efficiency of nutrient flow and for soil building. The net result of such structuring is increased levels of both biological and economic stability, reduced levels of physical inputs, and a significant savings in the energy value of inputs. This energy savings in a highly structured system may be greater than 50% on a per unit produce basis. The structuring and net savings of an integrated Pennsylvania farm are given as examples. This more information-intensive regenerative farm system will require a changed and heightened level of farm management assistance.

What is Scientific Agriculture? Holism as an Orientation in Scientific Effort
RAY W. JACKSON (Science Council of Canada, Ottawa, Canada)

A scientific approach to agriculture would presumably be rational, tested, and based on knowledge, as against approaches based on superstition, guesswork, and ignorance. It would be regarded as credible and would inspire trust. Small wonder, then, that the right to use the label is hotly contested among different factions each claiming the authority of knowledge. A philosophical analysis is called for. It is not possible to settle the question scientifically because we cannot wait for the test of history. Besides, actual practice is a dialectical process, with irreversible elements. We have to distinguish between science (knowledge) and policy (action). Even the field of knowledge itself presents problems for policy. The rapid growth of knowledge leads to coping strategies of specialization, fragmentation, and reductionism. Yet science proper, and especially ecology, aim ultimately for completeness and integration. Orientation of effort toward this program goal of holism is impeded in practice by vested interests, intellectual as well as material (the latter including a marriage of convenience between reductionism and industry), and an inadequate neuro-epistemology. A truly scientific approach would accord a greater respect to folk wisdom.

Expert Systems: The Substitution of Knowledge for Materials in World Food Production.
BRIAN GAINES (Univ. of Toronto, Industrial Engineering), MILDRED SHAW (York University, Computer Science)

The standard approach to problems of control has been to identify in detail a physical model of the system to be controlled and then to compute optimal control strategies from this model. This has been very effective in a wide range of applications, but breaks down if the system to be controlled cannot be modelled in detail. The expert systems approach to decision and control is a new paradigm that notes that people can operate effectively many systems for which we do not have detailed models. Instead of modelling the system it then makes sense to model the people and compute decisions and control strategies that mimic their expertise. This approach has been remarkably successful in some industrial control situations where automation was previously felt to be impossible. It has also been successfully applied to medical, geological, and other high level expertise. In general, it seems applicable to areas where human skills are available to encode. It is suggested that many aspects of agriculture may be characterised in this way. The presentation will be concerned with the nature of expert systems and their relevance to agriculture.

★★★★★

Worldwide Food Production Potential

Arranged by RALPH J. McCRACKEN (USDA, Washington, DC) and HAROLD A. HENDERSON (Tennessee Valley Authority, Muscle Shoals, AL)

Sat., 26 May / N.Y. Hilton / Rhinelander Center

9:00 a.m. - 12:00 m. and 2:30 p.m. - 5:30 p.m.

Quantity and Quality of World Soils and Their Responsiveness to Fertilizers in Relation to Future Food Production.
S. W. BUOL (NORTH CAROLINA STATE UNIV.) and P. A. SANCHEZ (NORTH CAROLINA STATE UNIV.)

Within their climatic limitations, most soils can have their food production increased with addition of site specific formulations of fertilizer. As a corollary, no soil can sustain maximum production without infusion of those soil borne elements harvested in the food produced. Consequently, the amount of food produced on a given soil is that resulting from the practices which bring about the maximum return over input costs.

Acid soils, in climatic settings favorable for food production, have very low potential to produce without application of lime and fertilizers. Amelioration of certain phosphate fixing soils can be made by a single application of phosphate. Slow downward migration of basic cations during several years of lime and fertilizer application increases the thickness of the root compatible topsoil in naturally acid soil. This increases the plant available water and reduces the deleterious effects of rainless periods during the growing season.

Since the majority of naturally acid and phosphate fixing soils are in well watered and sparsely populated areas, they provide a considerable reserve of potential food producing land. Capital investment and technologically advanced farmers are required to properly fertilize these potential food producing areas and interface them with viable markets.

Technologies for Projecting Climate Trends and Assessing Their Potential Impact on World Food Production. REID A. BRYSON (Univ. of Wisconsin-Madison).

Climate, like food production, consists of many elements and is a non-linear response to multiple forcing functions. A number of the causal factors have been explored in some depth (e.g. carbon dioxide, volcanic aerosols, albedo, astronomical variations) but predictive models are ill-developed. Modelling of climate in the simulation mode has progressed rapidly but there is much yet to be done for the inclusion of the above causal factors in the predictive mode. Current methods for climate forecasting may be categorized in several ways: subjective or objective, based on external forcing or on internal features of the climate system, tested in real time or untested and theoretical, etc. A number of forecast programs have demonstrated that individual causal elements can produce a small amount of skill on month to season forecasts of temperature, and some have shown skill on precipitation forecasting and at longer lead times. It is not yet known whether methods integrating the effects of several causal elements will produce greater skill. Models of crop yield as a function of climate do not yet, in general, appear to be sufficiently accurate for use with predicted climate input. It does appear that, in some instances, long range climate forecasts can be used as inputs to agricultural policy decisions even now.

Technologies For Conserving Water For Future Food Production
CORNELIUS H.M. VAN BAVEL (Texas A&M University)

Water is an essential input in the global production of food. The quantities needed are prodigious, and the quality of the water must meet fairly rigid standards. Yet, the main tenor of this report is that presently available water resources are not likely to be a restraint in attaining a world-wide goal of an adequate diet for all inhabitants of the world in the foreseeable future. There is an abundance of technical and institutional opportunities for vast increases in the amount of the necessary food and feed units produced per unit amount of water applied. Current, wasteful practices of water use can easily lead to predictions of a "water crisis". However, such waste can be minimized by a three-pronged approach of improving the overall productivity of agriculture, pricing water at its replacement cost, similar to other production inputs, and curbing the pollution of ground and surface waters.

Gaines, B. R. and Shaw, M. L. G. (1984). Expert systems: the substitution of knowledge for materials in world food production. In Abstracts of 150th Annual Meeting of the American Association for the Advancement of Science, pp. 80. American Association for the Advancement of Science, Washington.