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1971 McDougall Memorial Lecture

MANKIND AND CIVILIZATION AT ANOTHER CROSSROAD

by

NORMAN E. BORLAUG

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Once again the "Naked Ape" -Homo sapiens L- stands at a crossroad. Before deciding along which road to proceed, he hesitates and glances behind at the long road he has trod.

He is both amazed and proud of the tremendous progress he has achieved as he manoeuvred and advanced along the pit-fall laden trail of human survival during the brief period he has inhabited the

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planet Earth. Within the last second -representing a short 5 million years as measured on the geologic clock- he remembers emerging from the bush somewhere in southeast Africa, standing upright on his back legs and beginning to assume the role of Desmond Morris's so-called "Naked Ape". With a club in one hand and a rock in the other, he stalked animals and became a carnivore. For a long time he struggled for survival as a hunter and food gatherer under the hostile environmental pressures dispensed by a fickle mother nature. More than once he barely averted extinction. He remembers having seen certain other species perish, because of their inability to adjust to the capriciousness of the environment. They have left for posterity only a fragmented history of their existence recorded in the book of fossil rocks.

During his long early period as a hunter, social progress was negligible. Survival itself was man's only sense of achievement. Then his helpmate, neolithic woman, only about 9000 years ago, invented agriculture and animal husbandry. This brought new hope. It insured his food supply and lightened his load. Survival became less of a problem. The quality of human life improved. It gave him time for pleasure and time to think. There was time to develop his intellect, a society and, subsequently, a culture.

The discovery of agriculture and animal husbandry brought in its wake the specialization of labor. Pottery making, weaving, metal working and other crafts were developed and these products were

exchanged for food. These activities soon gave birth to trade, commerce and small industries. And so, progressively, societies based on villages, cities and city-states evolved.

The Naked Ape was, nevertheless, physically too weak to accomplish many of the things he wanted to do. So he harnessed first animal power, then successively wind-power, water power, steam power, fossil-fuel power and, eventually, atomic power. Combining these with his own brain power, he built great industries, powerful nations and civilizations.

He developed transportation, which permitted him to roam the world. He crossed the oceans on and under its surface, and in the air above. He developed rapid, diverse and efficient land transports to span the continents. He even eventually learned how to put fellow men on the moon and bring them safely back to the earth again.

He developed the arts, letters, music and sports for his own enjoyment. He learned how to transmit these messages and events to fellow men, first through written messages and printed pages and later along wires and eventually through the ether.

He made many worthwhile scientific discoveries that made life more comfortable, gratifying and enjoyable. Among these were the discoveries of control for many diseases that had plagued and scourged him from the beginning of time.

With the control of diseases and the resultant drop in death rates, combined with a reliable food supply, human population growth soared.

The population monster looms ahead and now threatens to obstruct further progress, and even to erode progress already achieved, unless tamed.

Ironically all the forementioned tremendous progress has been achieved by the Naked Ape even while repeatedly dissipating much of his talents and energies inhumanely and wastefully in warfare against his fellow man. Even though he has tried many times in the past to find the magic formula for a lasting peace, he has not succeeded. Time and time again peace has proven to be ephemeral. He has, however, finally succeeded, despite his folly, in building something approaching a world civilization. Even more recently an infant world-wide inter-governmental organization: The United Nations, and its family of satellite service organizations, including FAO, have come into being. They are charged with the responsibility of further improving the lot of mankind and to continue searching for lasting peace.

The speaker is privileged today in having an opportunity to deliver this lecture paying honor to one of the founding fathers of the Food and Agriculture Organization of the United Nations, Dr. Frank Lidgett McDougall, for his contributions toward building a better world.

All these events that have taken place along the tortuous road of human progress over which the Naked Ape has travelled, flash back to him now, as he hesitates and reflects before turning forward again to make the necessary decision as to which road to choose, at this, the most complex series of cross-roads and inter-sections that he has

ever encountered along the highway of social evolution. He realizes, as he now meditates his decision that the world civilization has split into two factions -the privileged world of the developed nations and the impoverished world of the developing nations. One is living a life of luxury never before experienced by man outside of the proverbial Garden of Eden; the other still leads a life of misery built on poverty. Discordant voices cry out to council him now concerning his choice at the next crossroad.

Man's choices at the early crossroads, before he had developed a complex society, were relatively simple. In fact the early choices were made automatically and inadvertently in response to the biologic imperative: "evolve and adapt, or perish", imposed by a hostile, ever changing, environment. Having been richly endowed genetically, the Naked Ape adapted beautifully to each of the barriers imposed, whereas many of his contemporary species being less well endowed genetically, flunked the test and became extinct. One great advantage that man had over all other species was a brain and mind that could reason and improvise. Within certain relatively narrow limits this, over a long period of time, permitted him to modify the environment to better serve his own needs. Thus, through the combined ability of being able to evolve favorably in response to these selection pressures linked with his ability to modify modestly certain aspects of the environment, man -in a short span of time on the geologic clock- was able to build a very complex world civilization.

Now, as the Naked Ape ponders his decision at the crossroad he senses the ugly menacing storm clouds ahead. There appear to be two types of storms brewing: one on the general biological front and one on the human socio-economic front.

Angry pleading voices cry out from the wilderness on the left side of the highway he treads. They are many in number, but cry out in one uniform loud voice. They plead for the basic necessities for a decent life, which they have not been privileged to enjoy in the past. Among their basic, simple, demands are adequate food, housing, clothing, medical care, education and employment. Their pleas are both reasonable and convincing.

But then, from the forest on the right of the highway rings out the shrill, demanding, disharmonious tri-tonal voices of the privileged developed world, demanding the attention of the Naked Ape. One of the siren songs is that of the so-called establishment which councils for continuing on the road that has brought the high standard of living to the developed or privileged nations. This infers that these benefits can be extended to those in the underdeveloped world by following the same path.

A second tone cries out against the establishment and the materialistic world, even while they themselves are living as social drop-outs, social parasites in reality. The tomentose appearance of many of this fraternity even throws doubt on the validity of Desmond Morris's taxonomic classification of Homo sapiens as a "Naked Ape".

The third, and most seductive voice, is that of those extreme environmentalists who discredit science and advocate a back to nature movement. They demand the discontinuation of the use of chemical compounds - even though they are absolutely essential for protecting man against diseases, and for restoring fertility to the worn out soil so man can produce his food, and protect his crops against the ravages of weeds, diseases and insects. They give the impression that they are either naive or, even worse, more concerned about preserving the beauties of nature and wildlife and the environment in general, than they are concerned about the well being of their fellow men, especially if he is a member of the developing world.

How can mankind moderate these tetra-furcated demands?

We will now leave the Naked Ape to arrive at his decision at the cross-road and proceed ourselves to explore in depth some of the basic problems that confront mankind, which have brought him to this sad state of confusion.

THE COMPLEXITIES OF THE BIOLOGIC, SOCIAL AND ECONOMIC PROBLEMS THAT CONFRONT MANKIND

Most of us admit that the world has strongly polarized into two sectors: the "privileged world" and the "forgotten world", during these part two centuries.

Thirty percent of the world's population in the developed world are living in a luxury never before experienced by man. Meanwhile the people of the forgotten world, representing the greatest sector of the

world's population, live in poverty and misery without the basic amenities to live a decent, human life. What can be done to correct this situation? Correct it, we must, or the world will disintegrate into social and political chaos. There are many people who are concerned about this situation, but most want a simple answer to the complex biologic, social and economic problems that now threaten to stifle future human progress. I assure you there are no simple, easy solutions to these complex problems. We must attack the problems from many different angles if we are to provide a decent standard of living for all who are born into this world. The first step toward achieving this end is to recognize the various facets of human needs and activities, and how they impinge upon one another. Among the different aspects of the problem that must be considered, are:

1. Population pressure and population growth.
2. Food and fiber requirements.
3. Housing and clothing requirements.
4. Medical care requirements.
5. Employment opportunity requirements.
6. Educational requirements.
7. Transportation and communication requirements.
8. Energy and power requirements.
9. Non-renewable resource requirements.
10. Recreation requirements.
11. Environmental safeguard requirements.

It is apparent, from a glance at this imposing list of human needs that there is no simple single action that can be taken to solve all of these complexities. It is also readily apparent that one factor, namely population pressure and growth directly affect all others.

In the remainder of this lecture I will devote most of the time to commenting on the food and fiber requirements and what can be done to solve this problem and how other aspects of human activities impinge upon this most basic of all human needs. I will touch briefly on several other aspects within the limits imposed by time.

THE IMPORTANCE OF FOOD IN THE DEVELOPMENT OF CIVILIZATION

Civilization as it is known today, could not have evolved, nor can it survive, without an adequate food supply. Yet, food is something that is taken for granted by most world leaders, despite the fact that more than half of the population of the world is hungry and even a larger proportion malnourished.

Man seems to insist on ignoring the lessons available from history. Man's survival, from the time of Adam and Eve until the invention of agriculture, must have been precarious because of his inability to ensure his food supply. During the long, obscure, dimly defined prehistoric period when man lived as a wandering hunter and food gatherer, chronic food shortages must have forced man to expend virtually all of his energies in struggling to feed himself, and thereby precluded him from developing a sedentary way of life. Under these conditions the growth of human population was also automatically slow because of the

limitations on his food supplies.

In the misty, hazy past, as the Mesolithic Age gave way to the Neolithic, there suddenly appeared in widely separated geographic areas the most highly successful group of inventors and revolutionaries that the world has ever known. This group of neolithic men and women, and almost certainly largely the latter, domesticated all the major cereals, legumes and root crops, as well as all of the most important animals that to this day remain man's principal source of food. Apparently, nine thousand years ago, in the foothills of the Zagros Mountains, man had already become both farmer and animal husbandryman, which in turn, soon led to the specialization of labor and the development of village life. Similar discoveries and developments made elsewhere in the world soon laid the groundwork from which all modern agriculture and animal industry and, indeed, all of the world's subsequent civilizations have evolved. Despite the tremendous value of their contributions, we know none of these benefactors of mankind by name. In fact it has only been within the past century, and especially within the last 15 years -since the development of the effective radio-carbon dating system- that we have begun even vaguely to understand the timing and sequence of these epochal events which have shaped the world's destiny.

The invention of agriculture, however, did not permanently emancipate man from the fear of food shortages, hunger and famine. Even in prehistoric times population growth often must have threatened or exceeded man's ability to produce enough food. Then, when droughts

or outbreaks of diseases and insect pests ravaged crops and flocks, famine resulted. That such catastrophes occurred periodically in ancient times is amply clear from numerous Old Testament biblical references. Thus, the Lord said: "I have smitten you with blasting and mildew" (Amos 4:9); "The seed is rotten under their clods, the garners are laid desolate, the barns are broken down; for the corn is withered...The beasts of the fields cry also unto thee: for the rivers of waters are dried up, and the fire hath devoured the pastures of the wilderness" (Joel 1:17, 20).

Plant diseases, drought, desolation, despair - were recurrent catastrophes during the ages. Man's abilities to prevent them were limited. And yet, the concept of the "Ever-normal granary" appeared in elementary form, as is clear from Pharaoh's dreams, and Joseph's interpretation of imminent famine and his preparation for it, as indicated by this quotation from Genesis: "...And the seven years of dearth began to come according as Joseph had said: and the dearth was in all lands; but in all the land of Egypt there was bread..." (Genesis 41:54). For his time, Joseph was wise, with the help of his God. The Incas also had developed a system of national granaries before the coming of the Spaniards.

But today, we should be far wiser; with the help of our science we must not only increase our food supplies, but also insure them against biological and physical catastrophes, through international efforts involving both developed and developing nations. International Granaries

of Food Reserves, financed by all nations, should be established for use in case of need. These granaries should be strategically located in different geographic areas so as to simplify logistics in time of emergencies. And these food reserves must be made available to all who need them - and before famine strikes, not afterwards. Man can and must prevent the tragedy of famine in the future instead of merely trying with pious regret to salvage the human wreckage of the famine, as he has so often done in the past. We will be guilty of criminal negligence, without extenuation, if we permit future famines. Humanity cannot any longer tolerate that guilt.

The destiny of world civilization depends upon providing a decent standard of living for all mankind. It has been said that "Universal and lasting peace can be established only if it is based upon social justice. If you desire peace, cultivate justice". Almost certainly, however, the first essential component of social justice is adequate food for all mankind. Food is the moral right of all who are born into this world. Yet today 50% of the world's population goes hungry. Without food, man at most can live but a few weeks; without it all other component of social justice are meaningless. Therefore I feel that the aforementioned guiding principle must be modified to read: If you desire peace, cultivate justice, but at the same time cultivate the fields efficiently to produce more bread; otherwise there will be no peace.

Perhaps no one in recent times has more pungently expressed the interrelationship of food and peace than Nobel Laureate Lord John

Boyd Orr, the great crusader against hunger and the first Director-General of the Food and Agricultural Organization, with his famous words: "You can't build peace on empty stomachs". These simple words: of wisdom spoken twenty two years ago are as valid today as when they were spoken. They will become even more meaningful in the future as world population skyrockets and as crowding, social pressures and stresses increase. To ignore Lord Orr's admonition would result in worldwide disorders and social chaos, for it is a fundamental biological law that when the life of living organisms is threatened by shortage of food and crowding, they tend to swarm and use violence to obtain their means of sustenance.

It is a sad fact that on this earth at this late date there are still two worlds: "the privileged" and "the forgotten world", as far as food availability is concerned.

The privileged world consists of the affluent, developed nations, comprising 25 to 30% of the world population, in which most of the people live in a luxury never before experienced by man. The forgotten world is made up primarily of the developing nations, where most of the people, comprising more than 50% of the total world population, live in poverty, with hunger as a constant companion and fear of famine a continual menace.

THE CONCEPTION AND GENESIS OF THE GREEN REVOLUTION

When the Nobel Peace Prize Committee designated me the recipient of the 1970 award for my contribution to the Green Revolution,

they were in effect, I believe, selecting an individual to symbolize the vital role of agriculture and food production in a world that is hungry, both for bread and for peace. I accepted this honor as a member of a vast international team made up of many organizations, officials, thousands of scientists, and millions of farmers -mostly small and humble- who for many years have been fighting a quiet, often times losing war on the food production front.

During the past five years spectacular progress has been made in increasing wheat, rice and maize production in several of the most populous developing countries of southern Asia, where widespread famine appeared inevitable only six years ago. Most of the increase in production has resulted from increased yields of grain per hectare, a particularly important development because there is little possibility of expanding the cultivated area in the densely populated areas of Asia.

The term "Green Revolution" has been used by the popular press to describe the spectacular increase in cereal grain production during the past five years. Perhaps the term Green Revolution, as commonly used, is premature, too optimistic, or too broad in scope. Too often it seems to convey the impression of a general revolution in yields per hectare and in total production of all crops throughout vast areas comprising many countries.

These implications both oversimplify and distort the facts. The only crops which have been appreciably affected up to the present time are wheat, rice and maize. Yields of other important cereals, such as sorghums, millets and barley, have been only slightly affected; nor has

there been any appreciable increase in yield or production of the pulse or legume grain crops, which are essential in the diets of cereal consuming populations. Moreover, it must be emphasized that thus far the great increase in production has been in irrigated areas. Nor have all cereal farmers in the irrigated areas adopted and benefited from the use of the new seed and the new technology. Nevertheless, the number of farmers, small as well as large, who are adopting the new seeds and new technology is increasing very rapidly, and the increase in numbers during the past four years has been phenomenal. Cereal production in the rainfed areas still remains relatively unaffected by the impact of the Green Revolution, but significant change has been made in several countries during the past three years.

Despite these qualifications, however, tremendous progress has been made in increasing cereal production in India, Pakistan and the Philippines during the past three years. Other countries that are beginning to show significant increases in production include Afghanistan, Algeria, Brazil, Ceylon, Indonesia, Israel, Iran, Kenya, Malaysia, Morocco, Thailand, Tunisia and Turkey.

Before attempting to evaluate the significance of the Green Revolution one must establish the point of view of the appraiser. The Green Revolution has entirely different meanings to most people in the affluent nations of the "privileged world" than to those in the developing nations of the "forgotten world".

In an affluent, industrialized nation such as the USA, only 5% of

the labor force is engaged in farming and ranching. Each farmer produces enough food for himself and 45 others. The consumer's food bill represents only 17% of his take-home pay. Surpluses of wheat, maize and sorghum are commonplace; cattle, swine and poultry are fed and fattened on cereal grains; meat, fish, milk, eggs, fruits and vegetables are within the economic reach of most of the population; well balanced diets are more or less automatically achieved, and cereal products constitute only a modest portion of the "daily bread". Consequently, most of the people in such societies have difficulty in comprehending and appreciating the vital significance of providing high yielding strains of wheat, rice, maize, sorghum and millet for the people of the developing nations. Understandably then, the majority of the urbanites in the industrialized nations have forgotten the significance of the words they learned as youngsters: "Give us this day our daily bread". They know that food comes from the super-market; and only a few see beyond to the necessary investments, to the toil, struggle, and frustrations of the farmers and ranchers on the land who provide this daily bread. Since the urbanites have lost their contact with the soil they take food for granted and fail to appreciate the tremendous efficiency of their farmers and ranchers who, although constituting only five percent of the labor force in a country such as the United States, produce enough food for their nation as well as large quantities for export.

Even worse, urbanites often vociferously criticize their government for attempting to bring into balance the agricultural production

of its farmers with the domestic and foreign market demands for farm products while simultaneously attempting to provide the consumer an abundant food supply at reasonable cost. At the same time governments must assure a reasonable return to the farmer and rancher, if they are not to drive the smaller operators off the farms and into the slums of the large cities.

The new challenge for agriculture in the USA and other developed nations for the 1970's is to re-educate the city dweller on the importance of the farm and food production; to teach them that farmers have a love for the land and for nature, that is not newly discovered like that of the urbanites, who are now activists in the wildlife movements; and that the farmer also knows something about the environment. The urbanites must be shown that the farmers are not despoilers and wasters of national resources as they are so often described by the popular press today.

Contrasting sharply, in the developing countries, represented by India, Pakistan and most of the countries in Asia and Africa, 70 to 80% of the population is engaged in agriculture, mostly at the subsistence level. The land is tired, worn out, depleted of plant nutrients and often eroded. Crop yields have been low, near the starvation level and stagnant for centuries. Hunger prevails and survival depends largely upon the annual success or failure of the cereal crops. In these nations both, undernutrition and malnutrition, are widespread. They are a constant threat to survival and to the attainment of the genetic potential for mental and physical development. The diet consists primarily of

cereals, which provide from 70 to 80% of the calories and 65 to 70% of the protein intake. Animal proteins are so scarce and expensive as to be beyond the economic reach of the vast majority of the population. Sixty to eighty percent of the consumers' expenditure goes for food. Although many of these nations were self-sufficient and some were exporters of cereals before the second world war, they are now net importers, victims of population growth outruning agricultural production. There is little possibility in these countries of expanding the cultivated area to cope with the growing demand. The situation worsens if crop yields remain stagnant while human numbers continue to increase at frightening rates.

For the underprivileged billions in the forgotten world, hunger has been a constant companion and starvation has all too often lurked in the nearby shadows. To millions of these unfortunates, who have long lived in despair, the Green Revolution seems like a miracle that has generated new hope for the future.

The significance and magnitude of the impact of the so-called Green Revolution is best illustrated by changes in cereal production in India, West Pakistan and the Philippines. In both India and West Pakistan the rapid increase in yields per hectare of wheat has been the major thrust of the Green Revolution. Increases in rice yields also have played a major role in West Pakistan but up to now only a minor role in India. Increases in maize production have played a modest but significant role in expanded cereal production in both India

and Pakistan, and increases in rice yields and production have been largely responsible for the change in cereal production up to now in the Philippines, Ceylon and Indonesia.

The Green Revolution in India and Pakistan, which is still largely the result of a breakthrough in wheat production, is neither a stroke of luck nor an accident of nature. It is not due to favorable weather as Paddock has claimed. Rather its success is based on sound research, the importance of which is not self-evident at first glance. For, behind the scenes, halfway around the world in Mexico, were two decades of aggressive research on wheat that not only enabled Mexico to become self-sufficient with respect to wheat production, but which also paved the way indirectly for a rapid increase in wheat production in other countries. It was in Mexico that the high-yielding. Mexican dwarf varieties were designed, bred and developed. There, also was developed the new production technology which permits these varieties, when properly cultivated, to express their high genetic grain-yield potential, in general, double or triple that of the best yielders among older, tall-strawed varieties.

There are no miracles in agricultural production. Nor is there such a thing as a miracle variety of wheat, rice or maize which can serve as an elixir to cure all ills of a stagnant, traditional agriculture. Nevertheless, it is the Mexican dwarf wheat varieties and their newer Indian and Pakistani derivatives that have been the principal catalyst, or as Dr. Lester Brown has referred to them "The motor of change",

which triggered off the Green Revolution. It is the unusual breadth of adaptation, combined with high genetic yield, efficiency in the use of heavy doses of fertilizers, and of irrigation water, combined with a broad spectrum of disease resistance that had made the Mexican dwarf varieties the powerful catalyst that they have become in launching the Green Revolution. They have caught the farmers' fancy, and during the 1969-70 crop season 55% of the 6 million hectares sown to wheat in Pakistan and 35% of the 14 million hectares in India were sown to the Mexican varieties and their derivatives. This area increased further during the 1970-71 cycle in both countries, as well as in a number of other countries of the Near East and North Africa. This rapid increase in wheat production was not based solely on the use of Mexican dwarf varieties; it involved the transfer from Mexico to Pakistan and India of a whole new production technology that enables these varieties to attain their high yield potential. Perhaps 75% of the results of research done in Mexico in developing the package of recommended cultural practices, including fertilizer recommendations, were directly applicable in Pakistan and India. As concerns the remaining 25%, the excellent adaptive research done in India and Pakistan by Indian and Pakistani scientists while the imported seed was being multiplied, provided the necessary information for modifying the Mexican procedures to suit Pakistani and Indian conditions more precisely.

Equally as important as the transfer of the viable production package comprised of the new seed and new technology from Mexico to

India and Pakistan, was the introduction from Mexico of a Crop-Production Campaign Strategy. This strategy harnessed the high grain-yield potential of the new seed and new production technology to sound governmental economic policy which would assure the farmer a fair and stable price for his grain in relation to price of inputs, the availability of the necessary inputs: seed, fertilizers, insecticides, weed killers and machinery- and the credit with which to buy them. Collectively this strategy and the inputs became the base from which the Green Revolution evolved. The only other ingredient necessary to provoke rapid change was to demonstrate widely on farms the benefits of the new production technology package. This rapidly established the receptivity of the peasant farmer, and destroyed the myth of his ultra conservatism and resistance to change.

Never before in the history of agriculture has a transplantation of high-yielding varieties coupled with an entirely new technology and strategy been achieved on such a massive scale, in so short a period of time, and with such great success. The success of this transplantation is an event of both great scientific and social significance. Its success depended upon a team effort in which good organization of the production program was combined with skillful execution by courageous and experienced scientific leaders.

1. The Effects of the Green Revolution on Wheat Production

Experimentation with dwarf Mexican varieties was initiated in

both India and Pakistan in 1963 and continued in 1964. Results in both countries were highly promising. Consequently in 1965, 350 and 250 tons of seed of the Mexican dwarf wheat varieties were imported into Pakistan and India, respectively, for wide-scale testing on farms. Again, the results were highly promising and India reacted by importing 18 thousand tons during 1966. A year later, Pakistan imported 42 thousand tons. With these importations, the revolution in wheat production got underway in both countries. It was the first time in history that such huge quantities of seed had been imported from distant lands and grown successfully in their new home. These importations saved from three to five years time in reaping the benefits from the Green Revolution. It was not a wild irresponsible risk as has been implied by Paddock, Ehrlich, Perelman, Wharton and Armstrong. It was based on scientific evaluation. The results have fully justified the decision.

During the past four years wheat production has risen spectacularly in both countries. Using as a base the pre-Green Revolution crop year 1964-65, which produced an all-time record harvest in both countries, the production in Pakistan increased from the 1965 base figure of 4.6 million tons to 6.7, 7.2 and 8.4 millions of tons, respectively, in 1968, 1969 and 1970. Production figures are not yet available for the 1971 harvest. West Pakistan became self-sufficient in wheat production for the first time in the 1968 harvest season, two years ahead of our predictions. Indian wheat production has risen from the 1964-65 pre-Green Revolution record crop of 12.3 million tons to 16.5, 18.7, 20.0 and 23.2

million tons during 1968, 1969, 1970 and 1971 harvests, respectively. India is approaching self-sufficiency and probably reached it in the current 1971 harvest. It probably would have attained self-sufficiency in wheat earlier if rice production had risen more rapidly, because, with a continuing shortage of rice, considerable wheat was substituted for rice.

The introduction into West Pakistan of the high yielding dwarf rice variety IR8, developed by the International Rice Research Institute (IRRI) in the Philippines, together with the new technology that makes it highly productive, has also resulted in phenomenal increases in yield and production during the past two years. Unfortunately, this variety has been less well adapted to climatic conditions in the monsoon areas of India and in East Pakistan and therefore has had only a modest impact there. Newer varieties such as IR 20 and others which are now being multiplied promise to correct this situation.

2. Effects on Farm Income and Investments in Inputs

A. Income

The revolution in wheat production in India and Pakistan has not only greatly increased food production, but it also has had many indirect effects on both the farmer and the economy. It is estimated that Indian and Pakistan farmers who are cultivating the new Mexican dwarf wheat varieties under the recommended management practices have increased their net income from 37 dollars per hectare with the local varieties to 162 dollars with the dwarf Mexican varieties. During the past four

harvests a total equivalent of 3.0 billion dollars and approximately 1.1 billion dollars have been added to the gross agricultural production value of India and Pakistan, respectively, as the result of the increase in wheat production above the record 1965 base. The injection of this large increase in purchasing power into the economies has had many effects. Recent studies by Drs. C. Gilpatric and I.J. Singh, by M.S. Randhawa in India and by Refugio Rochin in West Pakistan indicate that both the small farmers -2 to 5 acres- as well as large farmers -who generally have "huge" farms of 20 to 30 acres- have received benefits from the new technology. Although the greatest impact has been produced on irrigated land, large areas of rainfed wheat in both countries are now also being sown to the Mexican varieties.

B. Tubewell development

Large numbers of tubewells are being sunk by farmers in both India and Pakistan in order to expand the irrigated area and improve the control of irrigation water. It is estimated that a total of 70,000 private tubewells were sunk during the 1969-70 crop season in India, which brought about 1.4 million hectares of additional land under controlled irrigation. This has not only greatly expanded the food production but serves as a stabilizing factor for future crops largely free of the vagaries of rainfall. It is estimated that at present less than half of the irrigation potential of India has been developed.

The tubewells have had another highly beneficial indirect effect in both India and Pakistan. They have brought clean water for drinking,

bathing and laundry purposes to millions of people who previously had relied on the foul multiple purpose village water tank which jointly had served the needs of both humans and buffaloes.

C. Fertilizer use

If the high-yielding dwarf wheat and rice varieties were the catalysts that ignited the Green Revolution, then chemical fertilizer was the fuel that has powered its forward thrust. The responsiveness of the high-yielding varieties has greatly increased fertilizer consumption. The new varieties not only respond to much heavier dosages of fertilizer than the old ones but are also much more efficient in its use. The old tall-strawed varieties would produce only 10 kilos of additional grain for each kilo of nitrogen applied, while the new varieties can produce 20 to 25 kilos or more of additional grain per kilo of nitrogen applied. Consumption of nitrogen fertilizer in India has increased from 58,000 metric tons of nutrients in 1950-51 to 538 thousand, and 1.2 million metric tons in 1964-65 and 1969-70 crop cycles, respectively; and about 60% of this amount was produced domestically. Phosphate consumption is approximately half that of nitrogen. A large part of the fertilizer currently being used is for wheat. The targeted consumption and domestic production needs of nitrogen for 1973-74 are 3 million and 2.5 million metric tons, respectively, a fantastic threefold increase in consumption and a fivefold increase in production. These fertilizer targets must be attained if the targeted production of 129 million metric tons of cereal is to be realized.

D. Mechanization

Mechanization of agriculture is rapidly following the breakthrough in wheat production. Prior to the first big wheat crop in 1968, unsold tractors accumulated at the two factories then in production; at present, prospective purchasers must make written application for them and wait one or two years for delivery. Although five factories, with an output of 18 thousand units per year are now producing tractors, 35 thousand units were imported in 1969-70.

The traditional method of threshing by treading out the grain with bullocks, followed by winnowing, is now inadequate for threshing the increased volume of wheat before the onset of the monsoon rains. Consequently, tens of thousands of small threshing machines have been produced and sold by hundreds of small village machine shops during the past four years. As this trend continues, the loss of crop after harvest is minimized. It has the additional benefit of providing additional employment in many new, small village industries. Many more threshers are still needed in order to speed up the threshing and avoid unnecessary losses. In 1971 the monsoons set in one month earlier than normal, while threshing was far from completed, with the result that considerable loss in quality was experienced.

In those areas most affected by the Green Revolution, there has been an increased demand for labor, resulting in higher wages and an actual shortage of labor at the peak seasons.

3. The Effect on Multiple Cropping

Mechanization has had another very important indirect effect on

the intensification of cereal production. When small mechanical threshers replace bullocks for threshing, the bullocks are released for use in the timely preparation of the land for the next (summer) crop. This need for timely preparation of land is also one of the main reasons for the surge in demand for tractors. Before the adoption of the new high-yielding wheat and rice varieties, in combination with heavy applications of chemical fertilizer, the time of sowing was relatively unimportant because yields were limited primarily by low level of available plant nutrients. Most good farmers would expect to harvest about one metric ton of wheat during the winter (rabi) season and about 1.5 metric tons of Paddy during the summer (kharif) season, or a total of 2.5 metric tons of grain per hectare per year. But by using the high-yielding varieties, fertilizing heavily, sowing at the right time, and managing the fields properly, the same farmer can now harvest 5 tons of wheat and 7 tons of paddy per hectare from the same land, a total of 12 metric tons of food grain per hectare per year, as contrasted with the 2.5 tons which he obtained with the old varieties and methods. If plantings are not done at the optimum time, however, the yield of wheat may drop to 3 tons and that of rice to 4 tons per hectare, a total production of 7 tons per year instead of the 12 tons obtainable when all operations are done properly and at the right time. A few of the most progressive farmers now use triple cropping, involving wheat-mung beans-rice, wheat-rice-potato or three consecutive crops of rice during the same year. By increasing the intensity of

cropping, both food production potential and employment are increased.

Yields should now be calculated on the basis of kilos per hectare per year rather than on the basis of kilos per hectare per crop.

The increased mechanization in cereal production has tended thus far to increase rather than decrease the employment opportunities for labor and, above all, it has helped to reduce drudgery and increase the efficiency of human energy, in India in particular.

4. Effect on Agro-Businesses and Consumer Goods

Millions of farmers who have successfully grown the new wheat, rice and maize varieties, have greatly increased their income. And this has stimulated the rapid growth of agro-industry by increasing the demand for fertilizers, pumps, motors, machinery and other materials and services.

Farmers in many villages are investing in better storage facilities. In some locations brick houses are beginning to replace those made of rammed earth. More electricity is being used to light the houses and to drive the motors on the wells. There also has been a rapid increase in demand for consumer goods. The purchase of transistors and radios for use in the villages has increased rapidly, and thereby the government for the first time can effectively reach the remote villages with educational programs. Sewing machines, bicycles, motor scooters and motorcycles are coming to the villages, and truck and bus service between villages is improving.

5. Effect on Infrastructure and Government Services

The Green Revolution has forced the Indian government to improve many of its public services. Although there was an extreme shortage of regular storage space for the first record-breaking wheat crop in 1968, the government improvised satisfactorily and very little grain was lost. During the past two years, stimulated in part by criticism by farmers and the press, warehouse capacity has been expanded greatly to provide adequate storage for the increasing grain production. The villages are demanding better roads, better public transportation and better schools; and they are beginning to get them. Thus the divorce between intellect and labor, which the great Indian leader Mahatma Ghandi, over 40 years ago, regarded as the bane of India's agriculture, is coming to an end.

The changes brought by the Green Revolution, which I have illustrated by the vast improvement of wheat production in India, have had similar effects in West Pakistan, Ceylon, The Philippines and Thailand, although the effects in different countries were produced by changes in different crops or combinations of crops.

Although the contributions of the Green Revolution to increase food production are considerable and highly significant, they are, nonetheless, modest in comparison with the magnitude of present global needs. The greatest obvious achievement is the rapid increase in cereal production during the past four years, and the generation of a climate of confidence in the developing nations with regard to their capabilities of achieving food self-sufficiency. Perhaps even more significant,

however, is the change in organizations and attitudes which have accompanied the increases in cereal production.

The All-India Coordinated Wheat Improvement Program, which is largely responsible for the wheat revolution in India, has developed into one of the most extensive and widely diversified wheat research programs in the world. Its success has generated confidence, a sense of purpose, and determination. The current agronomic research on wheat in India equals the best in the world. The breeding program, also one of the world's best, is huge, diversified and aggressive; already it has produced several varieties which surpass in performance those originally introduced from Mexico in 1965. Two newer groups of Indian varieties are already being grown extensively in commercial production. The first group was derived from selections made in India from partially selected materials received from Mexico. The second group of varieties are selections from crosses made in India between Indian and Mexican varieties. The rapidity of creation and distribution of these new varieties has already diversified the type of resistance to diseases and therefore minimizes the menace of destructive disease epidemics if and when changes occur in parasitic races of the pathogens.

Contrary to a widespread and erroneous opinion of Paddock, Bennett, Harlan and Perelman, the original dwarf wheats imported from Mexico definitely carried a wider spectrum of disease resistance than the local Indian types that they replaced. But the newer Indian

varieties are even better in resistance and of a different genetic type than either "desi" Indian wheats or the original introductions. This greater diversity reduces the threat but cannot completely eliminate the dangers of disease epidemics in a self-pollinated crop such as wheat or rice. The dangers are made vividly clear by the unexpected and destructive epidemic of southern leaf blight of maize over vast areas of the U.S.A. during the summer of 1970. The stage was set biologically for what could have been a disastrous epidemic in 1971. Nevertheless, the crop escaped serious damage because of a dry summer, not because of the replacement of the susceptible hybrids with resistant hybrids which will not be possible to achieve until the 1972 crop season. The only protection against such epidemics in all countries, is through resistant varieties developed by intelligent, persistent and diversified breeding programs, such as that being currently carried on in wheat in India. This is coupled with a broad disease-surveillance system and a sound plant pathology program, which is essential adjunct to the breeding program. From such a program, a constant flow of new high-yielding, disease-resistant varieties can be developed to check-mate any important changes in the pathogens.

Summary of Accomplishments and Limitations of the Green Revolution

In summarizing the accomplishments of the Green Revolution over the past 4 years, I wish to restate that the increase in cereal production, rice, maize and wheat, and especially in wheat, has been spectacular

and highly significant to the welfare of millions of human beings. It is still modest in terms of total needs. Recalling that 50% of the present world population is undernourished and that an even larger percentage, perhaps 65%, is malnourished, no room is left for complacency. It is not enough to prevent the currently bad situation from getting worse as population increases. Our aim must be to produce enough food to eradicate all present hunger while at the same time striving to correct malnutrition. To eliminate hunger now in the developing nations, we would need to expand world cereal production by 30%. If it were, however, as simple as increasing the total world production by 30%, regardless of where the production is to be expanded, it could be accomplished within two years by expanding it in the United States, Canada, Australia, Argentina and USSR. But this would not necessarily solve the hunger problem of the developing world. Their weak economies will not permit them to increase their food imports by 30%.

The economies of the developing nations are largely rural, with 70 to 80% of the population engaged in agriculture, mostly at the subsistence level. The attack on the food production problem must begin with them. Their production must be increased so that they produce more grain to meet their own needs, and leave a surplus for sale. In this way only will they be brought into the economy as prospective customers for industrial goods. They, then, will begin to exert a stimulatory effect on the economy of the country as a whole.

If present production could be expanded rapidly by 30% in the developing countries -which I believe is possible based on recent progress of the Green Revolution- so as theoretically to eliminate world hunger, the hunger problem as it now exists still would not be solved. There remains the unsolved socio-economic problem of finding effective ways to distribute the needed additional food to the vast underprivileged masses, both the urban and rural landless, who have little or no purchasing power. This is still the great unsolved problem with which the eonomists, sociologists and political leaders must now come to grips.

I am convinced that if all policy-makers would take sufficient interest in population control and in aggressively employing and exploiting agricultural development as a potent instrument of agrarian prosperity and economic advancement, many of the social ills of the present day could soon become problems of the past.

Criticism of the Green Revolution has become a popular pastime. Perhaps it reflects the feelings of some who had predicted famine and doom for the hungry nations and, consequently, cannot yet forgive the new strategy for being successful. Some critics have said that the Green Revolution has created more problems than it has solved. This I cannot accept, for I believe it is far better for mankind to be struggling with new problems caused by abundance rather than with the old problem of famine. Certainly, loyalty to the status quo in food production - when being pressured by population growth- cannot break the chains

that have bound the peasant to poverty and hunger.

One must ask:

Is it just to criticize the Green Revolution, with its recognized accomplishments, for failure to correct all the socio-economic ills of the world that have accumulated from the days of Adam and Eve up to the present?

Change we must, or we will perish as a species, just as did the dinosaurs in the late Cretaceous.

The Green Revolution is a change in the right direction, but it has not transformed the world into Utopia. None are more keenly aware of its limitations than those who started it and fought for its success. But there has been solid accomplishment, as I have already shown by concrete examples. I have also tried to indicate the various opportunities for capitalizing more fully on the new materials that were produced and the new methods that were devised. And, above all, I cannot emphasize too strongly the fact that further progress depends on intelligent, integrated and persistent effort by government leaders, statesmen, tradesmen, economists, scientists, educators and communication agencies, including the press, radio and television.

Unfortunately in virtually all of the developing nations there has been an overabundance of planning for agricultural development and an under execution of plans. Overemphasis has also been given to developing organizational structures and program projects. All of

such planning is sterile unless it can be implemented.

The shortage of trained scientists to carry on applied research and production agronomists to extend the research results is the single greatest obstacle to overcome in trying to revolutionize crop production in the developing nations.

This situation is complicated even further by a shortage of scholarships and fellowships for training more young scientists.

The budgets allocated to support research are also without exception very inadequate for the needs. Almost invariably the research program is hampered by inadequate transport facilities and complicated bureaucratic administrative procedures.

Threats to the Further Expansion of The Green Revolution to Solve our Food Production Problems

The Green Revolution has won a temporary success in man's war against hunger and deprivation. It has given man a breathing spell. If fully implemented, it can provide sufficient food for sustenance during the next three decades. This could, hopefully, provide man time to bring into reasonable balance population growth and man's

responsibility for providing a decent standard of living to all who are born into this world.

The continued success of the Green Revolution will hinge, however, upon whether agriculture will be permitted to use the inputs -agricultural chemicals- including chemical fertilizers and pesticides, both absolutely necessary to cope with hunger. If agriculture is denied their use because of unwise legislation that is now being promoted by a powerful lobby group of hysterical environmentalists -who are provoking fear by predicting doom for the world through chemical poisoning- then the world will be doomed but not by chemical poisoning, but from starvation.

But one must ask: Can this sort of folly, with its resultant disaster, really happen among the educated people of the developed nations? My answer is yes, I believe it can, There is still within man some basic animal instinct that all too often urges him to join and follow leaders of a hysterical movement, in much the same way that most individuals in the arctic lemming population, under severe population pressure, joins the suicidal march to the sea. But, what led to the present crusade by the hysterical environmentalists, and how did it gain its following and power?

The Environmentalists - and their Myopic Disastrous Policy on Conservation and Agriculture

The people making up the so-called environmentalist movement of today are of very diverse origin. The greatest number of this movement are urbanites who have recently rediscovered the beauties

of nature. Most of them have lived in large cities for one, two or three generations. They come from all walks of life. They are lawyers, doctors, dentists, business executives, business managers, clerks, teachers, professors, factory workers, bureaucrats, morticians, starlets, news commentators, radio and television celebrities, artists and politicians. They all have several things in common. Among them are the concept -that has persisted since their parents, grandparents or greatgrandparents "escaped from the dreadful life in the country"- that all people who continue to live in the countryside are dullards and country rubes. Unfortunately this disdain for rural people still unconsciously widely persists.

Within the past 15 years there has been a growing exodus of weekend visitors and vacationeers from the cities into the countryside. This does not happen now only on the annual vacation, as was the case before World War II, but happens several or even many times each year. This change in travel has come about because of: 1) higher incomes, 2) better transport -most families now have at least one automobile and many have two-. Moreover, there are now excellent highways, and 3) more leisure time, because of a shorter work week.

These three factors have combined to change the exodus from the cities into a flood of people into the countryside many times each year. The number of trips and excursions into the countryside is greatest in the developed countries and especially in countries like USA, Sweden and other privileged western European countries. It is also in these countries and especially in the USA and Sweden where the

environmentalist movement is strongest and most vociferous.

We must understand why these privileged vacationeers abandon the cities as often as possible before we can comprehend their actions in the environmentalist movement. By leaving the large urban centers, they are escaping from the industrial and automotive smogs, the traffic jams, noise, stress, crowding, crime and the smelly stinking sewers, rivers and harbors.

The "escapees" who come to the countryside on vacations are rediscoveri ng nature. They are falling in love with the blue skies, the fresh air, the clean water of the streams, the verdure of the landscape, the beauty of the trees and flowers. They thrill to the song of the meadow lark, bobolink, oriole, to the call of the bobwhite and the loon, and to the crowing of the ring-neck cock. They are enchanted by the mating call, the drumming of the ruffed grouse, the whir of wings of the teal and the majestic flight formation and cadence of the Canadian honker. They delight in the sassyness of the chipmunk and the petulance of the blue-jay. Their heart is won by the gentleness of the fawn, the inquisitiveness of the bear, and the industry of the beaver. They are fascinated and invigorated by the changes in seasons and by many other marvels of nature.

They are motivated. They want to do something, to join some organization so as to preserve this beauty so that it does not degenerate into the ugliness of the large metropolis, where they are imprisoned most of the year. It is obvious to most that the first thing that must be

done is to protect nature from the brutes and despoilers: the "hayseeds" (farmers), the cow-pokes (ranchers) and jack-pine savages (lumbermen and pulpwood producers) who do not appreciate its beauty and will destroy it if left unfettered.

They fail to realize that they are themselves some of the worst despoilers of nature. They litter the countryside with beer cans, soft drink bottles, waste paper, garbage and refuse of many other kinds. They inadvertently set forest fires, frighten wildlife and add general noise and confusion to the countryside. Although they are oblivious to their own effects on the environment, they are generous in their criticism of the farmer, rancher and lumberman.

The result of this attitude has been that agriculture (farming, ranching and forestry) has been placed much too high on the list of despoilers of the environment. Whereas these urbanites who have rediscovered the beauties of nature should be the first to insist on correcting the abuses of dumping of city sewage and industrial wastes into our rivers, lakes, harbors and oceans, and reducing the pollution of the atmosphere around our cities from industrial and automotive smog and reducing noise, they instead insist on oversimplifying and want to make a scapegoat of farmers and ranchers as the great public enemies. Perhaps this is because the unorganized farmers and ranchers are much easier to attack legally than are the large cities and large industries who are the worst polluters and to which these same urbanites each contribute their own bit each day. Besides, corrective measures would increase their taxes.

That this attitude still prevails is evident from the writings of Frank Graham Jr., a member of the environmentalist movement and author of "Since Silent Spring", "Disaster by Default" and more recently "Man's Dominion". In the latter he states: "An appreciation of scenic beauty or even a sense of stewardship in relation to the land, was no part of the spiritual makeup of the settlers".

It never occurs to the environmentalists and members of these groups that these dullards and deep oilers of nature are the same people who provide their food, building materials and paper at very low costs. So the problem, for them, is simple: How can we prevent nature from being raped by these vicious enemies?

Fortunately for the environmentalist movement in the USA -but not for the general public- the organizations with long time experience in the field of lobbying for legislation for conservation of natural resources stood ready and captured the role of leadership in organizing and expanding programs to protect nature. It should be pointed out that certain of these organizations, such as the Sierra Club, National Audubon Society and the Isaac Walton League or their predecessor organizations assisted through effective lobbying in the establishment of National Parks, National Forests, Game Refuges and legislation to protect wildlife in the USA during the critical period, from the early 1880's through 1918. The citizens of the USA and the world are indebted to them for the role they played in these worthy movements, but it must be pointed out that many individuals, such as

Gifford Pinchot -who were not members of these organizations- made equally great contributions. Moreover, these organizations -with lack of understanding- have claimed that the legislation they sponsored is what has saved the bird life in the USA. This is a gross oversimplification of facts. The various Audubon societies were instrumental, beginning as far back as 1862 and continuing through four decades in having legislation passed in many states to prohibit the slaughter by meat hunters of the passenger pigeon and many other bird species.

Despite such legislation the passenger pigeon continued to be slaughtered to a point where it became rare by 1905 and extinct by 1914. It was not only the passenger pigeon that was being slaughtered by the meat hunters to fill the protein needs of the large cities, but also many other species, classified today as song birds in the USA. Graham, in Man's Dominion reports "Visitors...told of seeing robins hung up for sale in strings like onions"."...meadowlarks, blackbirds, sparrows, thrushes, warblers, vireos and even woodpeckers could be found hanging beside robins and bobolinks in the (meat) stalls". This slaughter went on well into the first decade of the 1900's, but had begun to tapper off before the legislation of the Model Acts of 1900, and 1905, and long before the Migratory Bird Act of 1913 and 1916.

The prime factor in saving several of these bird species as well as wild ducks and geese from possible extinction was not so much these legislative laws but the production of cheaper and better sources of meat to cover the consumer needs in the large cities. The increase

in efficiency of production of poultry, pork and beef products by the nation's farmers and ranchers, combined with improved transportation and refrigeration was what put the wild-bird meat hunters out of business.

None of the various conservation organizations have ever -so far as I know- acknowledged this important indirect role played by agriculture in conserving wildlife.

But one must ask: What does this historic conservation struggle have to do with the present world food and health problem and with the environmental degradation issue?

In the late 19th. century and first three decades of the 20th. century, it was possible to have a furious, vitriolic debate and struggle going on over conservation and wildlife issues in the USA, without it having any appreciable impact elsewhere in the world. The rapid improvement of communications -especially of radio, television and the international news services during the past 25 years- has changed all this. Today, lobbying and pressure for legislation on matters affecting the environment, health, food and fiber production programs in the USA will have both an important direct and indirect effect on programs and policy issues of the developing nations. Indirectly unwise legislation could have much to do with whether there will be political stability or political chaos in the world. The present day "new aristocratic" environmentalists of the USA either fail to comprehend this or, more probably, insist on ignoring it even though they know very well the disruptive influence that self-centered, ill-

-conceived and precipitated legislation will have on the developing nations.

Let us now turn to the current crusades of the privileged environmentalists in the USA and see how the policies they are advocating will affect both that nation and the developing nations. Before doing this, however, I must establish the points of view and platform of experiences from which I speak. First, I assure you that I, too, am concerned about the deterioration of the environment. But I am even more apprehensive about the impulsive emotional myopic tactics that are being advocated by some environmentalists to correct this deterioration.

I dislike fighting my way through industrial smog, automotive smog and traffic jams each morning and evening. I dislike the noise and crowding of the large cities. Nor do I enjoy the ugliness of mountainous junk heaps and garbage piles. I have always enjoyed canoeing and boating, but not in rivers and lakes laden with stinking city sewage and industrial wastes. Nor do I approve of farmers, ranchers, timbermen, foresters or urban gardeners, using agricultural chemicals carelessly. I am equally interested in the welfare of the food producer and the food consumer. I am especially concerned about the food production problems and health problems of the developing nations. I began my professional career as a forester, as a forest ecologist, as a matter of fact. I lived and worked as a forester in the largest most remote and undisturbed, primitive or wilderness area

of the USA, and it was there where I learned firsthand about the over-simplification of the cliché "in balance with nature". To this day I enjoy nature, the luxury of undisturbed wilderness, forests, mountains, lakes, rivers and deserts and their wildlife. But I also know that the greatest danger to their perpetuity is the pressure of human population. I worked for several years in the chemical industry, and was one of the first American scientists involved in research on DDT. I assure you, however, that neither I nor the organization which I represent, have had any financial support or assistance from any part of the chemical industry for the past 27 years and, consequently, are not influenced by any of their lobbying. For the past 27 years I have been engaged in the struggle of trying to assist the developing nations to improve their agriculture and expand their food production.

In Balance with Nature - A Biological Myth

The current vicious, hysterical propaganda campaign against the use of agricultural chemicals, being promoted today by fear provoking, irresponsible environmentalists, had its genesis in the best selling "half-science-half-fiction novel" Silent Spring, published in

1962. This poignant, powerful book -written by the talented scientist Rachel Carson- sowed the seeds for the propaganda whirlwind and the press, radio and television circuses that are being sponsored in the name of conservation today, but which are to the detriment of world society, by the various organizations making up the environmentalist movement.

It is both sad and unfortunate that Silent Spring was the last book which was written by this gentle, great scientist and authoress. She had previously contributed so much to the understanding of the beauties of nature in the best sellers "Under the Sea Wind" and "The Sea Around Us".

"Silent Spring" was not typical of her gentle, kind nature. It was a diabolic, vitriolic bitter one-sided attack on the use of pesticides, especially insecticides and weed killers. DDT was the main villain. She made no mention of the importance of DDT in protecting our food and fiber production. What was even worse was that she made no mention of the great contribution of DDT in bringing malaria -one of the worst scourges of mankind- under control.

Silent Spring has become the Holy Writ of the environmentalist movement. This distorted, oversimplified book of biologic half-truths is now required reading in many high schools, thanks to the influence of our environmentalist organizations. Rachel Carson has become a martyr.

The moving forces behind the environmental movement today

include The Sierra Club, National Audubon Society, Isaac Walton League, The Boone and Crockett Club, and the new legal arm of the movement: The Environmental Defense Fund, with its scores of lawyers baptized into the movement with the motto "Sue the Bastards". The principal individual supporters of the movement are wilderness explorers, bird-watchers, wildlife lovers, ill informed press and television personalities and confused youth and older members of society who have been frightened so badly by the doom sayers that they have joined. Although the collective active membership in these organizations is perhaps less than 150, 000, their superb organization and tactics make them as extremely effective force in lobbying for legislation to ban pesticides, and for brain washing the general public. The propaganda and lobbying tactics being used today by the environmentalists is very similar to the tactics that were used effectively in lobbying for wildlife legislation by Hornaday and Grinnell during the first two decades of this century, judging from Graham's description of their efforts. The righteousness of their cause seemed - in their minds - to justify whatever questionable methods were needed, such as over-exaggeration and half-truths for furthering their cause. History repeats itself today, but it is being done even more flamboyantly.

The scare tactics used by The Environmental Defense Fund, based on bits of unsubstantiated scientific data, questionable ethics, emotion and oratory has been used very effectively for raising funds and gaining support for their battle against DDT. One of their

advertisements in The New York Times -on Sunday March 29, 1971- headlined "Is Mother's Milk Fit for Human Consumption?" was especially effective. It stated that DDT had been found in mother's milk. No mention was made of the fact it was present at very low levels. Of course no mention was made of the fact that caffein, nicotine or alcohol in small quantities might also be present in mother's milk when she drinks coffee, smokes cigarettes or drinks cocktails. Nevertheless, the report of detection of DDT in mother's milk provoked indignation and brought in much financial support.

Previously both, the Environmental Defense Fund and the National Audubon Society had stated that DDT causes cancer, even though the Surgeon General of the U.S. Public Health Service has stated: "We have no information on which to indict DDT as a tumorigen or carcinogen for man and, on the basis of the information now available, I cannot therefore conclude that DDT represents an imminent health hazard".

The gravest defect of Silent Spring was that it presented a very incomplete, inaccurate and oversimplified picture of the needs of the interrelated world-wide complex problems of health, food, fiber, wildlife, recreation and human population. It made no mention of the importance of chemicals such as fertilizers and pesticides for producing and protecting our food and fiber crops. Nor did it mention that by producing more food per unit of cultivated area more land would be available for other uses, including recreation and wildlife.

Certainly the greatest inexcusable error of omission was that of neglecting to mention the valuable role DDT has played in bringing malaria under control in many countries.

Silent Spring convinced the general public that the use of pesticides -and especially DDT- was upsetting the "balance of nature" and was doing great damage to wildlife, especially birds and fishes. It implied that a number of species were facing extinction because of its use. Moreover, it left the impression that agriculture really did not need insecticides if it changed its methods. It indicated that farmers by adopting a system of extensive mono-culture, have made their crops more vulnerable to pests than necessary. According to this expert, farmers have compounded their errors more by applying insecticides in attempting to kill insect pests and in the process have generally only killed off the predators, parasites and pathogens that normally kept the insect under control, and thereby only further upset the "balance of nature". Moreover, according to the author, insects have invariably soon developed resistance to the insecticide. It implied that, by shifting to other suitable insect control measures already available, that the losses from insects could be kept under control without chemicals. Let us examine this general hypothesis:

The Parade of the Species

I am in complete agreement that we should try to preserve all forms of wildlife as part of our heritage, as far as it is possible to do

so. On the other hand, let us not become egotistical to the point of assuming supernatural powers. A glance at the book of rocks tells us of the impotency of many species, including man against the forces of nature. Yet it is incredible that only a few, if any, of the leaders of the current environmentalist movement have studied paleontology and the "parade of the species", in the geologic past. Spencer estimates that 99% of all the species that have lived, since the candle of life was first lit on the planet earth about 3.2 billionyears ago, have flunked the adaptation imperative: "evolve or perish", and consequently have now become extinct.

The implied command: "evolve or perish" has been an unwritten natural law from the beginning of time. It is equally evident in the physical and biological world. Astronomers tell us change is a universal phenomenon throughout the cosmos. The process of physical change is most evident within our own solar system and especially on our planet Earth. Long before there was life on earth there were countless physical changes in the earth's crust. Repeatedly mountains were built through volcanic action or by physical shifts in the earth's crust. The mountains in their turn were eroded away and the debris deposited elsewhere as sedimentary rock. The oceans invaded and inundated what was once the land, only to in turn recede again. Physical changes, of course, continue to reshape the planet earth to this day.

The multitude of changes in the physical features of the earth, as well as in our solar system itself, have repeatedly greatly modified the environment of the earth. Climates have changed time and again in many parts of our world. Vast areas that once possessed tropical climates have subsequently been covered by continental ice sheets. Areas that once were blessed with heavy rainfall have become desert and vice versa. These changes in environments have, in turn, exerted strong selection pressure on the evolution of all forms of life.

There are undoubtedly many subtle changes being exerted on the environment of the planet today that are beyond the influence and control of man. Man too, however, is exerting strong influence on the environment. The composite effect of the present day selection pressure of the environment, affected both by natural and man influences, will undoubtedly continue to take its toll of some species that are poorly adapted to the current world environment.

Rhodes, Zim and Shaffer estimate that there are at present approximately 1,100,000 species of animals, many of them very simple forms, and 350,000 species of plants that currently inhabit the planet earth. Of these, the United States Fish and Wildlife Service in 1966 listed 33 species of mammals, 49 species of birds and 9 species of reptiles and amphibeans, and 38 species of fish in the U.S.A., which were either rare or endangered. In discussing the causes for reduction in numbers and possible disappearance of these 129 species, the destruction of the habitat and disturbances

resulting from man's activities were paramount. Pesticides were mentioned as possible contributing factors in only two cases. In the past three or four years there has been much propaganda, but little convincing scientific evidence, put forward by environmentalists indicating that DDT has contributed to the decline of the Bald Eagle, Peregrine Falcon, American Osprey and California Condor. One does not need a thin egg shell hypothesis due to DDT to explain the reduction in the population of these species. The truths of the matter is that many ornithologists had reported on the reduction in populations of these large birds of prey as far back as the 1880's and 1890's, long before the time of DDT. It is almost a forgone conclusion, for anyone who uses some common sense, that one or more of these species is about to flunk the imperative "evolve or perish". His habitat is being destroyed by the encroachment of man. Protective legislation alone will not, in the most cases, be adequate to save them. Dynamic research, propagation and good sound game management might do so, providing human population pressures on their habitat are not too great.

Although it is generally the long time continuing effects of changes in the environment which exert its effects on the evolution and survival or the extinction of a species, there are many other changes in the environment that effect the more short term "balance of nature", among the many species in a given habitat or ecosystem. These are the seasonal shifts we are concerned with in producing and protecting our crops or animals. The cliché "in balance with nature", which is in common usage today by modern

day environmentalist is very misleading. It implies we would have a favorable "in balance with nature" to assure the protection of our crop species if the "balance of nature" were not upset by man. This, of course, is not true. Nor is there in existence a single in balance with nature ecosystem. Rather there is, within a given area, an infinite number of local and many merging more extensive ecosystems. None of them are in static equilibrium. They are in a constant state of dynamic change, responding to the changes in the environment. At different times, the selection pressure provoking change is drought, floods, frosts, heat, insect or disease attacks, or invasion of the habitat by other species.

Early in my career as a forester working in a large primitive or wilderness area completely isolated from the infuence of man, I learned of the fickleness of nature. I have seen 20 forest fires ignited by a single "dry thunder (electric) storm". Some of these fires started by lightening destroyed or damaged vast areas of several forest types (ecosystems). In the same area I have seen 10's of thousands of acres of lodgepole pine killed by Dendroctonus spp., infestation. The havoc done by the Dendroctonus beetle should not have happened according to some pseudo-ecologists, for it was, after all, a native insect pest with its entire army of natural predators, parasites and pathogens, and consequently should have been "in balance with nature".

Many times I have seen attempts made to grow cotton without the use of insecticides in the native home of the boll weevil in Mexico where all of the native predators of this insect were present. The results were disastrous.

Similarly, I have observed cotton grown without insecticides in West Pakistan, the native home of the pink bollworm, with all of its natural predators and parasites present. In this case also the results were disastrous. In fact, in both of the cases it was difficult to tell from casual observation whether the cotton was being grown for the production of fiber to cloth man or for the production of feed for a native insect. Nevertheless, in both cases there should have been, according to our environmentalist jargon, an "in balance with nature" equilibrium.

I must also point out that modern agriculture - with 3.7 billion people demanding food and fiber - has no choice but to grow extensive areas to a single crop in areas ecologically best suited to the culture of that crop. This was not true 5,000 years ago, when there was less population pressure, so that crops could be grown in small isolated fields. Nevertheless, we must also recognize that mother nature, even before civilized man, sometimes took the initiative of establishing 10's of thousands of acres of even aged single species stands of douglas fir, redwood, lodgepole and jack pine stands. Most of these pure stands ("mono-cultures" to the new environmentalists) were, of course, post-fire types.

It, therefore, becomes abundantly clear that we cannot relay on the biologic control alone to protect our food and fiber crops from the fickleness of nature. If left to mother nature wims, we will harvest only one third or one half of the yield per unit of cultivated area that can be harvested using a modern balanced technological package of practices.

Dr. Knipling has clearly indicated that we must, for the forseeable future, continue to use an integrated approach to control the insect pests of man, of the crops and of the animals on which he depends. Insect control is a complex problem for there are more than 200 insects that are or have been important on our main crops, animals and forests. We will need to use an integrated approach to hold them in abeyance. It is true that in the past few decades spectacular control of a few insect species have been obtained with biological, bio-environmental or other non-chemical methods i.e. cottony-cushion scale of citrus, the spotted alfalfa aphid and the screw-worm of livestock in Florida. Someday it may be possible to use alternate non-chemical methods to control many of the insects responsible for the most severe crop and animal losses, but that day, if ever attainable, lies far in the future. Today, however, conventional insecticides are needed to control 80 to 90 percent of the insect problems affecting agriculture and publich health. Meanwhile, research to find new techniques and methods, must be strengthened. Present control programs must be designed to take advantage of the best materials and techniques available so as to reduce losses to an acceptable level.

The control methods that are now being studied or used on different insects includes: 1) the use of natural predators, parasites and pathogens, 2) the breeding of resistant varieties - which may provide long time protection against some species, but may be ephemeral against other species which have great genetic variability combined with many generations per year, 3) the genetic male sterile technique developed by Knipling, which

has proven highly effective in controlling the screw-worm, and shows promise now on a number of other species, 4) the use of attractants, both sex and food, 5) use of traps i.e. light and sound, 6) development of hormones to interfere with life cycles, 7) improvement of cultural practices, which have been long used effectively in reducing losses from species, and 8) the development of better biodegradable insecticides, that will effectively combat the target species without doing damage to beneficial insects, to wildlife or to man.

What does this have to do with the controversy over the use of DDT in the USA?

As Knipling has pointed out, today in the USA conventional insecticides are still required to control 80 to 90 percent of the insect problems affecting agriculture and public health. The use of DDT in the USA has gone down greatly in the past five years, since other more effective controls have become available. It is still, however, used extensively in the south and southeastern part of the USA on cotton insects, especially on the boll-weevil.

The environmentalists would now like to have a legislative ban placed on DDT so as to prohibit it for any use in the USA. Almost certainly as soon as this is achieved, these organizations will begin a worldwide propaganda barrage to have it banned everywhere in the world. This must not be permitted to happen, until an even more effective and safer insecticide is available, for no chemical has ever done as much as DDT to improve the health, economic and social benefits of the people of the develop-

ing nations.

The World Health Organization (WHO) with the assistance of the Pan American Health Organization and the United Nations Children's Fund (UNICEF) in 1955 launched a worldwide campaign against malaria, based on spraying the interior of all houses with DDT, so as to kill the Anopheline vector and break the cycle. Of the 124 countries and territories in the tropics where malaria has existed, the disease has been eradicated from 19. There are 48 other countries in which eradication programs are in progress and an additional 37 where extensive control programs are underway. There remain only 20 nations in malarial areas where no programs have yet been initiated.

There is also dramatic evidence from Ceylon of what can happen if a program is stopped before eradication is accomplished. When the campaign was initiated in the mid 1950's there were more than 2 million cases of malaria in Ceylon. By 1962 it had dropped to 31 cases and by 1963 to 17, at which point the spray program was discontinued for budgetary reasons. By 1967 the number of cases had jumped to 3,000 and by 1968 to more than 16,000. Before the programs could be re-established, in late 1969, 2 million cases had reappeared.

In summarizing the progress in this World-Wide Malaria Campaign on February 2, 1971 officials of WHO made the following statement:

"More than 1,000 million people have been freed from the risk of malaria in the past 25 years, mostly thanks to DDT. This is an achievement unparalleled in the annals of public health. But even today 329 million people are being protected from malaria through DDT spray-

ing operations for malaria control or total eradication.

The improvement in health resulting from malaria campaigns has broken the vicious circle of poverty and disease resulting in ample economic benefits: increased production of rice (and wheat) because the labor force is able to work; opening of vast areas for agricultural production: India, Nepal, Taiwan and augmented land value where only subsistance agriculture was possible before.

The safety record of DDT to man is truly remarkable. At the height of its production 400,000 tons a year were used for agriculture, forestry, public health, etc. Yet in spite of prolonged exposure by hundreds of millions of people, and the heavy occupational exposure of considerable numbers, the only confirmed cases of injury have been the result of massive accidental or suicidal swallowing of DDT. There is no evidence in man that DDT is causing cancer or genetic change."

Although more than 1,400 chemicals have been tested by WHO for use in malarial campaigns, only two have shown promise and both of these are far inferior to DDT.

Despite the wild rhetoric of the environmentalists about the DDT pollution of the world, its getting into the food chain, and causing untold damage to both human and wild life, as more and more scientific evidence accumulates, the charges against DDT become less and less convincing. There, of course, is evidence that man and most species of birds, fish and animals that have been examined have small quantities of DDT and/or other related compounds such as polychlorinated bi-phenyls in their fat.

But there is very little convincing evidence available to date which indicates that it is threatening the existence of any species, nor is it causing any discernible injury to man.

Part of the past confusion concerning pesticides in the environment derives from the tremendous improvements that have been made in recent years in chemical analysis. Prior to the development of gas chromotography in 1956, the level of detection of many compounds with the paper chromotography was 1 p.p.m. With gas chromotography it became possible to detect 1 or 2 parts per billion, or even a few parts per trillion, both of which, of course, would have gone unnoticed 20 years ago. But such sensitive methods can also detect contaminants and in the hands of inexpert operator may lead to wrong conclusions. The environmentalists have used detection to such trace amounts to mount scandalous propaganda campaigns against DDT. A recent article by Dr. Thomas H. Jukes, a reputable biochemist, emphasizes this dilemma:

"How reliable is the test? There is a delicate analytical procedure called gas liquid chromotography with electron capture. Sometimes I wonder whether this method in the hands of inexpert people has done more harm than good. There has been a great hue and cry over alleged traces of DDT in the Antartic penguins, amounts of the order of 1 or 2 parts per billion. I have not yet been convinced by the validity of these results. A few months ago at the University of Wisconsin, some soil samples that had been sealed since 1910 were tested for synthetic organochlorine pesticides by the latest most delicate gas chromotographic procedure. Several pesticides were detected in 32 of the 34 samples. The only flaw was

that these pesticides not only were not used in 1910, they did not even exist until 1940. Another complication is that the residues of a class of modern compound called polychlorinated bi-phenyls (P.C.B.'s) interfere with the DDT test. The P.C.B.'s are used in water-proofing compounds, asphalt, waxes, synthetic adhesives, hydraulic fluids, electrical apparatus and general plastics. They are widely distributed in the fat of wildlife species, in which they have originated as industrial wastes taken up by aquatic species. They overlap in the tests with DDT and its metabolic breakdown products, DDD and DDE. P.C.B.'s are sufficiently toxic to kill fish in hatcheries. To sum up, P.C.B. are not used as pesticides, but they interfere with pesticide residue analysis and they are toxic. Thus I do not believe the stories of "newspaper scientists" about pesticide residues until they have been published in the scientific literature, scrutinized and reliably confirmed."

Another complicating factor in identifying the origin of chlorinated hydrocarbons in human, animal, bird or fish tissue is that many thousands of tons of chemical wastes of all kinds have been and are still being dumped into the oceans. Do not some of these also get into the food chain, even if they still have not got into the "hysterical word chain"?

DDT the First of the Dominoes

It is now obvious that the current aim of the Environmental Defensive Fund and its affiliated environmentalist lobby groups is to ban DDT, first in the U.S.A. and then in the world if possible. But DDT is only the first

of the dominoes. But it is the toughest of all to knock out because of its excellent known contributions and safety record. As soon as DDT is successfully banned, there will be a push for the banning of all chlorinated hydrocarbons, then in order, the organic phosphates and carbamate insecticides. Once the task is finished on insecticides, they will attack the weed killers, and eventually the fungicides. As a matter of fact, by default, they have already been successful in having organic mercury seed disinfectants and slimeicides for papermills banned. This ban was achieved during all of the confusion resulting from finding mercury in fish, first in fresh water species, in the Great Lakes, and rivers of the U.S.A., and subsequently in both tuna and swordfish. The ridiculous of some of this rhetoric came to light recently when someone analysed tuna caught 90 years ago and found it contained about the same level of mercury as those caught today. Moreover, it has been shown that swordfish recently caught in ocean waters hundreds of miles from possible industrial contamination contained 1 to 2 p.p.m. of mercury. This indicates clearly that both tuna and swordfish are picking up the low levels of mercury from the ocean food chains, of which this metal has always been a part.

If the use of pesticides in the U.S.A. were to be completely banned, crop losses would probably soar to 50%, and food prices would increase 4 to 5 fold. Who then would provide for the food needs of the low income groups? Certainly not the privileged environmentalists.

Agricultural Fertilizers and Their Effect on the Environment

Soil infertility is the greatest curse of the densely populated developing nations of the world. Continuous cropping over centuries of time has depleted the soil of one or more of the essential plant nutrients. The result is that grain yields have reached equilibrium at a very low level, generally between 500 to 800 kilos per hectare. Since the per capita area of land that is available for cultivation in these countries is very limited and cannot be appreciably expanded, most of the population lives in poverty at near the starvation level. The only way that this vicious cycle can be broken is by the restoration of the limiting plant nutrients to a level which permits the production of high grain yields. This can be achieved by applying the proper kind and amount of fertilizer. Under most of these conditions the major elements limiting crop yields are nitrogen and phosphate, although in some soil types potassium may also be limiting. Under certain situations, one or more of the minor elements must also be added in combination with the proper dosages of major elements, in order to restore high yields.

The breakthroughs in wheat, rice and maize production that is being achieved by the Green Revolution in a number of countries could not have been realized without the application of heavy doses of the right kind of fertilizers. A great expansion in the production and application of chemical fertilizers is needed in the developing nations in the next decade if these nations are to revolutionize their

agriculture.

Unfortunately in the case of fertilizer use, just as in the case of pesticide use, the rhetoric of the hysterical environmentalists is clouding the basic problem.

We have long had a small cult of organic gardeners and organic farmers who believe that food crops produced by the use of organic fertilizer derived from decomposed plant residues and animal manures are different and superior in nutritive value from those grown from chemical fertilizer. They refuse to believe that the plant is unable to distinguish between nitrate, phosphate or potassium or any other essential element derived from the decomposition of organic materials from that applied from a sack of chemical fertilizer produced in a factory.

What is even more serious and disorientating is that organic gardeners using heavy applications of organic fertilizers but without using insecticides or fungicides, grow three beautiful tomatoe plants in their garden or patio and with this success claim they have found the solution to the world food production problem. They have apparently now joined forces with other environmentalist groups in initiating propaganda campaigns to show that chemical fertilizers and pesticides are really not necessary to solve the world food problem and, moreover, that both add to the pollution of the environment. They suggest that sufficient plant nutrients to meet world food production needs can be obtained from legumes, crop residues, animal manures and from the treated sewage of cities. They, of course, fail to

understand the magnitude of the plant nutrient deficit, and that the use of these organic materials can do but little to solve the fertilizer needs of the world. In the past several years they have won a surprising number of converts to the organic food fad, and many of the converts are people who should have been able to separate facts from fancy.

Environmentalists have recently taken up a crusade against eutrophication. Eutrophication refers to the process of enrichment of waters of lakes, ponds and rivers with nutrients which in turn gives rise to an increase in growth of all aquatic life, including plankton, algae and higher forms of aquatic plants. Eutrophication, consequently, can detract from the recreational values of lakes for boating, sailing and swimming. When aquatic plant growth is unusually great, especially in small shallow lakes, it may deplete the oxygen content of the water to a level where some species of fish cannot survive in it. It may also in some cases affect the odor and taste of water and thus increase costs of providing potable water for city or urban needs.

Within the past three years some so-called ecologists and their alarmist followers have taken up the cry that the eutrophication process can disturb "the balance of nature" to such an extent that it could lead to "the death of the human family". They often state and imply that one of the primary causes for the accelerated rate of eutrophication is agricultural fertilizers.

Natural eutrophication with marsh formation is the eventual fate of most shallow fresh water bodies of water having drainage outlets.

Eutrophication is not a new process as some environmentalists apparently believe. It has obviously taken place since early geologic time in many different parts of the planet earth. Eutrophication, in fact, is the first phase of the process, which has provided man with his fossil fuels, lignite, anthracite, natural gas and even the gasoline that provides the power to take the environmentalists to their favorite lake abode. In more recent prehistoric time, the vast peat bogs of Minnesota, Wisconsin, Michigan and south-central Canada were formed by the process of eutrophication. In Minnesota alone there are 7 $\frac{1}{2}$ million acres of peat bog, containing more than 6.8 billion tons of peat, dry weight, and 102 million tons of nitrogen and 5.5 million tons of phosphorus that owe their origin to this process. All of these bogs or swamps were formed before there was any farming in the area. The rate of eutrophication is not controlled simply by the amount of nutrients present or entering the lake. It depends upon a complex interrelationship of climatic, physical, chemical and biologic factors, affecting the lake metabolism. The metabolism of the lake is influenced by the depth, size and shape of the basin, the geologic material of the area, temperature, nutrient input and perhaps many other undescribed factors. It is possible to see advanced eutrophication in lakes surrounded by farms, but there are also lakes surrounded by farms with no eutrophication. Similarly one can see lakes in advanced stages of eutrophication surrounded by undisturbed forests, and other lakes only a few miles away in the same

forests, with no eutrophication.

The nutrients which have been studied most in connection with eutrophication are nitrogen and phosphorus. G. E. Smith estimates that if other factors are favorable, plant growth is not limited until the concentration of nitrogen in water drops below 1 to 2 parts per million, and until phosphate concentration falls below 50 parts per billion. Let us recall that from 5 to 10 kilos of nitrogen per hectare in rural areas, and 15 to 35 kilos per hectare near cities and coal burning industries are added each year by rainfall alone. This quantity of nitrogen is enough to support aquatic plant growth. This amount, moreover, is supplemented by additional quantities from seepage and silt from both undisturbed forest land and unfertilized farm land. It seems ridiculous, therefore, that legislation is being proposed, and in some states of the USA has already been adopted, to ban the use of phosphate detergents, and to restrict the use of nitrogenous fertilizers, when there are already sufficient quantities of these nutrients in our lakes and rivers to support rapid eutrophication whenever other factors are favorable for aquatic plant growth. It is doubly idiotic to even consider such action while we continue to dump countless billions of gallons of raw sewage-one of the best of all fertilizers for aquatic plants- into our lakes and rivers. Lake Erie alone receives 40 billion gallons of raw sewage annually. Is there any wonder that it is sick, if not dead, as some say? This action certainly justifies labeling those recommending such legislation with the old English

saying "Penny wise and pound foolish".

Modern crop production technology not only provides more food, but provides other indirect benefits to society

Many of today's environmentalists and affiliated doom sayers discredit science and technology and blame it for all of the ills of our present society. They never indicate, for example, what shape the world would now be with respect to food and fiber production, were it not for the new technology which has greatly increased crop yields.

A recent study by Barrons in the USA clearly indicates the increase in efficiency in food, feed, oil and fiber crop yield and production over the past 30 years. He included in this study the 17 food, feed, oil and fiber crops that were sown on a million acres or more during the 1968-70 period. The average figures for area sown, yield per acre and total production for each of these crops were calculated. The same calculations were made for the same crops for the 1938-40 period.

Using the average yield and production figure for each of the crops for the 1968-70 period as a base, calculations were made for each crop to determine the area that would have been required to provide the same total output using the 1938-40 yield figures. The results are startling. The area of 281 million acres cultivated to these crops in 1968-70 produced enough to meet the domestic needs of the USA, with an additional amount of produce for export, valued at 7 billion dollars. The amount of additional land that would have

been required to produce the same quantities of these products using 1938-40 yields and technology would have been 291.9 million acres, more than double the area under cultivation in 1970. Much of the increase in per acre yield and total production in 1970 compared to 1940, was due to the increased use of agricultural chemicals, especially fertilizers, insecticides and weed killers. Improved cultural practices and better seed undoubtedly also played a role.

Within the past decade because of the improved technology and higher yields it has been possible to remove 50 million acres from cultivation and still meet both the domestic and export needs for agricultural products. Were the country still relying on the 1940 technology, however, not only would the 50 million acres now held in reserve be back under the plow, but, moreover, an additional area of 241.9 million acres by necessity would have been opened to cultivation. In reality it would require considerably more than 241.9 million acres of additional land since the quality of the land would have been poorer than that now in cultivation. In order to have brought under cultivation an additional 241.9 million acres (and perhaps considerably more because of the poorer land quality) it would have been necessary to open to cultivation lands that in a large part would be rolling or semi-arid, and consequently vulnerable to erosion by water and wind. It would also have required clearing the forests from large areas so as to meet the food, feed, oil and fiber needs of the nation. Now reflect on the additional havoc that this expansion of cultivated area would have done to wildlife habit, and especially on

rare and endangered species of animals and birds that are already on the brink of extinction.

Looking at it from another angle 291.9 million acres of land, an area roughly equivalent to the total land area of the USA east of the Mississippi river and south of the Ohio river, is today available for other uses, because of the improvements in crop production technology that has taken place in the past 30 years. These uses include recreation, wildlife and forestry.

It would appear that if the magniloquent environmentalists and conservation organizations were not so myopic, they would change their tactics and not discourage the use of agricultural chemicals, but encourage their use. For higher yields per cultivated area means less land is required for the food and fiber production and more is available for other uses, especially wildlife, forestry and recreation.

Although Barrons study was made in the USA, it behooves all mankind to increase the efficiency of agriculture throughout the world if we wish to alleviate human suffering, conserve wildlife and improve recreational opportunities. Unless the food production of East Africa is expanded to meet the growing food needs, the large animals in the Game Reserves of East Africa will be poached out of existence within the next three decades. Similarly, the elephant, tiger, and peacock will perish from India because of population pressure.

It is hard to understand why the conservation organizations and environmentalists have taken a negative rather than positive view in trying to protect wildlife. Why have they not promoted research and fought for more funds for game management in general? Why have they not fought for more funds for research so that qualified scientists can be assigned to study the reasons why certain threatened species are on the verge of extinction, and whether it is feasible to try to save them? Why have they not been aggresive in obtaining funds to study the biology of "the red tide" that periodically takes a tremendous toll of thousands of tons of fish in the coastal waters of the USA, instead of spending their time and energies crying "the villain at DDT or mercury" whenever they see a few dead fish in one of the lakes or rivers? Why do they not spend more of their energies and funds on educating the public on the adverse effects of population pressure and rampant population growth on wildlife and the environment? How many of the US public, for example, know that more than 100,000 deer are killed each year by automobiles, whereas everyone is informed in the press or television whenever a few birds or fishes are found dead, presumably -but not necessarily proven- from a pesticide?

Imagine the rhetoric that would be produced if 100,000 deer were killed by a pesticide.

I have been a great admirer of the spendid work that has been done by game management experts in the USA in re-establishing species such as the wild turkey that was nearly extinct. Under wise

management and protection many other species of wildlife have made spectacular comebacks. The tremendous success of the introduction of the Chinese ring-neck pheasant, the Hungarian and Chukkar partridge are other tremendous accomplishments. The research that has brought under control the lamprey, that threatened the survival of the lake trout is another tremendous achievement; so is the introduction of Coho salmon into Lake Michigan and Lake Superior. The breeding of faster growing and more sturdy salmon is another tremendous step forward.

I repeat what I have said many times before: Without thinking conservationists and environmentalists, both in and out of government and only partially informed people in the communications media have embarked on a crusade designed to end the use of agricultural chemicals, such as pesticides and fertilizers. They give no thought to the end result of such action: the eventual starvation and political chaos that will plague the world. Why is this short-sighted policy pursued?

And now, in closing, I relinquish the final testimony to Dr. John Carew, who will eloquently plead the case for mankind, and also indicate the consequences of being swayed by the seductive siren of the privileged few -if the Naked Ape, who now stands ready to act, at the crossroad- makes the wrong decision:

IN BALANCE WITH NATURE

In the beginning
There was Earth; beautiful and wild;
And then man came to dwell.
At first, he lived like other animals
Feeding himself on creatures and plants around him,
And this was called IN BALANCE WITH NATURE.
Soon man multiplied.
He grew tired of ceaseless hunting for food;
He built homes and villages,
Wild plants and animals were domesticated.
Some men became Farmers so that others might become
Industrialists, Artists, Doctors, Lawyers or Bureaucrats
And this was called Society.
Man and Society progressed.
With his God-given ingenuity, man learned to feed,
clothe, protect, and transport himself more
efficiently so he might enjoy Life.
He built cars, houses on top of each other, and nylon.
And life was more enjoyable.
The men called Farmers became efficient.
A single farmer grew food for 41 Industrialists, Artists
and Doctors
And Writers, Engineers, and Teachers as well.
To protect his crops and animals, the Farmer produced
substances to repel or destroy Insects, Diseases and
Weeds.
These were called Pesticides.
Similar substances were made by Doctors to protect
humans.
These were called Medicine.
The Age of Science had arrived and with it came better
diet and longer, happier lives for more members of
Society.
Soon it came to pass
That certain well-fed members of Society
Disapproved of the Farmer using Science.
They spoke harshly of his techniques for feeding,
protecting and preserving plants and animals.
They deplored his upsetting the Balance of Nature;
They longed for the Good Old Days.

And this had emotional appeal to the rest of Society.

By this time Farmers had become so efficient, Society
gave them a new title: Unimportant Minority.
Because Society could not ever imagine a shortage of
food
Laws were passed abolishing Pesticides, Fertilizers, and
Food Preservatives

Insects, Diseases, and Weeds flourished.
Crops and animals died.
Food became scarce.
To survive, Lawyers, Bureaucrats, Industrialists, Artists and Doctors were forced to grow their own food.
They were not very efficient.
People and governments fought wars to gain more agricultural land.
Millions of people were exterminated.
The remaining few lived like animals,
Feeding themselves on creatures and plants around them,
And this was called IN BALANCE WITH NATURE.

The Naked Ape is impressed. He chooses the road of the many for he does not want to begin the struggle all over again "stalking animals with a club in one hand and a rock in the other". As he now begins to climb along the newly chosen road we can hear him mumble:

"But why won't mankind learn to use the brain and mind with which he is blessed, which permits him, unlike all other species, to take stock of himself and project ahead to see the great difficulties that will be forthcoming -from hunger, exploding unemployment, inadequate housing, clothing and education, worsening difficulties with transportation and communications, lessening opportunities for recreation, a frightening rate of depletion of non-renewable resources, and a worsening situation with the environment as well as increasing problems with social, political and civil chaos- if he insanely insists on trying to compete reproductively with the highly fertile aphids?

Unless man abandons this folly, he will flunk the imperative:

Evolve or Perish, and leave behind only his imprint in the book of rocks".

And now, as he climbs further up the mountainous road and his voice is almost lost in distance, we hear him add:

"And why don't scientists resist the academic imperative: Publish or Perish, so as to minimize the publication of articles with maybe-truths, mini-truths and over-exaggerated truths. And when they are considering reform, why don't they cast off some of their oversophistication and replace it with that exceedingly rare quality: Common sense?"

Norman E. Borlaug

10/26/71.