia in the 1950s and in Peru, Ecuador, and Chile in the late 60s and early 70s. Many different organisational schemes have been imposed by agrarian reform agencies but the traditional Andean farming community has emerged in many areas as the most viable and best adapted institution. The structure of these communities, based on small private farms closely tied together by strong reciprocal relationships and communal hierarchy, is virtually unchanged since precolonial times.[6,13] These communities have existed in almost complete isolation from the national economies and until recently there was very little knowledge of their food crops or farming systems outside of the communities themselves. In spite of the often over-politicised agrarian reforms and imposed Green Revolution crops and technologies, these farming communities still represent the principal source of livelihood for some eight to nine million people in the Andean countries.*

Ironically, just as these communities are coming out of four centuries of isolation and political and social domination they are under greater pressure than ever before. Rapidly increasing population, over-exploitation of land, lack of governmental assistance, and increasing inroads by capital-intensive farming structures have put new stress on their historically strong social and cultural bases. Where farms have been consolidated and modernised with monoculture and machine technology, Andean food crops have tended to disappear along with the dissolution of the accompanying social organisation. Both the re-emergence of the communities and the new pressures on them have stimulated renewed interest in identifying, preserving, and studying native crops and indigenous technologies before they pass into oblivion.

One of the most important initiatives in support of this objective was the establishment of the International Congress on Andean Food Crops in 1977 under the sponsorship of the International Development Research Centre of Canada (IDRC) and the Inter-American Institute for Cooperation in Agriculture (IICA). The first Congress, held in Ayacucho, Peru, was able to bring together only a few persons, mostly from Peru and Bolivia, with any substantial knowledge of Andean food crops. The second, held in Riobamba, Ecuador in 1979, increased the number of persons to 40 and resulted in a recognition of the challenges that would be encountered and the assistance needed to preserve Andean food crops and

*In Peru, this sector contains 2.7 million persons in over 3,000 communities, representing a majority of the indigenous Andean population. Although it has the lowest per capita income in the country, it produces 50 per cent of the total annual food crop. There are another 2-3,000 traditional Andean communities in Bolivia and Ecuador (combined), representing close to 2 million persons in each country, with several hundred more in southern Colombia and northern Chile and Argentina.

support the farming communities. In 1982 in La Paz, Bolivia, 110 investigations were presented identifying almost all the food plants that could be considered Andean. The fourth Congress will be held in Pasto, Colombia in May 1984, anticipating over 200 representatives of all the Andean countries. With the growth of this Congress and the work on Andean food crops and farming systems that it has stimulated in the participating countries, a major neglected agricultural resource has finally (perhaps just in time) begun to receive the attention it deserves.

The most important quinua-producing region in South America is the Central Andes and altiplano of Peru and Bolivia. In terms of amount of land planted and total tonnage harvested, Peru has always been the largest producer of quinua. In recent decades, however, total tonnage has dropped close to the level of Bolivia. Quinua was even imported from Bolivia to satisfy local demand during the mid-1970s when Peruvian production reached its low and Bolivian its peak. The total area planted in Peru dropped from 47,000 hectares in 1951 to 32,000 in 1955 (36,000 metric tonnes), paralleling a period of rapid increase in North American wheat imports. The introduction of Green Revolution high-yield crops during the 1960s and early 1970s continued quinua's decline, reaching a low of 15,000 hectares in 1975. Since then, quinua cultivation has slowly recovered to the current level of about 25,000 hectares.

Tapia estimates that if Peru were to revive valley varieties and stimulate altiplano production, it could profitably cultivate 150,000 to 200,000 hectares of quinua, this of course assuming improvements in yield, processing technology, and urban consumer acceptance. In Peru, there is a notable difference between the agro-economies of quinua in the north and central valley regions and the southern altiplano. Peruvian valley quinua is similar to Colombian and Ecuadorean. Most of the national production drop has come in these regions which acutely felt the impact of the Green Revolution and the loss of coastal urban markets to imported wheat. Only the indigenous farmers of the Andean communities have continued to cultivate quinua, which they generally plant in association with corn in the lower valley floors, and interspersed with barley and fava beans at higher elevations.

The southern altiplano province of Puno cultivates fully 75 per cent of the total national land surface dedicated to quinua. Only here is it generally planted in single-crop fields, most often following a crop of potatoes which leaves unused nutrients and a soil texture appropriate to quinua. Quinua production and consumption in Peru has been affected more than in other countries by the cultural and geographic gap between rural mountain Indians and urban coastal whites, with the latter group's import-oriented consumer standards and lack of interest in indigenous food products. Traditional lack of government support for Andean crops research reflects the political priorities of the dominant coastal whites.

Quinua is relatively more important in Bolivia than in Peru because the altiplano and its indigenous cultures dominate Bolivia much more than they do Peru. Gandarillas[6] believes that quinua is "the only plant in the altiplano that can be cultivated extensively with relative environmental security. . . because only it can withstand the semi-arid and cold conditions of this zone." Because the environmentally imposed agricultural fate of the altiplano is so closely tied to quinua, production has been better able to withstand the impact of foreign food imports and Green Revolution crops and has received more support than in other countries from government and international agencies. Production in 1981 was 9,000 metric tonnes, near the average for the 1970s. The total cultivated land surface reached a high of 22,000 hectares in 1977 and has averaged around 18,000 since the early 70s[6].

In most years, more than half of Bolivia's production comes from the arid central and southern altiplano, where annual rainfall varies from four to fifteen inches. Since no other crop grows well in this region, quinua is the principal food crop, in some areas approaching monoculture. This area is quinua's stronghold, especially around the barren salt flats of southern Oruro and Potosi provinces. Here quinua cultivation is a way of life for the closely-knit Andean communities. It assumes a level of importance that the buffalo once had for the plains of Indians of North America, and probably best reflects the importance quinua once had at the times of the Incas.

Drought Resistence

The importance of maintaining quinua and other hardy native crops has been further dramatized by the devastating altiplano drought of 1982-83, the worst in Bolivia's history. As shown in Table 4, quinua production was the least affected of Bolivia's major crops, even though much of it is grown in the hardest hit areas. In some parts of Peru, the drier-than-normal weather even produced bumper yields of quinua.

TABLE 4. 1983 Crop Losses in Bolivia and Peru due to drought (As of June 30, with 1982—83 season harvests completed.)

	Tons Lost	Dollar Value (millions)	% of Total Nat'l Production
Bolivia			
Potatoes	587,378	180.5	66
Maize	112,476	19.4	25
Barley	33,286	6.3	54
Wheat	28,706	11.1	44
QUINUA	1,065	.4	7
Rice	25,095	6.3	29
Cassava	91,932	17.0	34
Veg & Fruit	147,918	28.7	40
Other	78,368	8.0	
Total	1,100,000	277.7	
Peru			
Potatoes	491,000	94.3	27
Maize	24,000	5.5	6
Barley	34,000	4.7	26
Wheat	5,500	1.0	
QUINUA	no loss	—	—
Olluco	16,500	3.8	48
Other		8.5	
Total	578,800	120.8	

Source: Latin America Weekly Report, 26 August 1983, WR-83-33, P. 9 (USAID estimates 30 June 1980).

The same quinua production, processing, and marketing blocks that plague other Andean countries work against the revival of quinua in Bolivia, but to a lesser degree. International and governmental support and financing can give quinua producers the edge they need to reinstate quinua as a vital part of Bolivia's agricultural economy.

In Argentina and Chile, quinua is also the primary staple crop in the northern mountain and altiplano areas bordering Bolivia. The indigenous Quechua-speaking populations and their agricultural systems are very similar to the southern Bolivians. They are also very isolated from white population centres and thus have received very little attention from their respective national governments.

The last significant quinua-growing area is the cold, rainy southern part of Chile. Here quinua has developed along very different lines from the rest of South America, producing a small dark grain well-adapted to cool, high latitude, low altitude conditions. It was first reported under cultivation by Spanish explorers in the mid-16th century in the Copiapó region at 27° south, and on the island of Chiloé at 43° south.[1] Aside from the altiplano, this is the only area in Chile of strong indigenous influence. The Araucanian Mapuche tribes, who were never conquered by the Incas nor by the Spaniards, apparently adopted quinua from the Incas sometime in the century before the Spanish arrival.

Quinua cultivation in Chile remained confined to subsistence, peasant agriculture until the late 60s, when farmers and researchers at the University of Concepción in the south began to investigate its extensive cultivation. A significant research and production programme got under way in the early 70s, supported by the socialist government of Salvador Allende. A number of farmers began to produce quinua on a commercial scale using modern farming technology. A bio-engineering laboratory was established at the university and it successfully developed an efficient cleaning and processing technology for quinua (and also for Andean lupine). By 1973, Chile was on the verge of establishing a viable commercial quinua industry in the south.

In 1974, government support collapsed as the new economic team of the military government which overthrew Allende withdrew agricultural subsidies from all but those products in which Chile had a comparative export advantage (especially wine and fruit). As the agrarian reform of the Allende years was dismantled, quinua production dropped, especially among small farmers. The commercial farmers continued to produce, but ran into a new problem: they were unable to develop a significant urban commercial market. In Chile, white urban centres around Santiago are much more isolated from the traditional quinua area than in Peru and Bolivia. Public knowledge and interest in quinua was extremely hard to establish, particularly under the policies of the new government. The small health food market was not enough to sustain large-scale commercial production. Although quinua production has again become relegated to subsistence farming and local consumption in the south and the north, commercial production could probably be easily re-established under different conditions.

The Challenge of Quinua Transplant and Propagation

It is often argued that if little-known food crops are not widely used outside of their local, traditional environment, it must be due to some inherent agronomic limitations or to lack of appeal for human consumption. Experience has shown that this is not the situation with other crops recently considered 'new'. Soybean and sorghum have risen from relative obscurity a few decades ago to world prominence; more recent successes are guayule, jojoba, and spirulina. Other 'new crops' have aroused immediate support and enthusiasm, only to fade when environmental, production, or marketing problems proved them to be unfeasible or unprofitable on a commercial scale.

Quinua's short day length requirement is one of the most important—and least substantiated—reasons put forth for lack of success outside the Andes. It has been frequently proposed, and widely propagated by a 1975 FAO publication[14], that quinua will only grow well in the cool, short (12 hour) day length of the tropical zone Andes[9]. A few unsuccessful attempts to grow quinua from the central Andes in the long day

length latitudes of North America and Europe (all at low altitude) have reinforced this myth without scientific evidence that long day length was the reason for failure.

In high mountain valleys of Colorado in 1982 we tried to compensate for 16-hour days by growing some plots in the shadow of mountain ranges, comparing these with other plots grown away from any sunlight-reducing obstructions. Without exception, the latter matured more rapidly and more fully than the former. The failure of experimental plantings in Pennsylvania and Minnesota may be due to other environmental or altitude-related factors, but probably not to day length. Quinua's long, productive adaptation to the high latitudes of southern Chile (27° to 43° south) is further evidence that this limitation is not inherent for quinua as a species. Equatorial varieties from Peru, Ecuador, and Colombia have not completely matured in Colorado, but this is clearly due more to their long vegetative cycle than to day length.

The exclusive high altitude restriction is a similar myth, dispelled by the Chilean sea level varieties and a recently discovered sub-tropical variety from the Bolivian Yungas. The most commonly grown and most productive varieties appear to be uniquely adapted over many centuries to high altitude environments, but even with this restriction there are ample areas in the Andes and in other mountainous regions of the world that could successfully cultivate quinua. Low altitude varieties could eventually be crossed with more productive altiplano varieties to increase the range.

Why is it that a civilization that fed its population so well, and grew up in such a difficult environment, finds its descendants of today in such a backward situation? This civilization will once again reconstruct its productive system. The least we can do is get to know it better.

Mario Tapia, 1982

A third reason given for the failure to transplant quinua is the length of its growing season, generally observed to be five to seven months in the Andes—too long for high altitude regions at higher latitudes. Once again, some altiplano (and possibly other) varieties have considerably shorter growing seasons. While it was once reported that quinua would grow well at high elevations in the United States but would never mature before being killed by winter cold[9], we have observed that several varieties mature and produce seed equally or more rapidly than they do on their native altiplano. Wilson[12] points out that the major reasons for failure to transplant have to do primarily with the limited number of varieties tested in different environments. Of over 2,000 ecotypes that exist from Colombia to Chile, only a few have been tried outside of the Andes (with at best random agroclimatic matching) prior to our Colorado experiments.

Quinua's traditional reputation for producing low yields 400 to 800kg per hectare often observed on Andean peasant farms—has been disproved on experimental farms using improved cultivation techniques. A number of references are made to individual test fields yielding as high as 5,000kg per hectare[15,7,1] which translates into 4,300 pounds per acre, or roughly 800 bushels (54.4lbs/bu). Up to 1,700 or even 2,000kg per hectare (1,400-1,700 lb/acre) under harsh dryland conditions and 3,500kg per hectare (3,000 lb/acre) with irrigation or ample rainfall are not uncommon. Increasing yield is a function of improved agronomy, breeding and improved cultivation techniques.

Despite these impressive results under ideal conditions, yield per unit of land is not the best measure of quinua's productivity. More important is its ability to produce under less than ideal conditions, often under extreme drought in heavily alkaline or saline soils where other crops cannot grow. Production per unit of land in a marginal area is a meaningless measurement, the only valid indicator being production compared to other crops under similar conditions. Yields per hectare on traditional Andean farms are low because 1, little effort was ever made to improve yields, and 2, among small farmers whose primary concerns are subsistence and security, dependability under adverse weather conditions is more important than high yield per land unit.

Wheat is the most commonly used crop for performance comparison with quinua. In the modern era (in South America) quinua has not been able to stand up against wheat as a staple grain because of low yields under traditional conditions, the extra cost associated with saponin cleaning, and the heterogeneity of the quinua seeds[1]. All of these agronomic problems are now capable of resolution. Morlon[16] points out that "to compare actual yields of quinua in which modern agronomic investigation is only at its beginning, with wheat may be of value for the farmer producing now, but is not valid for judging the potential of the two species"—because comparisons have never been carried out under technologically equivalent conditions.

Improved, well-adapted strains have been developed in Peru, Bolivia, and Chile. Breeding programmes in these three countries have aimed at obtaining high yield-per-hectare under difficult soil-climate con-

ditions, high protein and sulphur/lysine amino acid content of the seeds, even rates of maturity and seed head form, and resistance to shattering in order to allow mechanical harvesting.

Other breeding objectives are more controversial, especially the efforts in Bolivia and Peru to develop new saponin-free varieties. Apparently the new sweet varieties will cross-pollinate with dominant bitter varieties and will tend to lose their sweetness in subsequent regenerations. Morlon[16], in criticising over-enthusiastic promotion of the sweet Sajama, points out that campesinos could have selected for sweetness at any time over the past centuries but have not. They select to minimise the risks, including insect and bird predation against which bitterness is a good defence. As first priorities he proposes thorough study of the *raison d'etre* of campesino practices and cheaper and more efficient ways to clean the grain. Wilson[12] further warns of the dangers of genetic loss and displacement of native species if a genetically uniform strain is developed and pushed for commercial production throughout the altiplano.

Quinua in Colorado

In 1982 and 1983 we identified several dozen ecotype varieties from various regions of South America that appear to have characteristics that match the conditions of our high, semi-arid mountain valleys, mesas, and plains. Positive results have reconfirmed the soundness of this approach. Most varieties of quinua are clearly best adapted to high altitudes and cool (especially night time) temperatures. Some work better in one micro-climate than another, even within Colorado. In general, peasant-developed strains have adapted better than those from experimental stations. Andean genetic diversity, built up over centuries to provide security and quality food under a great variety of ecological conditions, is clearly our greatest asset for successful transplant. We may be able to move quickly to build a sophisticated breeding programme and to provide farmers in harsh agroclimatic regions of the Rocky Mountains with a productive alternative crop.

Technology transfer in this case is clearly a two-way process. International support has helped initiate the revival of research and experimentation with quinua and other little-known Andean crops. The work being carried on by South American scientists on experimental stations and in close communication with indigenous farmers is in turn the basis of any successful transplant to other regions of the world. As research and testing experience accumulates in Colorado and possibly other regions outside of the Andes, the results can be transferred back to help solve specific problems of production, processing, genetic improvement, and marketing in the Andean countries. The Andean campesino, the original source of seed and of information about quinua, can thus benefit from a successful transplant to another region of the world.

As we have seen, historical and cultural factors rather than any inherent problems with quinua have determined lack of marketing success in South

America. White urban dwellers in the Andean countries reject native foods because they are unfamiliar with them, unaccustomed to eating them, have little information about their qualities and methods of preparation, and are little inclined to find out about 'Indian' foods. Even in the areas of greatest quinua production of the altiplano it is unusual to find quinua served in a restaurant. The modern era of prepared foods, and radio and television commercials, has emphasised and reinforced the growing dependency on white flour and white rice and their products. Since much of the urban food industry in these countries is strongly influenced by multinational food companies and their subsidiaries, native food products must compete not only against ignorance and cultural prejudice but an international capital-intensive food system as well.

The reaction of indigenous Andean communities to these impediments has been to emphasise their own internal cohesion and economies, and interact even less with the urban middle-class sector—a tendency reinforced by the agrarian reforms of the 1960s and 1970s. A sudden end to centuries of exploitation does not inspire immediate confidence in the national food economy. The number of small subsistence farms in the Andes not producing for the urban markets has increased in recent years. Only a few enterprising peasant co-operatives and producers' associations have begun to venture into the area of preparing and processing their products for the urban markets.

Although lack of a cultivation tradition and complete unfamiliarity with quinua are greater problems in countries outside of the Andes, other countries do not face historical and cultural prejudices against quinua. If successful transplants can be made, quinua products may be readily accepted, moreover a developed country health food market is a logical place to introduce a new food crop like quinua, especially in view of its excellent nutritional quality. This considerable market ($2.4 billion in the United States) is made up of a clientele which values nutrition, is receptive to new products, and is intrigued by the unfamiliar and exotic. This market has been the starting point for the entry of many new products into the mainstream US market.

Opening a US market could be a positive stimulus for improving the South American market for quinua, which is the weakest link in the South American system. It can lead to increased consumer product variety and attractiveness, which in turn can have a significant demonstration impact on the urban populations of Andean countries. A Peruvian researcher once remarked that the shortest marketing route for quinua from Cuzco (the former capital of the Inca Empire) to Lima (the modern capital of Peru) may be through the US health food market. In a modern world interlocked by instant communications and mass media, increased consumer demand may be more easily transferred than sophisticated production and processing technology.

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For interested persons, the following publication is recommended: "Boletin de Cultivos Andinos"/Andean Food Crops Newsletter. Spanish version: Mario E. Tapia, Proyecto PISCA, Apartado 11185, Lima 14, Peru.
English version: David F. Cusack, editor, Sierra Blanca Associates, 75 Manhattan Drive, Suite 4, Boulder CO 80303 U.S.A.

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Nitrate and Cancer
— a broader view* —

by A. H. Walters

In a recently published paper[1] I described how, quite accidentally, I became involved in the modern nitrate controversy in relation to cancer causation. Briefly, the sequence of events was as follows: in August, 1982, I learned from Dr. Barbara Latto that a mutual friend, Dr. Geoffrey Taylor, was to address the McCarrison Society on September 11th, 1982. His subject was to be 'Nitrates, Nitrites, N-nitroso compounds and Cancer'. Since, in 1969-71 I had done some research which criticised the overuse of artificial fertilisers containing nitrates, Dr. Latto asked me if I would open the discussion. I readily agreed. Dr. Geoffrey Taylor had previously addressed the McCarrison Society Annual Conference at Oxford in 1980 when I was in the Chair. I recalled him as a very alert, spry person of considerable personal charisma. But, although I knew him well, at the meeting on September 11th, 1982, I failed to spot him.

In due course the Chairman announced that Dr. Taylor would now give his paper[2]. Then up rose a thin emaciated man, with sunken cheeks, skin very jaundiced and swollen ankles. His clothes literally hung on him. Here was an obvious case of terminal cancer. Yet, this dying man of 79 years stood for an hour and gave his lecture in a clear voice, his discourse illustrated by lantern slides. It was one of the bravest and most dedicated acts I have ever witnessed. A very moving and poignant occasion, the like of which I shall never see or hear again.

Dr. Taylor commenced his lecture with the words: "The work of Professor Helmut Vogtmann[3a & 3b] in Switzerland has shown that the addition of nitrates in artificial fertilisers leads to an increase of nitrate and water in plants and grass without an increase in the fibrous matrix, and a decline in their content of vitamin C." Dr. Taylor then continued: "Recently I discussed the problem of nitrates and tea with an ex-tea planter from Ceylon. The increasing use of nitrate fertilisers in tea gardens increases the yield dramatically, but, as with vegetables, it leads to an increase in nitrate and water content of tea leaves with a change of taste. Over three cwts of nitrate per acre are now commonly used in tea gardens."

At the domestic level, how frequently do we hear today of particularly elderly people complaining that tea does not taste the same as it used to? Dr. Taylor suggested that this was because of the uptake of excess nitrate into the tea leaf plants: whether or not that is so, has yet to be determined. Today, vegetables certainly grow faster and much bigger than in former times, which is due, of course, mainly to the application of artificial fertiliser to the soil in which they are grown. The uptake of excess nitrate into such plants I will deal with later.

Dr. Taylor was well aware of this problem. He concluded that human beings or animals eating such crops were ingesting excess nitrate. In the alimentary tract ingested nitrate can break down to nitrite which is a known toxic factor. Furthermore, in some exceptional circumstances, the nitrite can break down even further to nitrosamines (N-nitroso compounds) which are known to be potentially carcinogenic or cancer-producing.

The exceptional circumstances referred to (as far as is known at present) are when a person has no natural hydrochloric acid in the stomach. This condition is known as achlorhydria. It so happened that Dr. Taylor was an achlorhydric. Two years before giving his last lecture he was diagnosed as suffering from gastric cancer, for the treatment of which he underwent a gastrectomy operation. Thus, as a personal matter, he was well aware of the possible dangers of contracting gastric cancer in association with the ingestion of food or drink containing excess nitrates.

In fact, the final words of his last paper were: "I have written this brief personal note, as my own case may speed up these investigations, especially regarding the *total* quantities (of nitrate) in food and drink." In his lecture Dr. Taylor also drew attention to WHO having now officially recommended an upper limit of 50mg/1 of nitrate in drinking water. Most water authorities in the EEC and other developed countries

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*Address to the Annual General Meeting of the Farm and Food Society held at the Farmers Club, 3 Whitehall Court, London SW1 on October 29th, 1983.

endeavour to adhere to those recommendations. But, apart from Switzerland, there has been no attempt to set a similar upper limit for nitrates in foodstuffs. The levels of nitrates in water and food are likely to rise with the increasing use of nitrates in artificial fertilisers, but in the UK there is still no definitely defined safe nitrate level or threshold. One month after delivering his last lecture Dr. Taylor died. Before he passed on he asked me personally if I would do what I could to continue the work he had so vividly described. He made this request of me because he was aware, as mentioned earlier, that twelve years previously I had indicated the possible dangers which might arise if the use of artificial fertilisers was not controlled[4].

Earlier Work on Excess Nitrates

Prior to 1970, the general concensus of opinion was that under what was then considered as normal farming conditions, at least in Europe, the amounts of nitrate added to soil were not excessive. However, by then, experiments had already been done in the Netherlands, Germany, USA, and UK on hay, silage, grass, sugarbeet, turnips, maize, cocksfoot, rape and green oats. Those tests showed that where either none or only a light dressing of nitrate (up to 60 kg/h) had been applied, the uptake and retention of nitrate in the plants was averagely of the order of 0.005-0.05 per cent nitrate-N.

By contrast, when, under similar conditions, the application of nitrate had been medium to intensive (80-300 kg/h) the uptake of nitrate into the plants had been up to ten times higher, namely 0.5 per cent. Sometimes, according to the type and variety of the crops, the terrain, husbandry, and weather conditions, the nitrate content in the plants was even higher. In an area in New Zealand, where geological nitrate abounded naturally, some crops grown in that region showed very high nitrate uptake.

So, from this and other evidence available by 1970, it was quite clear that the application of increasing quantities of artificial fertiliser to soil would result in increased uptake of nitrate into plants.

Animal Consumption of Nitrate and Nitrite

As long ago as 1957, in the USA, the possible dangers of feeding high nitrate content plants to animals, if not to humans, were recognised. Breakdown from nitrate to nitrite as a toxic factor had been observed in pig-feed mixed with water with a high nitrate content, and in minced grass mixtures used in moist feeds. In the rumen of animals, the rapid conversion of nitrate to nitrite was clearly established as being due to microbial action. Some animals, however, appear to tolerate nitrate/nitrite conversion very well, while others appear to be nitrite sensitive. Much seems to depend on age, the breed, husbandry and the type and method of make-up of the feeds. For instance, when beet leaves have a high nitrate content their accompanying high sugar content appears to nullify, to some extent, the breakdown to nitrite. On the other hand, nitrate-rich swedes carry little or no oxidisable substances, hence breakdown from nitrate to nitrite may be rapid. When such stored swedes are fed to sensitive animals they may be seriously adversely affected.

Ingested nitrate/nitrite destroys vitamins A and E and may also give rise to mineral imbalances and hormone disturbances in sensitive animals. In the great drought year, 1954, in the USA, significant nitrate levels built up in plants, particularly maize and green oats. When used for silage, the nitrate broke down to nitrite and during fermentation nitric acid was formed. This caused carotene breakdown together with acidification of the silage. Sensitive animals eating such silage woud tend to develop a low-grade toxaemia which would lead to a decline in productivity.

In the *Farm Quarterly*/Winter 1963-64 (USA), there is a report of a farmer whose whole herd was eventually wiped out as a result of feeding 'drought-grown corn silage that was loaded with nitrates'. Because in such silage the vitamin A and carotene levels are low or absent, when it is fed during winter it causes a progressive lowering of vitamin A storage in the liver of the animals. If, during the following spring, this deficiency is not remedied, sensitive animals may suffer during the next summer.

Nitrate and nitrite poisoning of sheep has been reported, and in 1963 observations were published on the development of methaemoglobinaemia in chicks due to feeding them nitrite. In the chicks the vitamin A stored in the liver was also depleted and the thyroid weight diminished. More such evidence was to hand[4].

Early Official Recognition of the Nitrate Problem

In 1970, the first official recognition of the nitrate problem came from the USA where a Committee on Nitrate Accumulation was set up. This Committee comprised eleven members and was chaired by Dr. Martin Alexander, Cornell University. Five members came from various American universities, three from other State institutions, and one from industry. In addition, twenty-four persons from research laboratories and industry in the USA were invited to provide information to the Committee, and one from outside USA, namely myself. This gives some idea of the amount of Government-sponsored research and interest that was available from the rest of the world at that time. The answer is none.

However, in 1972, under the aegis of the National Academy of Sciences, USA, the Committee issued a considerable report entitled 'Accumulation of Nitrate'.[5] Over 200 references to published work were included, over 90 per cent of which related to American work. Nevertheless, some of the papers quoted, including my own, which had 186 references, added in reports from many other sources round the world.

While this Report, the first of its kind, was brilliantly compiled and presented, it was, like many such Government-sponsored efforts, very carefully phrased so as not to rock the economic or the political boat. But read carefully, it revealed, here and there, unexpected recommendations such as 'The long-term benefits of incorporating organic manures into soils as a means of recycling nitrogen should be assessed' (p.45). This was written in 1972. In 1980, the US Department of Agriculture's Report and Recommendations on Organic Farming[6] indi-

cates that in US, organic farming represents about 0.5 per cent of the total agricultural industry of the country.

The Report includes a table showing the nitrate content of vegetables grown in 1963 and 1964 analysed direct from the field, and a similar range purchased from shops in Missouri. The results confirmed what had already been found in other crops. There were low nitrate values in vegetables grown in soil receiving modest amounts or no artificial fertiliser, while those grown in soil dosed with up to 400 kg/h showed a nitrate content up to ten times greater. Furthermore, the Report states that beets, celery, lettuce, radishes, kale, mustard cress and collards may all 'accumulate large quantities of nitrate.'

On the other hand, it was shown that nitrite was generally found in very small quantities in the fresh and processed vegetables (p.47). It was noted that 'Nitrite is not commonly found in packaged fresh spinach, but it may appear after storage at room temperatures or in the refrigerator. Similarly, nitrite although not found in canned spinach, when opened, may form in open cans of spinach or in frozen spinach allowed to thaw.'

This raises the question of where did this nitrite come from? In the case of vegetables, the soil micro-organisms break down the excess nitrate taken up into the plant tissue to nitrite. So, the longer such harvested vegetables are stored and transported at room temperature, the greater the opportunity for the micro-organisms (as Aubert has shown for nitrite to be produced).[7]

For many years now, particularly in the USA, vegetables have been harvested mechanically, and, in many cases, immediately washed, packaged and refrigerated. They are then kept as far as possible at low temperature up to the point of sale. This keeps them looking fresh and retards nitrite production within them. This also explains what happened when cans of spinach were opened and left at room temperature or when frozen spinach was allowed to thaw. As soon as the temperature rose and the products were exposed to the air, the micro-organisms became activated and proceeded to break down nitrate to nitrite.

Table 1. Spinach at the time of harvesting and after 4 days of transporting and storage.

Quantity of N fertiliser	at Harvest time		After 4 days of Transport & Storage	
(kg/N/ha)	Nitrates (mg/kg)	Nitrites (mg/kg)	Nitrates (mg/kg)	Nitrites (mg/kg)
0	173	0.5	146	3.6
80	439	1.8	540	13.1
160	1449	3.9	1485	205.0
320	3482	3.0	2557	355.0

Nitrates in Vegetables by Claude Aubert (1982), Natur et Progres, Publication de l'association Europeene d'agriculture et d'hygiene biologiques, 76, 18.

This official Report confirms that animals have become ill or died after consuming feed or water containing high concentrations of nitrite, and that the losses are greatest in drought-affected areas. While such droughts do not normally occur in Europe, nevertheless under such conditions ingested nitrate and nitrite can be a killer. In a single year in the US the losses may number in the thousands.

The Report notes that the chronic effects of nitrate and nitrite are not so well documented as are the acute effects. However, several patterns of reduced productivity have been identified as being the result of long-term exposure to nitrate and/or nitrite. As already mentioned, it is acknowledged that the sensitivity of animals to sub-lethal doses is variable.

The new-born pig is probably as sensitive as the human infant. In both instances, when nitrate is consumed it breaks down to nitrite which leads directly on to methaemoglobinaemia, as has been noted in the case of chicks. Very young babies and animals in the early days usually have no gastric hydrochloric acid, and this accounts, to some extent, for their sensitivity, especially to nitrite.

The Report also confirms that when nitrate has been fed experimentally to sheep, cattle, horses, pigs, rabbits, dogs, lambs, guineapigs and rats, in the young animals methaemoglobinaemia has developed. In older animals receiving even higher doses, death has resulted. These are, of course, extreme circumstances, but they serve to show the links between the application of excess nitrate to soil, its uptake into plants, the breakdown to nitrite, and the illness possibly affecting those animals and humans who may be sensitive.

Nitrosamines and Potential Cancer-producing Effects

We are already aware that nitrates, after breaking down to nitrites, may finally break down to nitrosamines. In 1954, it was first observed that dimethyl-nitrosamines when used in industrial laboratories could cause acute or sub-acute effects on exposed personnel[8]. During the next twelve years it was shown that many of the nitrosamines when fed to rats in extremely small doses, such as 2ppm, could induce malignant tumours.

Various workers then reported that the nitrosamines vary in their ability to produce cancers in animals, and also that the organs affected varied. In rats, nitrosamine-induced cancers were also produced experimentally in the kidneys, bladder, nasal sinuses, lungs and bronchii, the oesophagus, stomach, intestine, the nervous system and the skin.

In humans it was noticed that in Transkei there was a high incidence of oesophageal cancer among Bantu men. Here, dimethylnitrosamine was found in the fruit of a solanaceous bush, the juice of which was used to curdle milk. In Zambia, cancer of the oesophagus had been tentatively linked to the drinking of locally distilled spirits (kachasu) which contain dimethylnitrosamine at 1-3 ppm. If fed to rats this concentration would produce cancer.

Another possible sequence might be that of nitrate breaking down to

nitrite in the upper alimentary tract, and then the bacteria in the gastro-intestinal canal could attack the tertiary amines and so produce secondary amines which are carcinogenic.

In an epidemiological survey, Dr. P. Fraser *et al* (1980)[9] observed that "In Chile, although there is a strong association between fertiliser usage and gastric cancer mortality, this does not constitute definite evidence of causation in the absence of estimates of total nitrate intake in areas of differing risk. Even in Colombia, where the evidence for a link between gastric cancer and high nitrate ingestion is most persuasive, the nitrate levels in well water showed considerable variation and the number of wells was small."

Such cautious ambivalence comes naturally to the epidemiologist. But, of necessity, such surveys are highly specific, and so may not influence the taking of decisions based on evidence obtained from a broader overall view. In fact, the Accumulation of Nitrate Report stated 'Little is known about the levels of nitrosamines that may be hazardous to humans'. And that there was an appalling lack of information on 'the importance of nitrosamines in nature and in foods; the formation of nitrosamines in the gastro-intestinal tract; and the sub-clinical hazards, if any, to man and animals arising from the consumption of water and food containing modest concentrations of nitrate.'

Additionally, the Report makes an interesting comment on hypertension. It quotes the studies of Weiss and others (1937)[10] in which a dose of 36mg of nitrate was given to men which resulted in increased heart rate, decreased blood pressure and circulatory collapse. Similar observations were made on sheep.

In this connection, in the International Register of Potentially Toxic Chemicals (UNEP, Oct. 1982) the following notice appeared: 'Potassium nitrate. Having regard to their obsolescence in clinical medicine and the *potential carcinogenic* risk attached to excessive use of nitrates, medicinal preparations of potassium nitrate were withdrawn from the market in France as from January, 1981.'[11]

Thus, regarding the uptake of excess nitrate into plants, the important factor must be for the nitrate content in foods to be kept within internationally agreed limits. This is precisely what Dr. Geoffrey Taylor was asking for: but, to date, it appears that only one country, Switzerland, has set such legal limits within the law.

This is a great step forward. I understand from Professor Vogtmann that in Switzerland vegetables are now monitored by random sampling, and if found to contain nitrate or nitrite above the permitted levels, such foodstuffs are withdrawn from sale. Indeed, for many years, Switzerland has been in the forefront of research in many aspects of environmental pollution control.

In Switzerland vegetables are now monitored by random sampling and if found to contain nitrate or nitrite above the permitted levels, such foodstuffs are withdrawn from sale.

Historically, in 1972, I was invited by WHO/IRC to give a paper at the Technical University in Zürich[12]. There I dealt with the uptake of excess nitrate into plants, and, after ingestion, the effects of breakdown to nitrite and nitrosamines in animals and humans. I made special mention of the onset of methaemoglobinaemia and the possible connections between nitrosamines and cancer. Attention was drawn to the fact that, at that time, very little government money, if any, was spent in the UK on independent research into the effects of nitrate in foods or into the economics of waste recycling.

However, my pleas did not fall on deaf ears in Switzerland. There, over the intervening years, results of research such as I advocated have now resulted in the institution of maximum nitrate levels for vegetables, as already mentioned.

The Present Position

Modern farming, that is agrochemical oil energy-consuming so-called 'conventional' farming, being what it is, must be reliant, to some degree, on artificial fertilisers. That has always been acknowledged—until, if and when, suitable alternatives become economically available. But, since 1970, I have consistently opposed the folly of *excessive* use of nitrates.

According to the House of Lords Select Committee on the European Communities 1st Report, 1983-84[13], the artificial fertiliser bill in the UK now runs at about £800 million per annum. In 1970, it was of the order of £300 million per annum. Even allowing for inflation these figures speak for themselves.

We have seen that a great deal of scientific information was freely to hand at least twelve years before Dr. Geoffrey Taylor gave his last paper. Therefore, through their scientists, successive Governments must have been well aware of the true situation. Obviously, for economic and political reasons they have chosen not to heed the clear warnings given so long ago.

At present, the highly specific case of the nitrate and gastric cancer controversy is being used to mask the true issue in the broader view. The 'official position' in the UK was neatly summed up by Dr. D.D. Bryson[14]. Speaking at the Fertiliser Manufacturers' Association Seminar held in London, April, 1983, he said, "The incidence of stomach cancer is significantly greater in males than females. Since, in general, both consume similar food and drink it does not seem likely that the intake of nitrates in food and drink is an important cause of stomach cancer. The incidence of stomach cancer is steadily decreasing on a worldwide basis. Since, in general, *nitrates in the environment are increasing* as everyone moves towards a more efficient and *intensive agriculture*, it would be reasonable to conclude that whatever causes stomach cancer it is most unlikely to be nitrates."

In the face of present uncertainty regarding cancer causation *in toto*, such a simplistic explanation is beyond my comprehension.

Between 1968 and 1978 some 700,000 deaths from cancer arose in England and Wales. A cartographical study of this period, shortly to be

published, will show that the distribution patterns are still very puzzling. For instance, Liverpool, Salford and Jarrow, all have high death rates in men and women from cancer of the lung and stomach which are the two biggest killers. In other areas this may not apply at all. During my working life of over fifty years I have seen many people die of cancer. Hence, taking the evidence now becoming available, I feel very strongly that no stone should be left unturned, and no clue, however slender, disregarded regarding the cause of cancer of any type. I submit that excessive nitrates are suspect, and, since nitrates in the environment are increasing, further research is necessary. The question arises, when is a state of nitrate pollution reached?

Lead Pollution vis-a-vis Nitrate Pollution

Dr. Bryson's opinions are doubtless based on the results of annual returns and epidemiological surveys. As in the case of double-blind trials, owing to the operation of unknown parameters, many workers, especially clinicians, are now viewing such results with considerable caution, if not suspicion. A liberal, informed, overall and broader view of a problem will always eventually modify, if not defeat conclusions derived from specific statistical surveys.

For example, take the problem of lead as an environmental pollutant in the atmosphere of towns. Hitherto, it has been postulated by some that the most important aspect is its effect on the intelligence of children so exposed. There will shortly be published three independent surveys which will show that in three large inner city areas in UK there is no statistical evidence to indicate that the intelligence of local children is affected to any significant extent by lead fumes.

While being aware of these findings, the Royal Commission on Lead in the Environment (9th Report, 1983) states that lead is a pollutant 'because of large quantities released into the environment, its persistence and widespread and potential toxicity to life.' The UK Government has accepted this view and has endorsed the compulsory reduction of lead in petrol from 0.4 to 0.15g/l by the end of 1985[15].

Similarly, despite the fact that the case of ingested nitrate derived from food possibly causing gastric or any other type of cancer, and possibly other illnesses in sensitive persons is not statistically proven, it is hoped that overall clinical judgment and commonsense assessment will eventually prevail. Then, EEC governments will be able to endorse the compulsory reduction and control of the use of artificial fertilisers.

Excess is the True Problem

Even if Dr. Bryson's opinions should turn out, in some measure, to be correct—albeit for the wrong reasons—the principal problem is not the causation of gastric cancer. In Europe, owing to the EEC Common Agriculture Policy the real problem is firstly over-production. This turns on over-subsidisation which makes possible the continued flagrant excessive use of artificial fertilisers and the herbicides and pesticides that go with them.

Dr. Bryson extolled the move towards a more efficient and intensive agriculture. Within the context of the EEC, what has this meant? The answer was perhaps best put by Richard Lindley on a recent BBC Panorama programme who said: "Like farmers throughout the EEC, UK farmers are producing more food than we could possibly eat and are being paid by the taxpayers for all of it." Or, as put by Mr. Statham, a National Park Officer appearing on the same programme, "They say if you thought you could grow bananas on Ben Nevis, the Ministry of Agriculture would pay for it."[16]

This all reminds us of that great satire, *Gulliver's Travels.* It will be recalled that in Laputa some of the resources of the inhabitants went into extracting sun out of cucumbers! Further, how often in the past have we heard Ministries quoting with solemn approbation—'Whoever could make two ears of corn, or two blades of grass, to grow upon a spot of ground, where only one grew before, would deserve better of mankind, and do more essential service to his country, than the whole race of politicians put together.' How Dean Swift would have lampooned the present situation where, the farmers having done just that, and produced more food than Europe wants, must now cut production. Meanwhile much of the rest of the world goes hungry!

Conclusion

Taking the broader view, I have tried to indicate that the nitrate and cancer controversy is part of a very far-reaching problem. The problem is principally one of excess in many directions. One is over-production of food. This is the result of excessive financial subsidies for agrochemical farming. Arising from this is the possible danger associated with ingestion of food containing excess nitrate affecting sensitive animals and human beings. Denial of one aspect of such possibilities—namely nitrates and gastric cancer—tends to divert attention from the other main issues. This is merely an ostrich head-in-the-sand attitude.

Neither by nature nor by inclination am I a protester. Protest without power is powerless and therefore mainly a waste of time. But, for over half a century, as a technologist, I have seen and participated in many of the practical benefits of applied science. On the other hand, I have always warned of the dangers arising in any technological advance where there is lack of monitoring. This applies especially in industry. On the specific issue raised by this paper, I believe the possible connections between cancer incidence and any form of pollution are too potentially dangerous to be brushed aside.

Only a month ago Dr. John Black, in Buffalo, USA, recorded that he and others had noted high cancer rates in freshwater fish in areas where there were also unusually high rates of human cancer. Such observations must alert scientists to threats to human health from chemically polluted waters[17].

Recently, Dr. J. Fletcher, at Farnborough College of Technology, has obtained results similar to those quoted earlier of Aubert[7]. He has found in spinach on sale in the UK a nitrate content of 2500 mg/kg; and very much higher levels in lettuce, up to 8000 mg/kg. If we allow for a human daily consumption of 250g of vegetables, this could indicate a possible intake of over 500 mg of nitrate per person per day. Again, the ques-

tion arises, what is the safe intake level of nitrate for sensitive persons? In 1973, I wrote: "It may be, of course, that relatively few dangers exist, but, judging from the evidence already quoted with reference to animal health and babies, they cannot be ignored[12]". In my view, this still applies. Surely, we must now get definitive answers. This is not being alarmist. Quite the contrary. A technical contribution towards controlling the *excessive* use of artificial fertiliser would be to monitor nitrate and nitrite levels in food and drink. This is already being done for drinking water, why not extend it as the Swiss have done? That was the last wish of Dr. Geoffrey Taylor.

Acknowledgement:

My thanks are due to Mrs. M.A. Barnett, Chairman, and Mrs. J. Bower, Hon. Secretary of the Farm and Food Society, who asked me to present this paper and provided several sources of information. Also to Mr. Ray Lance, of the Soil Association (Devon) for his kind co-operation.

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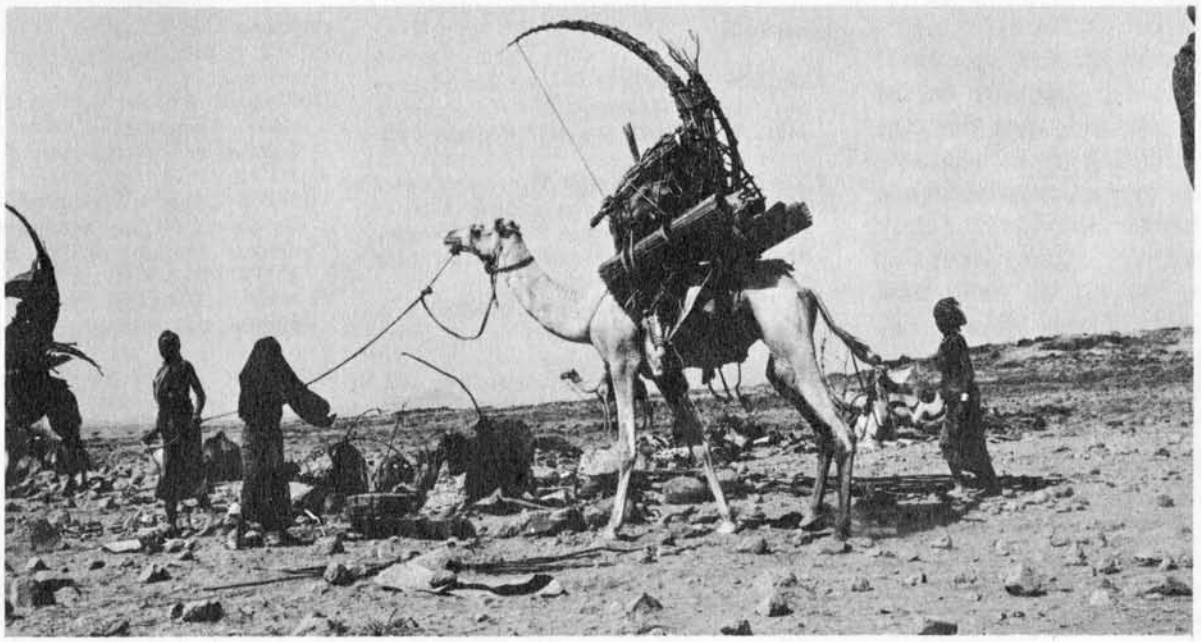

Stopping the Desert spread—with a Camel

by Daniel Stiles

The Chalbi Desert of northern Kenya is one of the hottest and most arid areas in all of sub-Saharan Africa, yet even here people manage to adapt to the harsh conditions and survive from what meagre resources the land has to offer. That prodigious feat is made possible by the utilization of a beast which inspires the deepest love and affection from its owners, interspersed by moments of profound loathing. Many other desert-dwelling peoples of Africa, the Middle East and Asia who would not survive but for the remarkable qualities of the camel have a similar love-hate relationship with it. This haughty and cantankerous creature is highly misunderstood by the rest of mankind, who are inclined to think that it has nothing to do with contemporary life, belonging solely to the dying world of the nomadic pastoralist. They are wrong, inasmuch as the camel could improve the lives of untold numbers of people and also save from desertification the remaining rangeland of Africa. The future of the dromedary camel concerns us all. So does the history of its past.

Flying over northern Kenya today it is difficult to believe that the sparse *Acacia* scrub one sees was once thick woodland, and that the barren, dusty patches at one time were lakes, ponds or waving fields of lush grass. Thousands of square kilometres of bleak lava cobbles and boulders were once probably covered by at least a metre of soil, held in place by trees, shrubs and grass. Most of the vegetation is now gone, and so is the soil. The Chalbi itself was once a lake that rivalled the present Lake Turkana (8,000 km^2) in area. Much has changed over the past few millennia in terms of climate, environment, and the culture and economy of man in the region. The dessication of northern Kenya is not an isolated case, and what happened there has parallels all over Africa and other parts of the world. Since the origin of domestic plants and animals—the so-called 'Neolithic Revolution'—many parts of the world have degenerated from highly productive habitats into desert or near desert. A big question that is generating much heat and dust of its own is the cause of this land degradation, and what can we do to halt or reverse it.

Are the more recent deserts—those formed since the end of the Pleistocene some 10,000 years ago—due to desertization or rather to desertification? *Desertization* refers to a situation where rainfall decreases over time and becomes low and variable, punctuated by extended periods of drought, which leads to a steady impoverishment of wild plant and animal life.[1] It is a relatively slow process and its cause is climatic change, on account of atmospheric alterations or topographic changes such as the eruption of a mountain chain which blocks moist air from travelling to the leeward side. *Desertification* is caused by the misuse of land by man and his livestock. In arid areas the first stage is deforestation when people chop down trees and bushes to clear land for cultivation or for fuel, fodder and construction materials faster than seedlings can sprout and grow. The next stage occurs when animals overgraze and trample the land, leaving bare soil at the mercy of wind and water erosion. The entire process takes place much faster than desertization, and it can happen even without climatic change.

It is difficult to disassociate those two processes in

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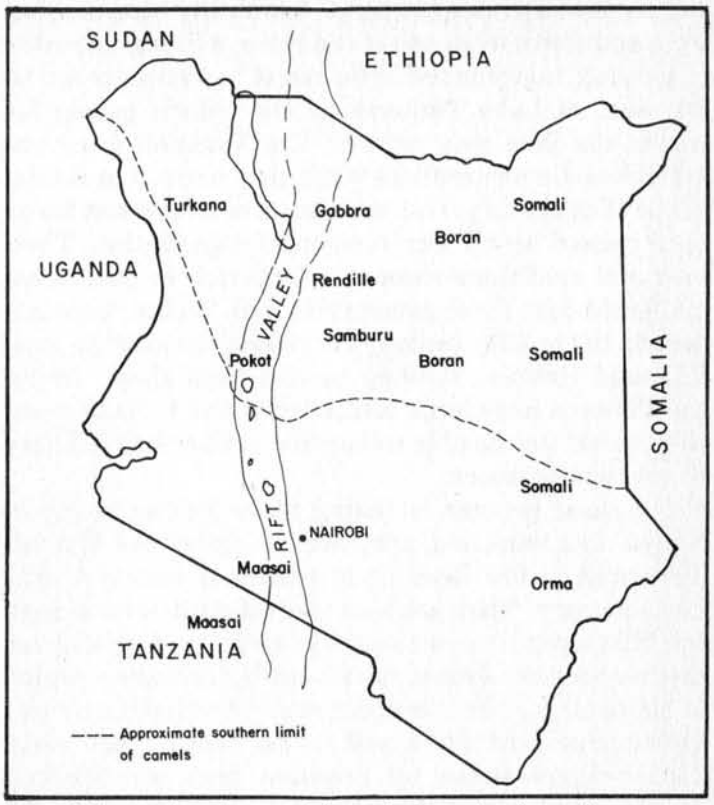
Africa because there is good evidence for climatic change at the same time that domestic animals first appeared and spread, beginning between 7,000 and 8,000 years ago in the Nile Valley and the Sahara.[2, 3] Did migrating pastoralists in spreading south and east out of the Sahara create the arid wastes we see today in the Sahel and northern Kenya, or was the cause climatic change? If pastoral activities were then more at fault, it follows that they still will be today; consequently how can the situation best be changed to preserve the rangelands that remain? The question is an important one for Africa, as the continent is highly dependent on livestock. The value of livestock food and other products is $10 billion annually, while cereal production is worth only about $8.5 billion.[4] Nevertheless Africa still has to import 80,000 metric tonnes of domestic animal products a year because of its burgeoning population. Most livestock production comes from pastoralists, but with the steady degradation and loss of their land, production will inevitably drop—unless something is done.

The story in northern Kenya can begin some 8,000 years ago. Approximately 30 kilometres west of the present Chalbi 'shore' line samples of fresh water snail shells in lake deposits which are located at a height between 30 and 40 metres above the floor of the dry lake flats have a carbon-14 date of 8100± 220 b.p.[5] The Chalbi floods today after heavy rains, but never extends anywhere near those dated lake sediments. If the deposits are the remains of an 8,000 year old Lake Chalbi, as is most likely, it would indicate that rainfall was significantly higher then than at the present time. The Chalbi is an internal basin fed exclusively by run-off waters from rain which falls on the surrounding highlands; hence a high lake level is evidence of high rainfall. An expanded Chalbi lake at that time is in accord with the results of studies conducted on lakes located to the north in the Ethiopian Rift Valley, to the south in the Kenyan central rift, and also nearer at hand around Lake Turkana.[6, 7, 8, 9]

Archaeological research shows that man inhabited most of the Saharan region at that time, which was then a well watered savannah, with the result that in the Sahara and in East Africa fishing became an important part of the economy.[10, 11] Sometime between 4,000 and 5,000 years ago Late Stone Age pastoralists began to filter into northern Kenya from the north.[12] Pollen collected from pits dug into the Chalbi show that *Podocarpus* forests on the surrounding highlands were much more extensive than today.[13] The region was probably one of wooded savannah, tall grasslands and with numerous streams feeding the permanent Lake Chalbi. Those early pastoralists herded cattle, sheep and goats, possibly cultivated sorghum, made pottery with a wide variety of styles, pecked out lava and pumice cobbles to make vessels, and buried their dead under stone cairns. The oldest cairn burial yet known from East Africa comes from near Kalacha, an oasis on the eastern margin of the Chalbi. The human skeleton under the stone mound dates to approximately 1500 BC. Those first East African pastoralists probably were Southern Cushitic language speakers who were migrating down the Great Rift Valley in search of richer pastures.[14]



Map of Kenya showing most important pastoral peoples.

For the next 3,000 years a highly varied procession of pastoralists entered Kenya from the north: Eastern Cushites such as ancestors of the Rendille, Somali, and Oromo (Galla) from Ethiopia and Somalia, followed first by Southern Nilotes (Kalenjin ancestors) and then by Eastern Nilotes (Maasai, Samburu, Turkana) from the Sudan and Uganda. All of those people were originally cattle pastoralists, although they also herded sheep and goats. Already 1,000 years ago the lakes were much lower than earlier on, but the fact that Lake Chalbi still existed suggests that there was still more rainfall than today. The Chalbi had greatly shrunk in size from the days when it lapped at the foot of Mt. Kulal, and charcoal in a hearth buried 90cm under the surface of a sand dune near North Horr dated to 1150± 110 b.p. indicates that dessication and land degradation had begun.[13] Pastoralists were now living on extensive sand dunes on the north end of a lake which had once covered the entire area. Geological evidence from near Kalacha suggests that the lake had almost dried up by the 9th century AD, and that it became an ephemeral lake by approximately the 13th of 14th century, probably much as it is today.[13, 15]

Coincidentally, it was at about the same time that the Chalbi was invaded by a people who built huge rings of lava cobbles and pebbles around the graves of their dead, some measuring up to 20m (65 feet) in diameter.[14] Some camel pastoralists today continue the practice of putting a stone ring around a grave in the Chalbi region, but their rings are much smaller than the earlier ones. Could the carbon-14 dated 200-600 year old giant rings be remnants of the first camel pastoralists to immigrate into the Chalbi area? The drying up of the Chalbi, which signals more arid conditions than previously, fits well with a hypothesis that a camel herding people began migrating into the region between the 10th and 13th centuries.

Over the centuries the camel has slowly been moving west and south from out of the Horn, a living indicator of a dying environment. The camel has now spread to the west of Lake Turkana, to the Nilotic people for whom the lake was named. The Turkana were originally cattle pastoralists when they arrived in Kenya in the 18th century. But their large numbers and herds soon caused severe environmental degradation. Their own oral traditions recount a land rich in rain, trees and grass just three generations ago. Today there is a desert. In the 19th century they began to raid the Rendille and Gabbra, stealing camels from them. Today the Turkana have large camel herds and without them they would not be able to survive in their increasingly hostile environment.

The same process is taking place further south in Kenya. The Samburu, northern cousins of the Maasai, live south of the Rendille in relatively heavy *Acacia* bush country. They are also blessed with several high rainfall mountain areas which provide good grazing for cattle—once the forests have been burned down, which is happening at an alarming rate. The Samburu have been compressed into about 60 per cent of their early 20th century range by pressure from surrounding peoples and by land alienation for a national park and private ranches south of them, and their population has grown considerably over the past 80 years. The ancient response of migrating to better pastures is no longer open to them. Increased population necessitates larger herds to feed the people, which when coupled with smaller grazing lands inevitably leads to overgrazing, deforestation and desertification. As a result of a drop in the productivity of the land, which is then expressed in lower milk, meat and blood yields from livestock, the Samburu have recently become interested in acquiring camels. The price is very high, preventing the acquisition of as many camels as the Samburu would want.[16]

The Pokot, who live south of the Turkana and west of the Samburu, are also turning to camels. Those fierce pastoralists have managed to built up quite substantial camel herds from incessant raiding on the Turkana. Camels are now even spreading south of Lake Baringo to the Maasai-speaking Njemps (Il Chamus). Camels cannot move any further south by natural means as the land is owned by farmers and ranchers. The land used to be occupied by the Maasai, but the British colonial government moved the Maasai south and opened the land to European settlement. Most of the land has now been transferred to indigenous Kenyan ownership since independence in 1963, but modern agricultural techniques and a private land tenure system still prevail. If it were not for that barrier of private land and fences in all probability camels would continue their southward migration down the dry Rift Valley to the Maasai and with them into Tanzania and eventually even further south. Kenya marks the most southerly extent of camel expansion in Africa, yet they would do comparatively well in many parts of southern Africa.

People like the Samburu, Turkana and Pokot have a deep emotional attachment to cattle built up over centuries of interrelations and mutual dependence with

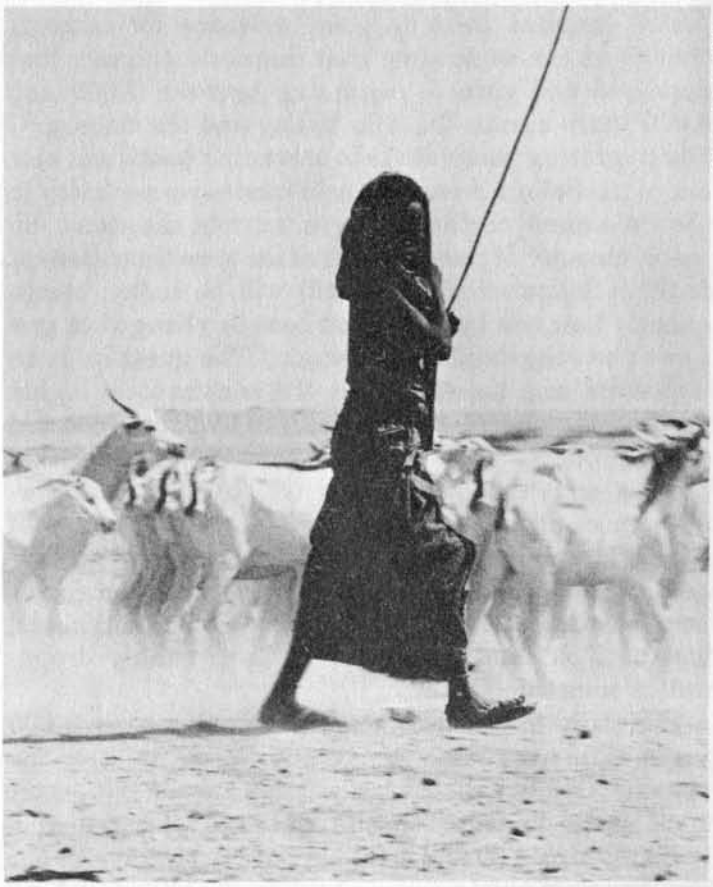


Photo: Daniel Stiles

A young Gabbra girl taking a herd of goats to graze. The sharp hooves of these goats will tear up the ground surface and their sharp teeth will devour every edible scrap of vegetation in their path.

them. A cow or bull is not simply a piece of property or a source of food for the Kenyan cattle pastoralist; each animal is like a part of the family, being named and cared for, and it can have an important social or ritual significance. What then is the great attraction of the camel for such cattle-loving people? Why do they desire it? In a trade a good milch camel will fetch between two and five cows and up to 30 sheep and goats—if a milch camel for trade could ever be found. The pastoralists with small camel herds are also constantly complaining that available camels are too few and too expensive. They want to increase their camel herd, but are unable to do so.

There are some excellent reasons why the camel is so sought after. Some the pastoralist realizes, others he does not appear to be conscious of. Indeed anyone interested in combating desertification should be interested in the unique qualities of the camel, some of which have only recently become appreciated as a result of detailed research within the last decade. The camel is significantly superior to other livestock animals in terms of food production, its effect on the environment, and even in controlling human population growth. The camel should not be thought of as a specialized animal, adapted only to deserts. In fact, the camel is an extremely versatile animal, while it is the cow which is the more specialized in terms of its needs and potential uses.

Milk Production

The average female camel in northern Kenya produces from five to ten times more milk per lactation

period than a cow. A camel will lactate for more than a year after giving birth while the cow usually ceases giving milk within nine months or less. During the rainy season when pasturage is good the camel will give an average of about 10 litres of milk a day; a cow will produce less than 5 litres. In the dry season the cow will practically dry up while the camel will continue throughout to give from 3 to 5 litres a day of milk—approximately that which a cow will give at the best of times. Thus, a camel will consistently provide a substantial quantity of milk for human consumption over the course of an entire year, while cow's milk production is relatively small and highly variable.[17] Because of the very low milk producing capacity of the cow during dry periods, and their poor resistance to drought, the cattle pastoralist tries to have the largest herd that he can. There is no thought of culling unproductive animals to take pressure off the pasture; the expectation being that an unproductive animal may survive the next drought and then be used to trade for grain or for some calves to rebuild the herd. With everyone trying to maximize his herd the limited rangeland inevitably suffers.

The feeding habits of cattle and small stock are also much more destructive than those of camels. Cattle and sheep feed almost entirely on grass, as long as it is available. They also eat the green leaves of shrubs and herbs in the understory. The goat will devour almost anything within its reach, including *Acacia* seedlings, which seriously reduces tree reproduction. All three species travel to and from grazing areas and watering points in bunched up herds with their hard and sharp hooves kicking up clouds of dust as they scuff the earth. The cumulative results are the stripping of ground cover and the very destructive trampling of that barren land. Erosion gulleys that end up carrying away tons of top soil often start out as livestock trails.

Camels, on the other hand, have a very wide diet and eat the leaves of shrubs, trees and herbs, as well as grass.[18] They do not overgraze any type of vegetation, and they can eat into the upper stories of vegetation that other animals cannot (except for tree climbing goats), thus lessening pressure on the lower vegetation levels. Camels also disperse much more and travel farther than other livestock types while feeding, a trait which again lessens the effects of vegetation consumption. The dispersed movement pattern of camels also reduces the effects of trampling, although with their soft, flat hoofless feet little damage is caused anyway. In short, camels do not strip and kick up soil from the ground with the result that soil loss is minimized and trees have a much better chance to reproduce.[19]

Food Conversion Efficiency

The camel is also much more efficient that the cow in converting vegetation into milk. Studies in northern Kenya show that a camel can produce one litre of milk for human consumption from about two kilograms of vegetation dry matter. To produce an equivalent litre for human use a cow must consume more than nine kilos of dry matter.[17] The camel, then, is more than four times more efficient than cattle in converting its food to human food. The implications of this finding for the future of pastoral economies in semi-arid and arid lands cannot be underestimated.

Another environmental plus for the camel is the type of settlement pattern it permits for people. The more dispersed settlements and livestock are, the less the land is affected by tree and bush cutting for firewood, and stock enclosures, and by livestock grazing and trampling. Camels are justly famous for their ability to go for long periods without drinking, and they can carry water long distances to settlements for human needs. Camel pastoralists can thus live in areas where there is good pasture but no water. Cattle pastoralists have no such option since their animals have to be watered at least every three days, making it necessary to live within a maximum radius of about 40 kilometres from a water source, although 15 to 20 km is more common. This tends to concentrate cattle people in certain parts of the range, putting excess pressure on natural resources, while leaving other areas unused. Camel pastoralists can live up to 80 km from water, allowing a more even distribution of settlements over the land.

The surest—and perhaps only—way to halt desertification is to stabilize human population growth and reduce livestock herd sizes. It is very unlikely that either of those desirable objectives can be achieved as long as pastoralists depend primarily on cattle.

Camel Herders on the Move

In norther Kenya and most other semi-arid and arid areas rain falls unpredictably in patches over the landscape. It is rain that spurs plants to grow, so the pastoralists must be ready to go where the rain has fallen. Mobility is therefore essential, and it is that perpetual chase for patches of good grazing that makes the pastoralist a nomad. If a settlement stays in one area too long overgrazing results and the people create a surrounding circle of uprooted bushes and grotesque trees with lopped off limbs. Camel pastoralists like the Gabbra will move ten times in a year, but cattle people like the Samburu might stay in the same place for several years. It is a very great effort for cattle pastoralists to move, but camel people can pack everything on the backs of their beasts and be on the move with 24 hours notice.

The last environmental advantage of camel pastoralism over that of cattle pastoralism is one of the most important. Cattle pastoralists burn bush, forest and savannah to create grasslands, because cattle depend on grass. Camel pastoralists do not need to burn because camels do very well in a bush environment. Fire has undoubtedly done more to modify the earth's terrestrial habitats than any other single factor, and most fires have been and are anthropogenic. In highland areas where rainfall is high the creation of grassland plains might not be environmentally deleterious.

The Serengeti, for example, is a very productive habitat for animal biomass as is well known. The long term effects of repeated burning in lowland areas can have disastrous consequences, however. Rainfall tends to be much more unreliable in areas below approximately 1200 m in East Africa, and once protective bush has been burned off a prolonged drought can result in severe erosion and environmental degradation.

Population Restraint

In addition to the food and environmental advantages provided by the camel's physiological and behavioural attributes, the camel is also the only domestic animal that has demonstrated its ability to control human population growth. If livestock are the primary source of food, and if they regulate the creation of new families by their availability, then without outside economic inputs human population cannot grow faster than the herd. Cattle herds can increase up to 15 per cent a year under ideal conditions, and this is after counting those that have been eaten. Normally, however, over the long term a herd will grow at a 3.4 per cent annual rate.[20] Small stock herds grow at rates up to 30 and 40 per cent annually, but high off-take rates keep real growth lower. A camel herd usually grows at an average rate of only 1.5 per cent a year, and a 5 per cent growth would be considered extremely good by most pastoralists. Because of the slow growth of camel herds societies dependent on them practice many different types of social controls to regulate marriage and birth.

For example, the Samburu (cattle herders) and Rendille (camel people) are neighbours and they occupy roughly similar habitats in northern Kenya, though Samburu-land receives on the average somewhat higher rainfall. Between 1969 and 1979 the Samburu tribe grew by 34.4 per cent, or at a 3.0 per cent annual rate. The Rendille increased by only 16.4 per cent, or about 1.6 per cent a year, one of the lowest growth rates in Kenya (the national average was almost 4 per cent for this period, the highest in the world).[21] These human growth rate figures are remarkably close to expected herd growth rates. Just the overall size of the two groups demonstrates that cattle people tend to be more numerous than camel people; Samburu number more than 75,000 while there are fewer than 20,000 true Rendille. The difference is probably even greater between the closely related Boran cattle and Gabbra camel peoples, but no accurate growth figures are available since these two peoples commonly cross back and forth to and from Ethiopia.

The surest—and perhaps only—way to halt desertification is to stabilize human population growth and reduce livestock herd sizes. It is very unlikely that either of those desirable objectives can be achieved as long as pastoralists depend primarily on cattle. The history of the spread of camels has shown that their southward movement was not due to climatic change alone. It is a history that chronicles what an economy based on cattle and small stock can do to the environment. The fast growth of the herds encourages

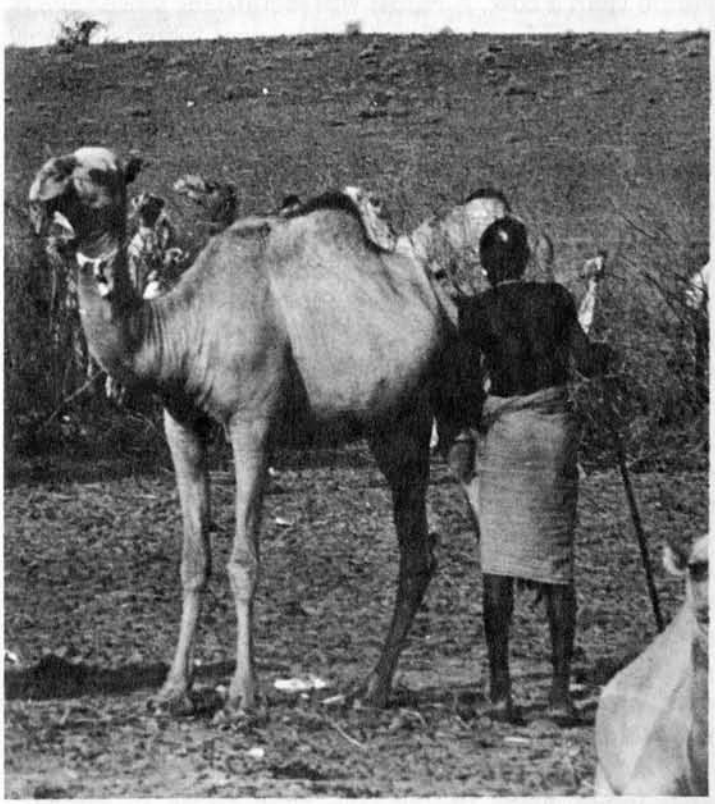


Photo: Daniel Stiles

A Rendille man preparing to milk a camel. This camel in the course of a year will give between two and three times the amount of milk for human consumption as a cow.

and makes possible high human population growth. When the range is in good condition and rainfall is plentiful there is copious milk, meat and blood to feed a growing population. When the grazing deteriorated the people simply moved on. Woodland is destroyed by tree-felling and by burning each year to regenerate the grass that the cattle need. A forest is transformed into a savannah, and the savannah into a treeless plain. Trampling and overgrazing finish off the ground cover. Wind blows dust into the atmosphere, a devegetated land reflects the sun's rays back into the sky, heating the dust. There is little moisture to evaporate into the air from such a land, and when humid air moves into this dry region from elsewhere it has difficulty forming rain clouds. Precipitation decreases over time, lakes and streams dry up, and a desert is created.[22,23] Man has created it, and he has actually modified the climate himself. The notion that land is merely a passive factor in climatic change, reacting helplessly to the vagaries of rain and temperature, can no longer be accepted. Conditions of land surface are inter-active with variables determining climate, and changes in the land can cause micro-climatic changes, with as yet unknown effects at the macro level.

Near the end of the desertification process, when the rains become more erratic and unpredictable, and cattle begin to die from drought, the camel makes his appearance. The camel can resist the drought, allowing life to continue. When the drought ends the cattle herds rebuild themselves, humans reproduce to replace those who died, and the cycle begins anew. Over centuries or millennia of these cycles a desert so desolate results that no cattle at all can survive, except in favoured spots. It was not global climatic change alone that degraded these lands; the process of desertification was greatly assisted by man and his beasts,

and it is still happening today in northern Kenya and other parts of Africa.

It would be interesting to see what would happen if cattle, sheep and goats could be reduced in northern Kenya substantially, to be replaced by fewer numbers of camels. If managed well there would be no loss of food production and the land and its wildlife would benefit considerably. Bringing camels into an area *before* the desert is created might well halt the desertification process, if it is integrated with an overall programme of education and training to teach the pastoralists care and management of camels and good land use methods. Camel breeding stations, centres where cattle and small stock could be traded for camels, a marketing scheme with incentives to trade and an efficient system to supply beef and mutton to the towns could all lead to a healthier people and environment.[17] It is not realistic to expect pastoralists to give up cattle entirely, they are too important culturally, but the herds could be greatly reduced if the attitudes of the people could be slightly modified and if the incentives were there.

It would be a long, slow process, as societies need time to develop new ways of organizing labour and for adapting their institutions and beliefs to a modified economy. Camels are not easy animals to live with, which is a main reason why people do not adopt them until forced to by environmental circumstances, but a desert is not easy to live with either. If camels can help to halt the spread of deserts then they may be the animal of the future rather than one of the past. The people who want camels should be given help to obtain them—that alone might do more to improve the life of pastoralists than many expensive, socially disruptive development projects. The pastoralists, at least, would appreciate the camels more than an irrigated field of cotton. In the long term, so would the land.

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Note: The views expressed in this article are my own and do not necessarily reflect those of UNEP.

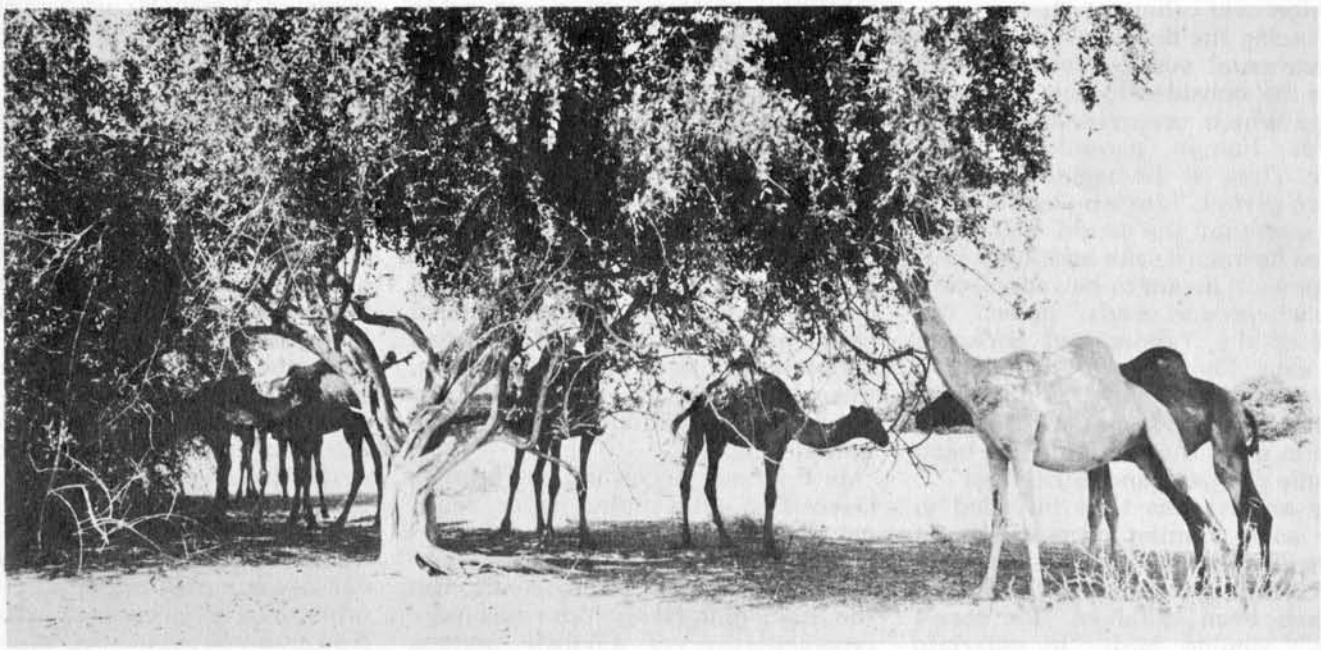


Photo: Daniel Stiles

Camels can feed at higher levels of vegetation, thus easing pressure on vital ground cover.

Books

Putting Man in his Place

MAN AND THE NATURAL WORLD, Changing Attitudes in England 1500-1800. Keith Thomas, Allen Lane, £14.95.

The three centuries between 1500 and 1800 saw an intense debate about man's place in nature. During the course of that debate, argues Keith Thomas, many of the seeds of modern-day environmentalist thought were first sown. Many people thus began to challenge man's previously unquestioned ascendency over other species and even to suggest that there was no rigid dividing line between animals and men. In many quarters, there was a new awareness of the natural world and numerous long-established dogmas about man's right to exploit nature came under attack. In short, not everyone espoused the mechanistic view of nature propounded first by Bacon and later by Newton: there were many who could not accept that the world was a machine or that science should be used to give man dominion over other creatures.

In tracing the development of such environmental sensibilities, Thomas begins by considering the dramatic change which occurred in attitudes towards human ascendency over nature. Thus, at the beginning of the modern period, "the long-established view was that the world had been created for man's sake and that other species were meant to be subordinate to his wishes and needs." Indeed, the world of the Tudors and Stewarts was, says Thomas, "breathtakingly anthropocentric" in its attitude towards nature. "It was with human needs in mind that animals had been carefully designed and distributed . . . Every animal was thus intended to serve some human purpose, if not practical, then moral or aesthetic."

Apes and parrots were considered to have been ordained "for man's mirth": singing birds "to entertain and delight mankind": wild animals "to foster human courage and provide useful training for the arts of war": and horse-flies "so that men should exercise their wits and industry to guard themselves against them". As for the lobster, it was held by the Elizabethan George Owen to serve several purposes at once: "it provided men with food, for they could eat its flesh; with exercise for they had first to crack its legs and claws; and with an object of contemplation, for they could behold its wonderful suit of armour."

Human ascendency over nature was considered to be central to God's divine plan. So much so that "some divines thought that after the day of Judgement the world would be annihilated: it had been made only to accommodate humanity and would have no further use."

Closely allied to the anthropocentric view of nature was the belief that man had the right to subjugate other species. Underpinning that belief was the deeply entrenched view that man was fundamentally different from other forms of life. Quite where that difference lay seems to have been a subject of much conjecture. Some held that man was unique because he could 'speak'; others because he could 'choose'; others because he had 'reason'; and still others because he had a 'soul'. (In the late eighteenth century, the aesthete Uvedale Price was to add a new dimension to the debate by arguing that only men had noses: "Man is, I believe, the only animal that has a marked projection in the middle of his face."

On the continent, the attempt to establish a rigid boundary between animals and men reached its apotheosis with the works of Rene Descartes. For Descartes, the vital difference between man and other species lay in man's ability to cogitate; both animals and men were machines but within the human machine there was a mind and therefore a separable soul. As Thomas observes: "Descartes denied souls to animals because they exhibited no behaviour which could not be accounted for in terms of mere natural impulse." He goes on to comment: "Descartes' explicit aim had been to make men 'lords and possessors of nature'. It fitted in well with his intention that he should have portrayed other species as inert and lacking any spiritual dimension. In so doing he created an absolute break between man and the rest of nature, thus clearing the way very satisfactorily for the uninhibited exercise of human rule."

In England, according to Thomas, Descartes' philosophy never really caught on. "Many physiologists agreed that the body had its mechanical and involuntary movements. But the theologian Henry More was more representative of English opinion when he bluntly told Descartes in 1648 that he thought his a 'murderous' doctrine. Most later English intellectuals felt with Locke and Ray that the whole idea of beast-machine was 'against all evidence of sense and reason' and 'contrary to the commonsense of mankind'. As Bolingbroke remarked, the plain man would persist in believing that there was a difference between the town bull and the parish clock."

The belief in human uniqueness did not, therefore, go unchallenged. Indeed, Thomas offers good evidence that in many quarters it became progressively weakened as the nineteenth century approached. "The attack on conventional orthodoxy came from two separate directions," he notes. "There were those who said that men were morally no better than animals, possibly even worse: and there were those who said that animals were intellectually almost as good as men."

In 1683, for instance, Thomas Tyron was to write that, in his opinion, lions and tigers "were not more savage and cruel, geese and asses not half so stupid, foxes and donkeys less knavish and ridiculous, wolves not more ravenous, nor goats more lascivious than abundance of those grave, bearded animals that pride themselves with the empty title of rational souls." Bolingbroke went further still: humanity, he opined, had certainly shown itself capable of 'superior attainment' but its achievements "though they are great (do) not take us out of the class of animality".

The idea that man held a monopoly on reason also came under attack from sceptics, as did the idea that only humans possessed language. Margaret Cavendish, Duchess of Newcastle, was among those who rejected the anthropocentric notions of the majority of her contemporaries. "Beasts", she maintained, "could experience the whole range of human passions and had their own type of reason and language, which was very probably as deep and expressive as anything available to humans. Man's advantage stemmed solely from his shape: and it was mere arrogance which made him think himself intellectually superior. His 'pride', 'self-conceit' and 'presumption' had misled him into judging other creatures by human standards, not realising that language and reason could take non-human form."

By the later seventeenth century, argues Thomas, the anthropocentric tradition itself was being eroded. In 1691, for instance, John Ray was to write: "It is generally received opinion that all this visible world was created for Man; (and) that man is the end of the Creation, as if there were no other end of any creature but some way or other to be serviceable to man . . . *But though this be vulgarly received, yet wise men nowadays think otherwise.*"

That view echoed earlier criticisms

of man's anthropocentric attitude towards nature. The revelations of astronomers made it 'absurd', according to Henry Oldenbury, writing in 1659, to think "the heavenly hosts, which are so many times bigger than our earth, are made only to enlighten and to quicken us."

Instead of seeing the world created for man's sole benefit, many thus came to argue that all creatures had the right to exist—and that man was a steward of nature. Indeed, some expressed an eminently ecological view of the world and even warned of the dangers of upsetting the balance of nature. "We dispute in schools," wrote John Bulwer in 1653, "whether, if it were possible for man to do so, it were lawful for him to destroy any one of the species of God's creatures, though it were but the species of toads and spiders, because this were taking away one link of God's chain, one note of his harmony."

Thomas argues (in my view, somewhat unconvincingly) that one of the major forces making for a less anthropocentric view of the world was the development of the study of natural history. At the beginning of the modern period, plants and animals were classified almost exclusively in terms of three categories: edible and inedible; wild and tame; useful and useless. Those 'man-centred' categories were gradually replaced by the "more detached, more objective" system of classification developed by naturalists.

But in banishing the 'man-centred' categories of the past, natural history also banished much of the symbolism popularly associated with wildlife in the early modern period. Such symbolism, as Thomas himself points out, reflected a very different attitude towards nature to that preached by theologians and debated by the academics at universities. Indeed, as described by Thomas, the vernacular view of nature saw no sharp boundaries between animals and men but rather it "presupposed that men, plants and wild creatures were inextricably bound up in one great community." If certain trees protected one against witchcraft or the gathering of medicinal herbs had to be accompanied by 'innumerable charms and observances', it was, says Thomas, because countrymen believed man and nature to be "locked into one interacting world. There were analogies and correspondences between species, and human fortunes could be sympathetically expressed, influenced and even foretold by plants, birds and animals."

Such ideas were increasingly depracated as interest in natural history grew. Indeed, as botanists came to learn more and more about the botanical properties of plants, so traditional husbandry—and with it folk wisdom—"came to seem riddled with ignorance." Naturalists expressed outrage that husbandmen did not know the names of grasses or that some plants did not even have vernacular names. Popular country lore—the belief, for example, that "robins would bury dead persons with moss" or that "the hare changed its sex and slept with one eye open"—came to be dismissed as vulgar errors. The days when the fly would be regarded as "a reminder of the shortness of life" or the glowworm as "The light of the holy spirit" were thus numbered.

The vernacular view of nature was undermined still further by the introduction of Latin names for many plants and animals. In so doing, argues Thomas, "the naturalists . . . completed their onslaught on the long-established notion that nature was responsive to human affairs." He goes on to comment: "This was the most important and the most destructive way in which they shattered the assumptions of the past. In place of a natural world redolent with human analogy and symbolic meaning, and sensitive to man's behaviour, they constructed a detached natural scene to be viewed and studied by the observer from the outside, as if by peering through a window, in the secure knowledge that the objects of contemplation inhabited a separate realm, offering no omens or signs, without human meaning or significance."

Natural history may thus have brought a less 'man-centred' view of nature, but it also played a fundamental role in shattering the almost animistic world of the common man. Indeed, in a curious way (which, sadly, Thomas does not explore) it may well have helped to foster a far greater gulf between man and the natural world than the previously anthropocentric categories of classification reflected. Natural history may indeed have encouraged a greater appreciation (and even a greater understanding) of nature—but it was a nature 'out there', apart from man.

In his concluding chapter, Thomas argues that whilst human ascendency over nature was still the "aim of most people and one, moreoever, which at last seemed firmly within reach", there had arisen "doubts and hesitations" about man's place in nature which would not go away. "A growing number of people had come to find man's ascendency over nature increasingly abhorrant to their moral and aesthetic sensibilities," he writes. "By 1800, the confident anthropocentrism of Tudor England had given way to an altogether more confused state of mind. The world could no longer be regarded as having been made for man alone, and the rigid barriers between humanity and other forms of life had been much weakened . . . The early modern period had thus generated feelings which would make it increasingly hard for man to come to terms with the uncompromising methods by which the dominance of their species had been secured."

It is a fascinating thesis, meticulously documented and written with supreme elegance and erudition. If I have one criticism, it is that too little attention is played to those other intellectual developments which would ultimately provide the justification for the industrial revolution. For whilst Margaret Cavendish was busy breaking down the barriers between animals and men, the mechanistic philosophers who followed Isaac Newton and Francis Bacon were equally busy seeking means to transform the natural world to man's ends. So too, whilst Sir Richard Blackmore extolled the value of weeds ("each shrub is sacred, and each weed divine"), the dark satanic mills which would ultimately produce the herbicides of the modern age were growing up throughout England. Indeed, as Thomas points out, in that new industrial world, the landscape gardens and animal sanctuaries set up by early environmentalists could only end up "as artificial oases or peepshows into an idealised world, whose very existence underlined their essential opposition to the fundamental values of ordinary society."

That criticism can be applied with equal force to the national parks we have set up today—Thomas rightly calls them "fantasies which enshrine the values by which society as a whole can no longer afford to live." The question which the Margaret Cavendishes, Blakes and John Rays of this world raised—and which we have still not answered—is not how those fantasies can be preserved but, rather, how we can create a society that no longer needs them. Perhaps, along with the Ranter Jacob Bauthumley, we need once more to appreciate that "God is in all creatures, man and beast, fish and fowl and every green thing". It is a message which is hard to knock. To learn more about it, I can only urge that you read Thomas' excellent book.

Nicholas Hildyard

Beyond the Pale

HAZARDOUS WASTE IN AMERICA, S. Epstein, L.O. Brown and C. Pope. Sierra Club Books, $12.95.

"No environmental problem poses more starkly than hazardous wastes the dilemma of industrial civilisation," write the authors of

Hazardous Wastes in America. "Materials . . . that have come to be taken for granted as fundamental features of modern life are dependent upon an exponentially increasing, proliferating and dangerous array of heterogeneous chemicals. These chemicals generally serve a useful purpose, but, when the purpose is completed, their dangerous properties often remain in the wastes—sometimes for a brief time, sometimes virtually forever."

Almost six years after the disaster at Love Canal, billions of pounds of toxic wastes are still being disposed of improperly. Of the 80 billion pounds of hazardous waste generated every year in the USA, only 10 per cent—according to the Environmental Protection Agency (EPA)—is disposed of safely. The rest is dumped into insecure pits, ponds, and lagoons (or else abandoned illegally) without apparent regard for its potential effect on both human health and the environment. Indeed, Epstein and his colleagues go on to claim that toxic wastes "have become the number one environmental problem" in America.

Apart from radioactive wastes—which the book does not deal with, except in passing—the wastes which pose the greatest dangers are heavy metals (such as lead, zinc, arsenic, cadmium, copper and mercury); asbestos; and such synthetic organic chemicals as benzene, DDT, endrin, dieldrin and vinyl chloride.

The dangers posed by such wastes are treated admirably in the first chapter of *Hazardous Wastes in America,* thus paving the way for the six case studies which go to make up Part II of the book. Those case studies look at the Love Canal story; the history of dumping in rural America; how the dumping of waste motor oil (where co-mingled with hazardous wastes) has contaminated large parts of the state of Missouri; and the growing threat of illegal dumping.

That last chapter on illegal dumping is of particular interest—for, as controls on hazardous waste begin to bite, so many unscrupulous operators have turned to illegal dumping in order to avoid the law. At times, the methods used by 'midnight dumpers' are simply mind-boggling. Thus Epstein *et al* quote an Associated Press report on illegal dumping in Connecticut: "One operation that allegedly runs out of Hartford . . . only works in foul weather. A driver watches the forecast for rain or snow, then picks up a tanker load of chemicals. With the discharge valve open, he drives on an interstate until 6,800 gallons of hot cargo have dribbled out. 'About 60 miles is all it takes to get rid of a load', boasted the driver, 'and the only way I can get caught is if the windshield wipers or the tyres of the car behind me start melting.' "

A particularly serious problem is the contamination of groundwaters by hazardous wastes—either directly from unlined dump sites or, indirectly, through pesticide and fertiliser run-off; mining; domestic septic tanks; underground petrol storage tanks; and petrol and gas exploration.

British readers should not be put off by the American slant to this excellent book. Even the history of US legislation on hazardous wastes is of interest (though it is clearly not of direct relevance to a European audience). Not least, it shows how the efforts of those who have attempted to tackle the problem of hazardous wastes have constantly been stymied in their efforts by both industry and those politicians who oppose greater government control over industry.

Epstein and his co-authors are at pains to stress that the solution to the problem of toxic wastes lies not only in applying new technologies in order to treat the wastes before disposal ('narrowly-based technological fixes are at best make-shift, as they fail to confront the fundamental problem') but also—much more to the point—in reassessing our general attitude towards the environment.

As they put it; "We will not solve the problem of hazardous waste dumps until we recognise that we are part of life and that we cannot destroy it for our immediate convenience without ultimately destroying ourselves." It is a lesson which Europeans, as much as Americans, have surely got to learn. If we do not heed it, then there is little hope for any of us. For, in dealing with hazardous wastes, we are dealing with the ultimate in human detritus—and that detritus, as Epstein and his colleagues point out, is often of a nature which is alien to our evolutionary experience.

Nicholas Hildyard

The World's Racketeers

PRESCRIPTIONS FOR DEATH: THE DRUGGING OF THE THIRD WORLD, by Milton Silverman, Philip R. Lee, and Mia Lydecker. University of California Press, $16.95.
PILLS, PESTICIDES, AND PROFITS: THE INTERNATIONAL TRADE IN TOXIC SUBSTANCES, by Ruth Norris, Karim Ahmed, S. Jacob Scherr, and Robert Richter. North River Press, $10.95.
DIET FOR A SMALL PLANET: TENTH ANNIVERSARY EDITION, by Frances Moore Lappé. Ballantine, $3.50.

The charge that multinational companies use the Third World as a dumping and testing ground for hazardous chemicals is not exactly new, but two recent books provide useful documentation.

Prescriptions for Death focuses on the trade in pharmaceuticals. The heart of the book consists of a detailed examination of the labelling of selected drugs, with these conclusions: that many products which have been banned in the US and the UK, or were never approved for sale there, are not only available but heavily promoted in the Third World; that serious or lethal side effects are often played down or totally ignored; that exaggerated claims are made for many drugs; and that both large and small companies engage in such unreliable labelling practices.

Silverman *et al.* also describe the promotional practices of drug companies in the *Third World.* Doctors are not only sent glossy advertising materials, but are visited by the company representative or detail man. Overworked doctors often rely on the company reps for their information on drugs and treatments, and yet the reps' information is partial and tailored explicitly to the goal of making a sale.

Doctors may also be bribed, with gifts or with "free samples" of drugs, which they then re-sell. More powerful individuals—the head of a medical organisation or a hospital, say—may be given a car or an expenses paid trip to the US or Europe.

The drugs which such doctors buy and prescribe may not only have serious side effects, but may be inappropriate to local conditions; doctors are encouraged, for example, to prescribe vitamin pills for malnutrition. Research on tropical diseases has never aroused much enthusiasm in the industry, which sees little prospect for a lucrative return on investment.

In compiling their list of drug-company abuses the authors maintain a careful tone of "fairness" toward the industry; as viewers of television news know, "fairness" lends itself to many interpretations, some of which make the teeth hurt and the blood boil. Their closing remarks are in this vein: "It is our belief that, within the international drug industry in general and the American industry in particular, change is possible. . . . There seems to be a new generation of industry leaders who are willing to move in the direction of decency, dignity, and social responsibility."

Pills, Pesticides, and Profits takes the opposite view, based not on perceptions of corporate management's incipient goodness but on economics: as demand in the developed world levels off, and controls on harzardous materials become tighter, the industry will look increasingly to the relatively unregulated markets of the Third World.

As its title indicates, the book doesn't confine itself to the drug trade. Many of the same abuses are found in the case of pesticides: products that are prohibited for use in the US and Europe are freely applied in the Third World, often on food crops which, with their toxic residues, later find their way to kitchens and tables in Cleveland or Coventry; the labelling of a pesticide may be such that not only its potential toxicity but even its identity is uncertain, and spraying crews are inadequately if at all protected. Every year, according to the World Health Organisation, direct contact with pesticides results in the death of 5000 people, half of them children, and the poisoning of more than half a million.

Lack of regulation may also prompt multinational companies to export an entire part of their production cycle. Asbestos plants servicing the US market have been set up in Mexico, Taiwan, and Brazil since 1969, as enforcement of US controls has intensified. Companies have even sought contracts to ship their toxic wastes to small countries in Africa and the Caribbean, rather than finding appropriate means of disposal in the US; the export of pollution is not usually so brazen.

Norris *et al.* end with a look at possible solutions. They conclude that improvements can only come through a combination of efforts by governments, international agencies, and citizens' groups. In the Reagan era, governmental and international initiatives are moribund, but there are vigorous consumer groups around the world; one of the largest is The Consumer's Association of Penang, Malaysia, which monitors toxic hazards and conducts extensive educational programmes on nutrition, health, and consumer-rights issues.

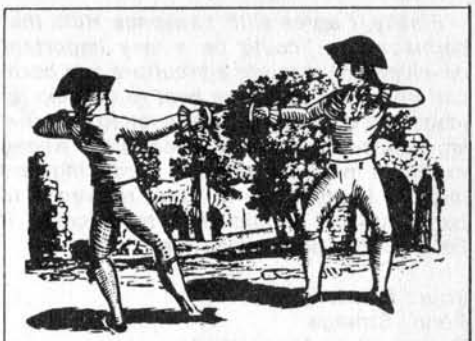
All in all, *Pesticides, Pills, and Profits* is a concise overview of the subject, but community groups might be better advised to hire the documentary films by Robert Richter called *Pesticides and Pills: For Export Only*, transcripts of which are printed as an appendix to the book. Covering essentially the same material, these give, even in transcript form, a much more vivid picture of the human suffering that the trade in toxic chemicals engenders and the human mendacity that sustains it.

The global trade in food is another system that rests on, and perpetuates, exploitation and human misery. Frances Moore Lappé has been exposing that system since the publication of her first book, *Diet for a Small Planet*, which has now been reissued in an expanded, tenth-anniversary edition. The lapse of time shows: whereas the first edition was a book built on a single idea, the latest version reflects a coherent political analysis.

The single idea was that, in the words of one of the author's friends, "eating that chunk of meat is as crazy as driving a Cadillac." Ten years later, the sections on protein myths and protein complementarity—the way in which combinations of plant and dairy foods may be used to meet nutritional protein requirements—remain, as do the recipes, but there is also scrutiny of the system of food production and distribution, and of the industry's marketing and advertising techniques. Moore Lappé discusses the impact of energy-intensive, meat centred agriculture not only on the health of ecosystems and individuals but on democracy itself, as control of the land and the marketplace comes to be concentrated in ever-fewer hands.

Even if your original copy hasn't long ago fallen apart, or become hopelessly encrusted with Garbanzo Bake and Chameleon Spice Cake, it would be worth buying the new edition for the author's account of her own political development: of how she has grown in understanding and self-confidence of what it means to be an activist in the struggle for a more humane world, and of the demands, and rewards, of that life. As she points out, working for change is a long and ever-continuing process, but what other work can offer the same sense of satisfaction and meaning?

Bernard Gilbert



Letters

Permaculture: Give it a chance

Dear Sir,

*Lawrence Hills in his letter (*The Ecologist *Vol 13 No 5) does indeed show that the yield of black walnut trees is no greater than that of wheat, per acre. However, he does not take into account the large amounts of energy used to produce such yields of wheat. Conventional agriculture prides itself on high output per acre; but a true assessment of productivity must relate input to output. If I follow Lawrence Hills right, he says that in the US, an acre of black walnut trees could produce a yield in kernels roughly equal to an acre of wheat; take into account the much lower energy input, the advantage to the soil, the water cycle and the microclimate, plus the very valuable timber crop, and the trees compare very favourably with broadscale annual cropping. Although there are only a limited number of trees which will produce worthwhile yields of food crops in Britain, trees could be used here more than they currently are for human food and animal fodder if effort were put into developing and improving varieties.*

I do not understand why Lawrence Hills attempts to discredit permaculture itself from this one dispute figure. Surely the important thing is whether or not the principles (based on criteria for a sustainable agriculture) are right, and then, how to apply them in Britain. The Permaculture Association in Britain is less than a year old—it is unreasonable to expect us to have detailed results to show. We are not offering advice as experts, but think it is worthwhile to share the ideas. This is the only way we will get a range of examples to show how permaculture can work in Britain.

A permaculture system is based on high diversity of species and activities, the yield coming in the form of many different products. It is easy to see why this is not immediately attractive to commercial growers who are geared up for a single product or a narrow range. Isolating such ideas as using chickens or reflecting ponds to heat a glasshouse is against the ideas of permaculture, in which these would form part of a system, in which no single method is relied on to heat the glasshouse, and the benefit or yield of the combination is received in more than one form.

In Australia and the USA, where permaculture is more established, designers include people with experience in forestry and fruit and nut growing. In Britain, designs have been favourably received by foresters with whom they have been discussed.

Finally, I agree with Lawrence Hills that permaculture "could be a very important development in world agriculture and horticulture". I am doing my best to develop its ideas and discover its relevance to Britain. I am saddened that Lawrence Hills, whose excellent work on organic gardening and interest in trees are of great relevance to permaculture, should seek to discredit it before it has been tried here.

Yours faithfully
Penny Strange
Permaculture Association,
Nottingham.

The Naked Experts

Dear Sir,

*My attention has been drawn to the above article (*The Ecologist *Vol. 12, No. 4, July/August 1982, pp 149-157) in which I appear to occupy the 'centrefold' and which does not appear to have been referred in any way.*

On a recent official visit to Britain, my former colleagues, who know my background and are familiar with my technical expertise and publications, expressed incredulity at the offensive, incorrect, and defamatory nature of the article and expressed amazement that I have not taken legal action.

Martin shows complete dishonesty and reckless discourtesy in writing that 'Leslie Kemeny declined to comment'. He and Diesendorf have in their possession material sent by certified post related to the only two topics upon which comment was possible or meaningful. Both received material in ample time for correcting their manuscript. Neither have acknowledged that popular journals or newspapers cannot and will not canvass all aspects of highly technical issues. Yet, much of their criticism is based on out of context quotes from such sources.

The irony of this situation is that Martin, who may never have left the sterile corridors of academia, seems to be 'cutting down to size' one who has spent a decade administering technical aid projects amongst the villages of South East Asia. This experience led to my Chairmanship of Australia's First International Conference on Technology for Development. At this conference, papers from authorities in the field of 'alternative energy' were welcomed. Furthermore, whilst Martin, Diesendorf and Walters seek to silence any advocacy of nuclear technology, they personally claim the right to promote any and every form of 'alternative' or 'renewable' energy. Is this a form of 'naked expertise' or 'naked inexpertise'?

The paper on 'The Naked Experts' is dishonest, defamatory and actionable. An apology for its publication is required from its author, his own collaborators, and the editors of The Ecologist. *The apology should be published in your letters section as soon as possible. It should contain the admission that Leslie Kemeny did supply technical information which was ignored. The author should also apologise in print for publishing a personal attack against a technologist of repute under the pretext of writing a 'Scientific Paper'.*

Yours faithfully
Leslie G Kemeny
Senior Lecturer in Nuclear Engineering.
Fellow, Australian Institute of Energy
Kensington, NSW, Australia

Dear Sir,

*Leslie Kemeny's letter concerning my article 'The Naked Experts' (*Ecologist, *July/August 1982) illustrates quite well the style of Mr Kemeny's pro-nuclear writings.*

In my article my purpose was to point out the problems of trusting the experts blindly. To illustrate my case I analysed the pro-nuclear writings of Mr Kemeny, who is a leading Australian advocate of nuclear power. Here is a summary:

"In quite a number of ways, Kemeny in his public advocacy of nuclear power does not fit the image of the objective, trustworthy expert: he addresses only some of the issues and seldom replies to anti-nuclear arguments; he presents large amounts of irrelevant material; he is subject to inaccuracy, and on occasion fails to acknowledge his mistakes; he continually denigrates opponents; he speaks from a position representing a potential conflict of interest; and his expertise is mostly irrelevant to the issues, or of doubtful quality." (page 154)

Mr Kemeny in his letter offers no information to challenge this assessment. In particular, he does not refer to even a single statement of mine which is offensive, incorrect or defamatory.

Mr Kemeny in his letter refers to material sent to me and to Dr Mark Diesendorf "for correcting their manuscript". The background is this: On 25 March 1982 I sent to Mr Kemeny a draft version of my article 'The Naked Experts', inviting him to offer comments on it. (It is routine practice for me to offer my articles in draft for comment.) On 27 April 1982 Mr Kemeny replied, stating that "I am afraid I have neither the time nor the inclination to become involved in the preparation of this type of paper". (I had not asked Mr Kemeny to become involved in the preparation of the article but, to repeat, simply to offer comments.) He offered no comments on the substance of the paper, but said at some length that he thought it was "dishonest, devious and actionable". It was on the basis of this response that I said that Mr Kemeny declined to comment.

The so-called "technical material" which Mr Kemeny supplied me mostly consisted of letters sent to Mr Kemeny about his work. In my view none of it had any direct relevance to the issues treated in my article.

Mark Diesendorf and Rosemary Walters did offer comments on the draft of my article, and I included them in the acknowledgements to my article in the usual way. They are not responsible for the article, nor were they my "collaborators" as Mr Kemeny seems strangely to think.

Mr Kemeny is completely wrong to say that I "seek to silence any advocacy of nuclear technology". On the contrary, I have frequently defended the right of individuals to advocate a variety of views, including ones with which I strongly disagree. It would seem that it is Mr Kemeny, by threatening an action for defamation, who seeks to silence views with which he disagrees.

Mr Kemeny seems not to recognise or agree with a key point in my article, namely that many issues concerning nuclear power—I would say the most important issues—are non-technical, and that participation in decisions about energy futures should involve all concerned members of the community. The issue is not one of expertise but one of social choices involving political, economic and social values in the widest sense.

There is no need for me to apologise, for Mr Kemeny has not presented a single bit of evidence to sustain his derogatory allegations about my article. I suggest that readers will find that Mr Kemeny's letter vividly illustrates many of the points about Mr Kemeny's style of argumentation which I made in my article 'The Naked Experts'.

Brian Martin
Dept. of Mathematics, Faculty of Science,
Australian Nat. University, Canberra,
Australia.

Dear Sir,

In his letter about Dr Brian Martin's article 'The Naked Experts', Mr Leslie Kemeny labels me incorrectly as a "collaborator'. The fact is that, like Mr Kemeny, I was invited to comment on the draft manuscript, but unlike Mr Kemeny I did offer comments on the substance of the manuscript.

As President of the Australasian Wind Energy Association (AusWEA) I have already expressed concern publicly that Mr Kemeny erected a windmill in Bangladesh, with the partial support of the Australian Development Assistance Bureau, at a site where there was known to be essentially no wind. Is this the kind of 'technical expertise' which qualified Mr Kemeny to chair a conference on Technology for Development and to write ill-informed articles, such as 'Alternative Energy: the Myth and the Reality', attempting to denigrate renewable energy?

Mr Kemeny accuses Dr Martin of dishonesty, but cannot provide a single example. I have checked all the points documented by Dr Martin, involving Mr Kemeny, and I am satisfied that Dr Martin's account is honest and fair. I see Mr Kemeny's wild charges as an unsubtle attempt to silence, through threat of legal action, public debate on an important issue.

May I offer an additional point about naked experts in general? It seems to me that nuclear power proponents, who are usually trained as nuclear technologists or scientists, and whose public credibility generally rests on specialised expertise in these areas, face a dilemma. To promote nuclear power, some of them must try to criticise renewable sources of electricity such as wind power, which is already more cost effective, in appropriate locations, than nuclear power. How are these narrow experts to extend their expertise, or at least the public image of it, to renewables?

Unfortunately, this has been achieved in some countries by governments which handed over R & D in renewable energy and much energy policy-making to former nuclear energy researchers and administrators, respectively. Furthermore, where wind and solar energy associations seek high status with governments, they have sometimes appointed as office-bearers senior engineers or administrators from electricity utilities and corporations, which tend to be strongly pronuclear. (So far this situation has not occurred in AusWEA.) Finally, in rare cases, claims to expertise in renewables are achieved through participation in government foreign aid programmes, which are not always noted for their emphasis on aid going 'from people to people'.

Yours faithfully
Mark Diesendorf
Australasian Wind Energy Association,
Canberra, Australia.

Classified

MISCELLANEOUS

THE RIDE FOR LIFE. This will take place along the coastline of Wales from April 27th to May 6th. A group of cyclists are trying to raise money for various anti-nuclear and peace/ecological causes. Anyone interested to take part or offer accommodation for overnight stops please contact Tony Fletcher, Rainbow's End, 27 Portia Terrace, Mount Pleasant, Swansea SA1 6XW (Tel: 49825 or 468500).

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SMALL SCALE INDUSTRIES Specialist/ Technician needed for a Development Programme in the Port Sudan. Please send detailed CV including names of two professional referees plus a statement of your views on development to: Euro Action Acord, Personnel Dept., Francis House, Francis Street, London SW1.

CONFERENCES

ECOLOGY PARTY SPRING CONFERENCE will be held at the Floral Hall, The Promenade, Southport, Merseyside from 22nd to 25th March 1984. For full conference papers and details ring Tony Jones on 01-735 2485.

PEACE DEVELOPMENT and OURSELVES. A Study Weekend on Global Issues and Personal Responses. 17th and 18th March 1984 at Sterts Centre, Upton Cross, Liskeard, Cornwall. For details ring Christine Godwin, Plymouth 20429.

The Seventh European Heritage Landscapes Conference will be held at Losehill Hall from April 23rd to 27th, 1984. The subject will be *Land Management for Conservation in Parcs Naturels, Naturparke, National Parks and equivalent reserves.* For details please contact Ms Rosie Simpson, Peak National Park Study Centre, Rosehill Hall, Castleton, Derbys. S30 2WB.

NATIONAL SOCIETY FOR CLEAN AIR 1984 Workshop: Regulating the Impact of Air Pollution. Held on 28th and 29th March 1984 at Lincoln College, Oxford. Enquiries to Jane Dunmore at the NSCA. Tel. (0273) 26313.

BOOKS AND PUBLICATIONS

The University of Arizona Press wishes to announce the establishment of a new series of scholarly books in human ecology, under the editorship of Dr Robert M. Netting. The aim of the series is to publish exemplary monographs and other books of original work, addresssed to both scholars and the wider public, on the relationships between humans and their environment, in a variety of fields, especially cultural anthropology, biology, geography, psychology, and sociology. Manuscripts and proposals are now being welcomed. Please direct all correspondence to: Dr Robert Netting, c/o The University of Arizona Press, 1615 E. Speedway Blvd., Tucson, AZ 85719, USA.

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