Holism Agriculture and Natural Resources

An Inaugural Lecture
Given in the
University of Rhodesia

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Professor J. M. de Villiers

UNIVERSITY OF RHODESIA

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Professor J. M. de VILLIERS
Head of the Department of Agriculture

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HOLISM, AGRICULTURE, AND NATURAL RESOURCES

I am unable to resist the temptation to recall for you tonight what Mark Prestwich, on acceding to the Chair of History and Political Science in the University of Natal, had to say about the Inaugural Lecture — this ordeal to which new Professors are subjected.

The occasion, said Professor Prestwich, affords his learned colleagues the opportunity to enjoy one of the pleasures of malice — the pleasure of noting his superficiality, his deficiencies of oratory and power of reasoning, the abysmal deeps of his ignorance. His students are able to taste revenge for what he has done or will do to them, and the lay public is treated to a display of academic nakedness which bears remarkable similarities to the initiation rites practised by primitive tribes. The purpose of all this, no doubt, is to ensure that he will not become too big for his boots. And there is the prospect of direr perils still. Such as the fate which befell a certain ninth-century philosopher — one Johannes Scotus Erigena — who so exasperated his audience that they rose up and slew him with their styluses. One is told also of Nicolas Cop who was compelled to flee for his life after his Inaugural Lecture as Rector of the University of Paris in 1533. And of Ernest Renan whose Inaugural Lecture as Professor of Hebrew in 1862 led to his instant suspension from the Chair. How much greater the hazards of the lowly agriculturist, this shallow man, the "swain mistrustless of his smutted face." You will understand when I say that I have approached tonight's task with circumspection and not a little trepidation!

Weltanschauung

But let me declare my purpose. One is, nominally at any rate, free to choose whatever subject he wishes for the inaugural occasion. As a soil scientist I would have been more comfortable talking about the chemistry of clays or the classification of soils. However, I am under some compulsion tonight to lift my nose from the ground, metaphorically speaking, and to seek wider horizons — in fact global horizons in time and space.

Now compulsion is a strong word; but had I been able to think of a stronger one, I would have used it. I am compelled then, for reasons which I trust will become clearer as I proceed, to attempt to articulate a *weltanschauung* — a view of life— and, within the perspective thus obtained, the place and the purpose of science applied to agriculture. Perhaps in doing this I will also give some indication of the spirit in which I shall be approaching my work in the University. This is probably what is expected of me.

Science and Society

It may or may not come as a surprise when I say that the place and purpose of science at this time is not as clear, nor as secure as it may seem to those who have become accustomed to its much-vaunted power. Its position is uneasy and its *bona fides* are being questioned. Society is becoming increasingly aware of the ugly side of science and the technology which it has spawned, it is becoming tired of its arrogance, and it is becoming uncertain of its contributions toward the common good because it can no longer identify itself with the extreme fragmentation that has accompanied the phenomenal growth of science. Increasingly, public and government opinion is demanding that scientists define their objectives. Society, which pays the bill, is wanting its pound of flesh. But perhaps most importantly, society, conscious of the lengthening shadows being cast over the world by the Four Horsemen of the Apocalypse — pestilence, famine, war and death — cries out with the melancholy poet, Houseman.

> *"I a stranger and afraid, I*
> *In a world I never made".*

Science and Anti-Science

I would wish not to over-paint the picture, and certainly a majority of scientists would defend their actions with the utmost vigour. But, in a different way and for different reasons, there is also a questioning from within — from scientists themselves. An eminent biologist at Harvard declares that "Science as we know it has outlived its usefulness". A professor of engineering suggests that one of the most pernicious falsehoods ever to be almost universally accepted is that the scientific method is the only reliable way to truth. And from a respected geologist — the archetype, with all due respect to present company, of rationality and conservatism among scientists — we hear doubts as to whether the qualities that we measure have any more relation to the world itself than a telephone number has to its subscriber.

I have spent most of my working life measuring things, relating things, and classifying things in nature. I suppose that I would be called a scientist by virtue of the fact that I subscribe to what is called scientific method, a uniquely powerful logic of problem-solving which has assured the quite astonishing progress of science, a compelling, engrossing logic that for so many men has become the *raison d'etre,* the very fabric of life itself. But there comes a time when the traditional questions of science, the "how's" and the "why's" are no longer the most important. The main question becomes "what for?". The once satisfying mechanistic view of life which reduces most things to ultimate physico-chemical reactions and formulae no longer satisfies. A violin concerto is more than the scraping of the tails of horses across the intestines of cats!

I sense that individuals in society and in science are looking for a new *weltanschauung,* that they need a new vision of the ends to which their quests will lead, a vision that will go beyond the gigantic distraction of 25 000 new books and over a million new scientific articles that are the result each year of the problem-solving activities of science. Some are looking outside of science, to mystical and transcendental experience for their *weltanschauung;* Others like myself believe that it must be sought largely, if not wholly in the knowledge that science has made available.

Thomas Kuhn in his book "The Structure of Scientific Revolutions" — a book, incidentally, that should be prescribed reading for every student of science — explains how science thrives and makes progress in just such a situation as this. Kuhn deals with paradigms which, I should explain, are models based on proven examples. They are to science what the example *amo — amas — amat* is to the conjugation of many Latin verbs. Except that they can change. The pattern is the paradigm accepted by the majority of practitioners of a particular science, then the appearance of anomalies, polarization of support between the paradigm and its rival, crisis, revolution and finally the acceptance of a new paradigm. The process which is repetitive always involves a re-orientation, and often this may resemble the famous *"gestalt"* switches of psychology. Here, an experimental subject wearing inverting lenses sees the entire world upside down. After extreme disorientation and acute personal crisis, he learns to deal with his new world and his visual field flips over. A very famous scientist once wrote "At the moment, physics is again terribly confused. In any case, it is too difficult for me and I wish I had been a movie comedian or something of the sort, and had never heard of physics". This was Wolfgang Pauli on reading Heisenberg's paper which pointed the way to quantum mechanics. Later — "Heisenberg's type of mechanics has again given me hope and joy in life". Perhaps we need a new way of looking at agriculture, although I should imagine that this would hardly involve as drastic a reorientation as a "gestalt" switch.

A Literal Weltanschauung

We have, today, got a literal *weltanschauung* — a real view of the earth from a great distance in space, even if it is a vicarious one through the astronaut's camera. This is where I want to start.

Two years ago I was present at an International Workshop on earth resources in Ann Arbor, Michigan, to hear William Anders describe his impressions on the Apollo 8 mission. "The most impressive sight for me on that flight" he said "was the view of the Earth itself. From the Moon, the Earth appeared as a small, blue-green sphere, like a beautiful, fragile Christmas tree ornament . . . very delicate and limited, the only colour in the whole universe, the only friendly place we could see . . . a small but inviting oasis in the vast blackness of space . . . a single, small outpost in the universe in which billions of human beings have a stake". Anders went on to point out that one of the most influential factors in the current space policy of the United States is the remarkable discovery, which was very clear to him on his Apollo mission, that the most interesting thing to explore in space is not the Moon, nor Mars, nor some far off galaxy, but our own planet. The United States has, at least temporarily, turned its back on the Moon.

Note that we have here a turning inwards, an involution. To this theme I shall return later.

An Evolutionary view of Earth

Come with me now and look at this Earth of ours. From a lofty position we see the outlines of land and sea essentially as they were at the end of the Pliocene, some two or three million years ago. Zoom in, and we see mountains and valleys and plains, rivers and lakes; but we also see something new, something we would not have seen two million years ago. We see cities, roads and cultivated fields — the imprint of man. A view in three dimensions at a moment in time.

And there's the rub. The view is meaningless until we add the fourth dimension, time. We really need to add something of the order of five billion years and go back to the time when it all began, when free atomic nuclei first came together, their electrons interacting with one another to form molecules. This was the beginning of shape and size, of matter as we know it. This world was inorganic and sterile until gases of the primeval atmosphere were sparked into organic molecules, more complex and seminal in their potential for life. Over the ages, organic molecules leached into the seas, and then, somehow, somewhere, about three billion years ago, it happened. A certain combination of dead, or rather pre-living matter — proteins — aggregated and took on the condition of life. Complexification followed on complexification — molecules, organelles, cells, tissues, organs, organisms. By means of a very wonderful process that we call photosynthesis, living organisms put oxygen gas into the atmosphere where there had previously been none. A small but significant percentage of that oxygen was made into ozone in the upper atmosphere. Ozone filtered most of the ultra-violet radiation, inimical to life, out of the sunlight before it reached the earth's surface, and life, hitherto confined to water, was able to emerge onto the land, there to evolve further. Some millions of years ago, man made his appearance. The evolution saga is familiar.

Population — what are people for?

And now man is super-abundant and clutters the globe. He appears, for all the world to be hell-bent on self destruction, rushing headlong, lemming-like, towards what is called the food population collision. This has been called a problem. I do not believe that science can regard it as a problem, not in its totality, because legitimate problems have solutions, and this one does not have a global solution that will avert the results of a crisis of food. A large part of humanity is still behaving like the man who eats strange mushrooms. He knows he shouldn't and by the time the result is known, its too late. This does not mean that I see the end of the world — far from it. Nor does this mean that there are not vitally important holding operations that must be mounted. It is not my intention to talk about world population — the subject suffers from rhetorical overkill. Rather, I would ask the question — what are people for? All three-and-a-half billion* today, a hypothetical projection of seven billion in 30 years time at the present rate of increase, and in 600 years, which is about 8 seconds at the end of the first day in the history of man, the hypothetical, potential population of the world shoulder to shoulder with one person for every square foot of land.

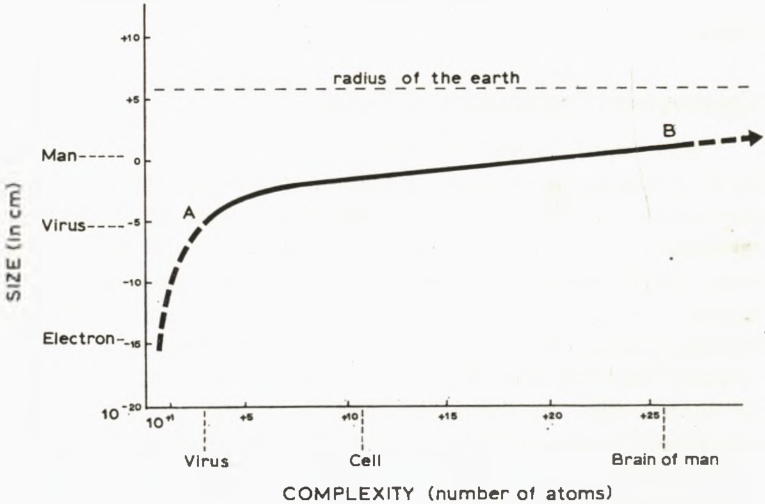
A Holistic World

Evolution has invested itself in man. The evidence for organic evolution and the pattern which it has followed led Jan Christiaan Smuts to conceive of the idea of a holistic world of unitary, enclosed wholes. Smuts saw holism as the driving force behind evolution, the force which works up raw material and unorganized energy units, utilizes, assimilates and organizes them, endows them with specific function and individuality and, finally, with the ultimate manifestations of evolution — mind and personality.

Teilhard de Chardin, who followed closely in the philosophical footsteps of Smuts, depicts this holistic tendency, conceptually, as a curve of complexification. When fundamental natural wholes are taken and their size is plotted against their degree of complexity using, say, the number of atoms as the parameter of complexity, then these units or corpuscles lie along a curve (Fig. 1). Such key objects are the atom, the molecule, the virus, the cell, the brain of man, and finally the earth itself.

*Here 1 billion = 1000 million

FIG. 1: Curve of complexification of matter (after Teilhard de Chardin)



This suggests a line of ascent, a thread of continuity between matter, life and mind. The two critical points on this curve are those of vitalization (A) and hominization (B). That there were quantum leaps across these thresholds is taken as evidence of the universal phenomenon of progressive complexification of matter within finite closed wholes and the evolutionary pressure which this exerts on the matter being compressed.

Teilhard's curve continues upwards in a very gradual approach to the next fundamental whole — the size of Earth itself. All of the forces of evolution are now concentrated in man as the leading shoot of the tree of life. Since his advent, no comparable species has evolved while countless other species have disappeared. Man's brain exploded into consciousness, became centred upon itself, became capable of foresight, reflection and invention, and transformed the surface of the earth. The curve of complexification approaches the dimensions of the earth asymptotically to indicate that man is forming an envelope around the earth, a new sphere of thought, what Teilhard has called the noosphere. Man exists and has his mental being in this intangible sea of thought in the same sort of way that fish exist and have their physical being in the hydrosphere — the material sea of water.

Contemporary implications of Holism

What must interest us now are the contemporary implications of holism. If we look at nature, we see the stabilization of population densities at some optimal level, either by environmental control or by a capacity for self-regulation. But not so with man. Development of a purposive mind has emancipated the human species from the routine of organic regulation. Having become master of nature, man is free to multiply to his heart's content. But the noosphere is still embryonic, and mind, with its uncertainties, its aberrations, and its failures seems a bungling experiment compared with the massive certainty and regularity of nature. For the noospheric experiment to be completed, for the world to become an integrated functioning whole, for individual personality to develop fully, the purposive mind must evolve into the rational mind. Mind, in its rational activity, is in the direct line of evolution from organic regulation.

Ironically, the increase in the population of the world, far from being a Sword of Damocles, may well be an evolutionary catalyst and the agent of further holistic advance. Compress living matter and it responds by organizing itself. Do we not recognize a familiar situation? The finite earth with its finite resources as an enclosed whole, human matter under compression, complexifying, being forced to turn in on itself, to involute and to reorganize. The result that we might expect is evolutionary advance towards a more holistic world, advance along the road towards the omega point of the noosphere. There are many examples that one might call upon to support a theory that the world is turning in on itself. Detente, the formation of economic communities of nations, the growth of an environmental conscience. Unfortunately, there are probably as many or more examples to suggest that this development of rationality is, at best, embryonic — there is lack of detente, confrontation, as we are experiencing at this moment, environmental deterioration and the irrationality of international anarchy and blackmail.

Food and Population

The situation is unbelievably complex and involves the whole web of life. But amidst the polemics, the hysteria, the psycho-semantic arguments and counter arguments, a few things do stand out clearly. I would like to enumerate these as follows:

1. The condition of more than two-thirds of the human race is deteriorating.
2. The limit to growth is not energy, is not pollution, is not living space, but is food.
3. What the Pollack brothers predicted in their book called "Famine — 1975" would seem to have been prophetically accurate. The times of famine are upon us. Not total, but sporadic, regional and selective, and they are occurring in the midst of plenty.
4. The scale, severity and duration of the world food problem are so great that a massive, long-range innovative effort, unprecedented in human history would be required to master it. The best effort can only be a holding operation until rationality prevails.
5. The world does have a conscience, and the developed nations will exert themselves to help, even in the knowledge that this help may initially make matters worse.
6. The developed nations will help for a second and more powerful reason. Hunger, the eternal involuntary fast, sets man against man, citizen against government and carries the threat of civil strife and political unrest. "Food riots" is already a new addition to our vocabulary. Two thousand years ago, Seneca warned the Roman senate "A hungry people listens not to reason, nor is its demand turned aside by prayers".

7. There are no panaceas. Synthetic and non-conventional sources of food will help increasingly but will not supplant modernized agriculture. The bulk of the increase in food supply must come from increased production of conventional farm crops. This is the simple unromantic fact of the matter.
8. Although education, research of all kinds, and political, economic, and social institution building are vital to the matter, scientific agriculture with its technology must occupy a centre position on the stage. It was only a few years ago that Norman Borlaug was awarded a Nobel prize — the first agricultural scientist to be so honoured. I take this as symptomatic of the increasing focus on agriculture. Samuel Johnson wrote that nothing concentrates the mind like waiting to be hanged. In its modern version this reads "Famine, like hanging, concentrates attention wonderfully".

One further point

There is one further point of importance and on this I would like to dwell for a while because it allows me to return to my theme.

The human population is approaching saturation point on the finite surface of the earth, and becoming continually more compressed through internal forces of reproduction and multiplication. The effect is to create, at the heart of the noosphere, an increasing source of free energy. Compress some inanimate matter and it will react in order to avoid or respond to the pressure by a change of structure or state. But compress some living matter (observing certain precautions of course) and it will organize itself. There is perhaps no more universal law than this to explain the genesis of the biosphere and, still more, of the noosphere.

It is historically correct to conclude that the more mankind has been compressed upon itself by the effect of growth, the more, in order to find room for itself, has it been forced to find new ways of arranging its elements with economy of energy and space. Scientific research has been one of the major outlets of generated energy, and agent for better biological arrangements.

Focus on Natural Resources

It is no more than one might expect to find that the earth's finite resources — the major limiting factor and the source of compression — should become the target of intense scientific attention. The usable part of the earth's land surface, that is all areas excluding wasteland in true desert and arctic places, is either in, or of necessity, bespoken for by agriculture. Cities, transportation networks and ecological preserves take up relatively little space, although this is increasing. The geographic dispersion and vastness of agricultural lands poses a problem of logistics that has only recently been fully appreciated as scientists and administrators have begun to turn their attention to the interaction between man and his agricultural resources.

Charles Kellog of the United States Department of Agriculture and doyen of soil scientists is on record as saying that for a long time, at least, the basic soil resources of the world need not be the factor that limits production if soil management is reasonably good. Lester Brown, also of the USDA and an agricultural economist maintains that there is little additional land left over that is, by nature, well suited for cultivation. One cannot help but be impressed by the wide differences in points of view relating to the potential arable lands of the world and the constraints of all kinds that hamper full exploitation of their potential.

In a now-famous study sponsored by the Club of Rome, a group of scientists at M.I.T. has predicted the breakdown of life support systems within the next 100 years. A group at Sussex University has rerun the model using the same data and has arrived at different conclusions. Surprising? No. The information available for these studies has been estimated at less than 1% of what is really needed to make such an exercise secure. Yet, that which was available required a massive computer exercise. Why, just this week I received a new book notice — a collection of 20 papers given at an international symposium on hydrology. The title of the book : "Decisions with inadequate hydrological data."

These examples demonstrate the important fact that although there is a frighteningly large amount of information available on natural resources, this still falls far short of what is needed to plan resource use. Much of the really relevant information on land use is difficult to obtain in real time, that is, sufficiently quickly so that it can be useful before it is superseded by changing conditions. Furthermore, because of the enormity of the detail and the geographic dispersion of the working area, conventional methods of data-handling are becoming increasingly inadequate.

There are two rapidly developing lines of attack on this problem of collecting and using resource information. I wish to touch on these briefly because I have had some experience of them in recent years, and also because they seem to me to have a strong holistic tendency. Both are examples of what is called the systems approach.

Remote sensing

The first is a technology that is called remote sensing, which simply means detecting or imaging from a distance. You will all be familiar with aerial photography — the classical method of remote sensing. There are now more refined and sensitive devices than the camera with normal photographic film and more powerful platforms on which to mount these devices than the conventional aircraft — I refer to rockets and satellites.

In addition to the weather satellites and Skylab, the first of a series of unmanned Earth Resources satellites is at present scanning the earth every 18 days from a height of about 900 km and sending back information on a scale that would have been inconceivable only a few years ago. This new technology has the potential to carry out land-use studies, to reveal soil and vegetation boundaries, soil characteristics and moisture conditions, to measure areas under particular agricultural crops, to reveal plant vigour and help in forecasting yields, to map disaster areas caused by floods, drought and fire, to detect and monitor disease and pest damage, and to do these and many other things synoptically in real time. I should add that this kind of research involves large systems, is very complicated, and is extremely expensive. However, there will undoubtedly be immense benefits to mankind when its potential becomes fully realized, and the systems become operational. An official of the United States Space Agency has put it this way: "We shall come to expect this information as regularly as our morning mail."

Resource Inventories

The second development that I want to mention is that of the resource and land-use inventory. Classically, agricultural research has conducted a frontal attack on technical problems directly related to the production of commodities on the farm. Investment in this kind of research has paid good dividends. Planning has been largely at the farm scale. Research on the broader spatial aspects of agricultural land-use — the regional and national approach — has lagged behind because its benefits are subtle, less obvious and less immediate. This I believe to be a dangerous situation that lays the agricultural industry wide open to technological and economic dysfunction, and permits or condones the mis-use of resources.

The Science Advisory Comittee of the President of the United States, in its 1967 report on the world food problem pointed to the national resource inventory as one of three new developments that show promise for increasing world food resources in the future. (The other two, incidentally, are weather modification and satellite technology.) After a truly exhaustive investigation of the entire agricultural industry in South Africa, a recent Commission of Enquiry into Agriculture came to the conclusion that inventorization of resource potential was of vital importance, not only for planning adapted production systems in agriculture but, indeed, for total land-use planning on a national scale. By the time the report appeared in 1970, a crash programme to quantify the nations land and water resources had already been launched. I was privileged to be able to initiate this programme. Here in Rhodesia, a number of regional agricultural surveys have appeared in the past five years or so from the Department of Conservation and Extension of the Ministry of Agriculture and from the Agricultural Development Authority. Might I remind you that this is Natural Resources Year in Rhodesia; and might I further remind you that the Third Rhodesian Science Congress next year will focus its programme on the "Scientific Management of Resources". I would hope that, here as elsewhere, total natural resources will be brought increasingly and holistically under the spotlight of attention.

One final point in this connexion. The map, like the wheel was a very wonderful invention. I have a great love for maps. But as a repository for land use and resource information, they do have certain limitations. Maps are passive things: they do not work for you. They are generally single-purpose, that is, a map will show soils, or climate, or geology only, not a combination of these. And thirdly, when it comes to cultural or man made features, they are often out-of-date to an extent by the time that they are revised.

On the other hand, if we were to take a suitable map sheet, overprint it with a regular grid to give us a number of cells, and if we were then to extract information pertaining to each cell from all possible sources including aerial photographs and thematic maps of various kinds, and file this information, cell by cell, in a computer program, then we would have a dynamic and very powerful planning tool. For we could instruct the computer to display, in tabular or map form, any combination of information that we might require. This would allow us to go directly to planning and decision-making. Several such systems have or are being energetically developed.

These new developments have the common aim to provide fast data collection and to illuminate the twilight zone between resource use and the actions of planners, administrators and lawmakers. In short, they are important and exciting tools of modern resource engineering.

The Department of Agriculture.

I would like to suggest to you that you have, in the Department of Agriculture at this University, a group of scientists dedicated to engineering the optimal use of resources. For agriculture goes beyond growing a crop or putting milk into a bottle. What, after all, is the geneticist doing other than engineering the gene pools at his disposal so as to exploit resources of land and climate. What are the crop and animal scientists doing if they are not engineering the adaptation, nutrition, and management of domesticated plants and animals under given environmental conditions with optimal production as the goal. Microbiologists, pathologists and veterinarians engineer ways around problems of resource utilization. The extension man engineers communities of people into a harmonious and productive relationship with nature. And so on down the list through soil scientists, agricultural biochemists, entomologists to the agricultural economist who perhaps more than anyone else in our free and competitive society, engineers decisions that can have the most profound effects on the utilization of resources. It always used to strike me as strange that agricultural graduates of many continental universities have the title of engineer. I assumed that this was some quirk of translation. I now know differently.

Each of the various disciplines embraced by agriculture has its origins in the purer sciences, and each has its own theories and paradigms, its own history and its own unique approach. We should be most careful not to smear them together. But ultimately they all converge to serve this one purpose. We will teach our students in depth the specialties which interest them, for this is the way of science. But we must never allow them to become so distracted that they lose sight of the real goal.

And with that, I propose to tie up my little package, this trinity of agriculture, natural resources, and holism. I have spoken of many and uncouth things. I have spoken for too long. Were that I had been a poet for then I should not have detained you. There is a being on a higher plane — a man who epitomizes holism through compression. What I have tried to say tonight took T. S. Eliot a mere five lines:

> "*. . . . . all shall be well and*
> *All manner of thing shall be well*
> *When the tongues of flame are in-folded*
> *Into the crowned knot of fire*
> *And the fire and the rose are one*".