

Soil Management in the 1990's

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Contemplating the future is always an interesting and challenging exercise. The authors claim no special ability as seers for they likely would have used this skill to become independently wealthy by now. However, there are trends and forces in motion or in a state of initiation that will have major impacts on how we use and manage our soil resources in the next 10 to 20 years.

Before making any projections on future trends in soil management, some comments on the present state of agriculture are in order:

1. Although a tremendous knowledge base exists, in many cases it is not being used to its fullest potential. For example, despite research advances in nitrogen fertilization, nitrogen deficiencies are still common in North Dakota.
2. The knowledge base that benefits production agriculture will continue to grow. Better varieties, better herbicides, better fertilization and management practices will be developed and adopted by progressive farmers.
3. More land is being cultivated than necessary to meet domestic food requirements. Export of farm goods, while important, is not at the level expected a decade ago.
4. A significant amount of erosion-prone land is coming out of production as a result of the Conservation Reserve Program and similar programs.
5. Agriculture is slowly recovering, hopefully, from the financial distress of the 1980s. However, we must continue to compete in the international price arena.

A major challenge and opportunity will be to effectively use our present information base along with new research data. One important soil information base will be complete in 1990 when the Soil Conservation Service finishes the detailed county soil surveys in North Dakota. Most fields are composed of many soils with divergent properties but at the present time are managed as homogenous units. This means parts of the field receive excessive inputs of seed, fertilizer or pesticide while other parts of the field receive inadequate amounts. Adjusting inputs based on differential soil properties will result in reduced production costs, higher crop quality, higher yields and less risk of environmental contamination.

How might this management option be accomplished? Computerized or digitized maps will list soil properties important to management considerations. These properties might include texture, organic matter, drainage, pH, fertility ratings, profile depth and slope. The computer maps will then be interfaced with field equipment through control mechanisms where seeding rate, fertilizer application and chemical application would be continually adjusted according to soil properties. Herbicide rates could be increased in areas high in organic matter and reduced in sandy areas subject to leaching or carry-over. Less nitrogen would be applied in low, wet areas that are prone to lodging. Higher rates of phosphorus might be applied in parts of fields that are eroded or calcareous. Other problems that are apparent during the growing season can be addressed by storing this information on the computerized soil map.

Agriculture in the future will emphasize efficiency and the economic elimination of yield constraints. Economic crop production will have to eliminate nutrient deficiencies, weed competition and plant disease without wasteful over application of fertilizer and pesticides. Presently, two extreme schools of thought exist regarding soil and crop management, neither of which is realistic.

One school of thought emphasizes a rolling back of the calendar, farming as we did 40 years ago. This philosophy states that we need a minimum input agriculture. Ten bushel per acre wheat yields are not economically viable in the international market arena. It is **never** economic to grow a crop which is allowed to be ravaged by nutrient deficiencies, weeds, diseases and insects.

The other extreme school of thought advocates the massive and rather indiscriminate input of fertilizers and pesticides in hopes of achieving a very high yield. This approach, in the extreme, supports high initial fertilization, foliar fertilization and multiple fungicide applications, without knowledge as to the need for these inputs. Such an approach dramatically increases a farmer's costs and risks.

Profitable crop production in the future will demand the aggressive use of fertilizers and pesticides, but each input will have to be justified by **actual** field measurements. The goals of fertilizing for high protein wheat are different than for barley or sugar beets. Soil testing, especially deep nitrate testing, will become more common as farmers try to efficiently utilize the fertility in the whole profile.

Fertilizer may be used for auxiliary benefits such as disease suppression. The Soil Testing Laboratory at North Dakota State University introduced the chloride test this fall because of chloride's potential for foliar and root disease suppression. Fertilizer products and practices of the future may allow precise metering of nutrients to the plant over the growing season. Consideration and study of secondary nutrients such as sulfur and certain micronutrients will become more important.

Much erosion-prone land will be removed from production in the next 10 years. This land will probably not be needed for domestic food production in the near future; however, some marginal land will still remain in production. The baseline information that has been developed during the past 10 years, along with continuing efforts in management of erosion-prone land, will be used to reclaim or improve the productivity of these areas.

Soil and crop management in the future will require greater use of information sources. Computerized production records and soil maps will be available for convenient reference with expert systems developed for farmers to

query regarding management choices. Extension personnel and consultants will require a greater depth of training and will be integral components of the required information exchange. Farmers will have to become more highly trained in identifying nutrient deficiencies, insects, weeds and diseases.

The possibilities in soil management in the future are exciting and challenging. We will learn to improve and make better use of the soil resource by incorporating both basic and applied information into the management information base. Better use will be made of cultivated land and new practices will be developed and evolve for marginal or erosion-prone soils. Removal of some of these erosion-prone soils from production and developments in sustainable agriculture will result in environmental improvements that benefit all our citizens.

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as far as you are able and evaluate how different your life style is from that of your parents, grandparents or greatgrandparents.

Our commitment to the future will be enhanced by the new tools in agricultural research now becoming available to the bench or field scientists. These tools will provide the opportunity to "direct" desired changes in the products of agriculture rather than dependence upon chance and/or empirical occurrences. The products of agriculture in the future will include food, feed, fiber and fuel. Their outward appearance and sources of origin could be quite different than those of today.

There is no doubt that the composition and source of many of the foods that we eat in the future will be much different than those with which we are currently familiar. The components will be formed from non-plant or animal sources directly from carbon, hydrogen, nitrogen and minor essential elements and formulated by a safe and inexpensive energy source. These foods of the future will have carefully controlled energy levels and be absolutely safe from contamination since many would have a nonbiological origin. Already today we are seeing these artificial foods in sweeteners, cooking oils and low calorie items commonly sold on our grocery store shelves. The future involving foods from nonagricultural sources is already here!

We see that the eating of food is still and will continue to be a social function. The food preparation industry will continue to grow for energy and economical reasons and we will see the home kitchen become more and more a food

assembly center rather than food preparation center. The food of the future will be healthful, nutritious and require a decreasing level of biological input.

Agricultural research of the future will strive to be a focal point for research important to homemaking and feeding a growing and healthy family. There is no doubt that our family composition will change little since much of the drudgery associated with earning a living will have been eliminated by science.

There is no question that many common fibers will also be produced by specially bred plants, animals and biological processes. Fiber from a vat? Why not?

Approximately 3 percent of the total energy budget in the United States is devoted to the production of farm and ranch products to the "farm gate." An additional 17 percent or so of the national energy budget goes to put those products to our use. Our dependence upon fossil fuels will over the next one hundred years or so switch to nonfossil fuels. One needs only to view photosynthesis as an energy trapping process, available to us in vegetable oils and other high energy compounds now available to us for conversion to fuels useful in our lives.

The real issue for agricultural research is the maintenance of public funding of research important to the public. The Hatch Act of 1887 clearly stated the role of the public in this respect. As we have seen, the return on investment is enormous and continuing. We must not falter! Our motto should paraphrase statements commonly heard during the scientific revolution, "Agricultural Research for a Better Tomorrow."