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FOCUSING FAO ON THE FUTURE

On October 16, 1970—25 years to the day since FAO was formed in Quebec City—the Canada Department of Agriculture hosted the Silver Anniversary of the founding of the Food and Agriculture Organization in a celebration that was held in the Sir John Carling Building, the CDA's headquarters in Ottawa. The author indicates some activities that FAO should concentrate on over the next 25 years.

HON. H. A. OLSON

Dans l'avenir, le rôle de la FAO consistera autant à s'occuper des structures agricoles, économiques et sociales que des techniques d'accroissement de la production agricole. L'auteur indique les domaines d'activité dans lesquels la FAO devrait, selon lui, concentrer ses efforts au cours des vingt-cinq années à venir. En effet, c'est grâce aux réalisations des vingt-cinq dernières années, attribuables en grande partie à l'esprit d'initiative, à l'énergie, à l'aide et à l'encouragement de la FAO qu'il est possible d'établir maintenant les priorités de demain.

My first reaction, after looking at the FAO reports giving the statistics of successes and near failures, was similar to that of the man who said "By the time I get to where it's at, it's always where it was". On balance, however, I am impressed with the progress that has been made in spite of the difficulties that could not have been visualized by the founders of the FAO. In 1945 there were 2.3 billion people on this earth and today there are 3.6 billion. Politically, half a dozen countries made all the major world decisions in 1945. Today, more than 130 nations are operating as sovereign nations. The great majority are economically underdeveloped. They are becoming more and more impatient with their slow progress towards higher standards of living.

In 1945, there were no space ships. Man's walking on the moon was still a wild dream. The 'green revolution' was not even thought of. Pollution was not a dirty word. However, the word *famine* struck fear in the hearts of many. Today we are on the verge of a major agricultural production breakthrough in the developing countries; we are beginning to be concerned over the social impact of the "green revolution". In 1945, the FAO was the first of the new U.N. specialized agencies. Today we have many. The concept of bilateral and multilateral aid for economic development was, as we understand it today, unknown 25 years ago. I could recite statistics and give many examples of the progress made,

Mr. Olson is the Minister of Agriculture for Canada. This article is based on his address to the FAO Silver Anniversary celebration.

by all countries, in farming, fishing and forestry, and the contribution FAO made. Instead, however, I would like to take a look at the next 25 years and ask what needs to be done? What can FAO's contribution be?

What makes FAO so important? The simple fact that nearly 70 per cent of the people in the developing countries depend upon agriculture, that is farming, fishing and forestry, for their livelihood. Too many of these people are still living under substandard conditions.

During the FAO's first 25 years, the agricultural problems facing developed countries changed from problems of shortages which followed World War II to problems of surpluses. As a result, the policies needed to meet these problems have changed from emphasis on technical considerations to concentration on *adjustment* programs. If the potential outlined by the Indicative World Plan for increased production in developing countries is realized, it is probable that in the next 25 years their problems will slowly undergo the same changes that have occurred recently in developed countries. As a result, FAO's role in the future will be as much concerned with economic and social adjustment in the structure of agriculture as with the technology of increasing agricultural output.

If we were asked now instead of 25 years ago to establish FAO, what would it be like? Technically, we would be starting well ahead of anything that existed in 1945. What with the "green revolution", the highly sophisticated modern equipment, the tremendous knowledge in the field of biochemistry, genetics, etc., we should be in a position to make rapid progress.

Today, there are many U.N. specialized agencies, and therefore there is more scope for specialization by the agencies. I am of the opinion that FAO should be more selective in its activities. It should concentrate on the problems that have the highest priorities in the light of current developments and future requirements. These requirements are to a large degree highlighted in the international strategy for the second United Nations Development Decade, and the FAO Indicative World Plan.

What does the strategy for the Second Decade of Development propose in the field of agriculture? It sets as a general target an average annual rate of growth of at least six percent in the gross national product of the developing countries during the decade; this will imply an average annual expansion of four percent in agricultural output—a staggering task bearing in mind past rates of increase. In order to meet this target, developing countries have committed themselves to augment production and improve productivity in agriculture. They have, for example,

It was in Quebec City on October 16, 1945, that the FAO of the United Nations was founded as an international agency to fight poverty, malnutrition and hunger. By the end of this first FAO conference 42 nations had formally joined the organization.

At the 25th Anniversary Celebration held in Ottawa on October 16, 1970, Minister of Agriculture the Hon. H. A. Olson focusses on the role of FAO in the next 25 years.

undertaken to formulate national strategy for agriculture to improve the quantity and quality of their food supply, and the reform of land tenure systems for promoting both social justice and farm efficiency. They will adopt appropriate agricultural pricing policies as a complementary instrument for implementing the agricultural strategy. On their side the developed countries such as Canada will support these endeavors by providing resources for obtaining essential inputs, through their assistance in research, for building of infrastructure, and also by taking into account in their trade policies the particular needs of developing countries. International organizations, especially the FAO, in respect to agriculture, will be actively involved in helping to attain these objectives.

Here are some of the activities that I believe FAO should concentrate on over the next 25 years. These priorities are now possible because of the progress during the past 25 years, which is in large part due to the initiative, drive, assistance and encouragement provided by and through the FAO.

The first priority is people. Economic development, the 'green revolution', protein supplies, education must be considered in terms of people. Development programs should always take into consideration not only the latest developments in the sciences but also what the impact will be on the economic and social structure of a country and on the welfare of the people affected.

In the past it has been assumed that any increase in agricultural production, any increase in food supplies, automatically results in economic and social benefits to all the people. This is not necessarily so. Technological changes, as we have said, lead to changes in the structure of agriculture, and can also have an impact on other sectors of our economy.

It has also been assumed that increased production will automatically result in increased food availability. This is not the case. Food, after it is produced, has to be processed, moved, stored. Also more consideration should be given to widening the spectrum of food types, to providing, especially in developing countries, a greater variety of foods.

More emphasis should be put on the marketing of agricultural products, and on the processing of farm and fish products. But here I would like to issue a word of warning. Many changes are occurring in the processing, packaging, storage and transportation of food. FAO should look ahead in providing marketing and processing know-how to developing countries. After all, the airplane has made it possible for New Zealand to deliver in the same day fresh lamb to Vancouver, and Canada to deliver purebred cattle to Uganda and Guatamala. With new technological developments and larger air cargo planes being built, we may find it economically possible to ship fresh food great distances within a matter of hours. Add to this new roads, refrigerated transports, increase in urbanization in all parts of the world, and the pattern of food distribution is completely altered. Perhaps high priority of research should be given even in the developing countries to market research.

Related to the above is the work of FAO in food standards. Good progress has been made to date in defining standards as they apply to quality, health and sanitary conditions. Good progress has been made in proposing international standards that will result in reducing the use of food standards as non-tariff barriers in international trade. To date, in the main, the developed countries have been most actively involved. Too few of the developing countries are participating. FAO should expand its activities in this area, and concentrate in assisting and encouraging developing countries to participate in the Codex Alimentarius program.

We have yet to discover a satisfactory technique that will enable us to transfer easily and effectively the technological know-how and scientific knowledge in a form that will fit into the requirements of the economically developing countries. We know that the gap between the low income and the wealthier nations of the world and between regions within a country is to a large extent a science and technology gap. However, past experience has taught us that direct transfers of capital, knowledge and experts do not by themselves provide all the ingredients necessary for the advancement of the less developed countries. These countries must develop their own capabilities of producing the goods and services they require to raise the level of well-being of their people. If capital and technical assistance are to be effective, they must be integrated into the specific economic and social setting of each of the developing countries. To do this requires development of new ways of applying existing technologies to meet the particular needs of the less developed countries.

We, in Canada, are very much aware of the importance of this aspect of multilateral and bilateral aid. We have set up an International Development Research Centre. In brief, the Centre will identify, initiate and encourage, support and undertake research into the problems involved in the development of economically deprived regions of the world. The Centre will seek to develop the most effective application of the results of this research to the needs of the people of those regions. It will give high priority to programs that assist the developing countries to build their own scientific and technological capabilities so that they will not be mere welfare recipients, but contributors to the solution of their own problems.

FAO should identify the problem areas in farming, fishing and forestry and indicate priorities, and relate this form of aid to its continuing work under the Indicative World Plan.

FAO should encourage increased research on food crop diseases. We cannot rest on the laurels of the "green revolution". Without new developments in disease and parasite resistance, it could fail completely in five years. The high yielding varieties are a great breakthrough but essentially they are simply shortstraw wheats and rices that can accept maximum applications of fertilizers without producing straw that is too weak to support the heavy yielding heads. These new varieties lack characteristics that would assure their continued usefulness in many tropical areas. It is well known by the developers and others that these wheats and rices do not possess high levels of resistance to diseases such as rusts. But eventually, resistant varieties will be developed. The developers of these varieties have taken calculated risks in releasing the present high yielding varieties that possess low resistance levels. Their success is obvious but care must be taken to prepare for onslaught of disease. In Turkey, of the 21 varieties of high yielding wheat that have been introduced since 1965, only one is free of disease. A crash program of breeding for disease resistance is needed to back up such introductions.

FAO should emphasize programs on protection of the environment in rural areas. The problem of environmental pollution, now serious in the developed countries, will also increase in the developing areas. The drive to control pests in crops, animals and stored foods, as well as pests of people, can lead to serious side effects unless all checks and balances are carefully employed. Thus the desire to control insect-borne diseases in cattle can quickly lead to unacceptably contaminated milk and meat supplies. Increased research and development in such pest control and the development of immunological techniques for the diseases transported by insects and other agents will be in top priority.

FAO should give more attention to encouraging and assisting the expansion and improvement of ruminant animal nutrition and management in the tropics. Such work should include the development of indigenous ruminant animals through domestication and selective breeding.

In the next 25 years FAO must continue to expand its important work in all aspects of fisheries development to ensure that the biological resources of the world's ocean and fresh waters are evaluated, rationally utilized and effectively managed to provide a continued supply of essential food products. Special attention should be given to raising the standards of production and of living for fishermen in developing countries through direct assistance in production, processing and marketing. Problems of over-utilization and environmental deterioration will increase during this period and FAO, through its Department of Fisheries, should be prepared to provide advice to national and international fisheries organizations on new and effective management methods and on pollution control measures if the traditional fisheries are to be maintained at productive levels.

A scroll is presented to Dr. A. H. Boerma, Director-General of FAO, by the Minister of Agriculture, to commemorate the 25th year of FAO.

The concept of bilateral and multilateral aid for economic development was, as we understand it today, unknown 25 years ago. Here, a Canadian scientist instructs students in Kenya on livestock improvement in an FAO project.

Forests cover one third of the world's land area. FAO should provide for dissemination of new knowledge for improving forestry education and training, developing forests in arid as well as tropical regions, management of wildlife and national parks, and in linking results of fundamental research to field practices. Special attention will have to be given to reducing losses caused by wasteful logging and processing practices, and by insects, disease and fire.

No other single aspect of man's environment so markedly influences his health and capacity as the food he eats. Nutrition has a paramount influence on social and economic development. We have at our disposal today adequate scientific and technological knowledge to enable the provision of ample food supplies to assure nutritional adequacy for the total of the world's population. Yet, there still remains a vast amount of unfinished business in nutrition. Doubtless the most pressing nutritional problem on a world-wide scale is protein-calorie malnutrition. A tremendous amount of work remains to be done to combat problems of undernutrition and malnutrition throughout the world, and emphasis must be given to the needs of special vulnerable groups.

FAO should help in changing the systems of agricultural extension from the present trend of 'pumping' information to the farming sector. In the present system, one hopes that some farmers will make good use of the information and that their successes will be picked up by their neighbors. Another system, the 'dirty hand' approach, has been remarkably successful on the Puebla Project in Mexico. This innovative approach in extension must be related to both production and marketing requirements.

FAO along with other U.N. agencies should continue to play a significant role in the search for new trading arrangements which will help to restore a degree of order in world markets. As the Director-General stated at the 1969 FAO Conference, it will be necessary to seek "an intermediate course where international social justice rejoins economic common sense". Without improved access to markets for commodities produced in developing countries, much of the development assistance for the agricultural sector provided by FAO, other international agencies and through bilateral programs will be of greatly reduced value. It is therefore essential that these problems should be faced and solutions found as soon as possible to realize the full benefits of future technical assistance efforts.

It will be necessary to consider the liberalization of trade policies and coordination of internationally domestic agricultural policies. It is nearly 10 years since FAO outlined the "Guiding Principles on Agricultural Price Stabilization and Support Policies". These Principles remain very relevant and during the next 25 years it will be necessary to build on them a practical international code of economic behavior.

FAO's commodity groups are providing an important medium for the dissemination of information and consultation and are well placed to adapt to the challenges of the next 25 years. The Washington Committee on Surplus Disposal and the Principles of Surplus Disposal will continue to constitute an important element in safeguarding commercial markets.

A major contribution by FAO over the past 25 years is the development of a food aid program—a scheme for intelligently utilizing surplus foods for economic development. The spectres of food surpluses and shortages will continue to haunt us for some time. The FAO must continue to seek better ways of utilizing food abundance to meet the shortages and to assist both social and economic development.

What kind of an organization do we need? The FAO has gone through several organizational changes. The organization chart has been revised many times. But this is inevitable. An effective organization must adapt itself to the changing needs, to the new requirements, and to the priorities of the day. It originally made sense to have a strong central headquarters, because FAO had a small membership, a limited program, and relatively slow communication between headquarters and the field. Now with many more countries involved, with many more programs to handle, and with improved world communications, it makes sense to have the FAO manpower and other resources distributed among the many individual countries or among groups of countries. The right balance of authority between headquarters and the field will not be easy to determine; it is easy to move to extreme positions. This, however, is not desirable. FAO should be a smaller organization at headquarters. Rome should be the center for program planning and coordination and for overall executive and legislative control. The larger field staff should feed into headquarters their proposals based on the needs of a country or group of countries. The field staff should administer their program of work and budget once it is approved by headquarters. Thus, while policy formulation and budget determination would continue to be the responsibility of headquarters, the field staff would be responsible for implementing these policies.

I have only highlighted some of the activities that FAO should concentrate on over the next 25 years. I am confident that the FAO can meet the challenge. If man can go to the moon and come back, if man can send a machine to pick up samples of moon-rock and bring both the machine and its pay load back to earth, he can certainly program his computers to help him answer the riddle to the problems of economic and social development.

We are living in an era of rising expectations. The alleviation of poverty and the attainment of freedom from want are major objectives in all countries, developed and developing. Let us not be distracted from our objectives by debates over definitions, by political arguments, or by the desire to score a debating point. Let us not dissipate our efforts and motivations simply by supporting and establishing new institutions, e.g. a committee, a group, etc., every time we are confronted with a difficult problem. Priorities are not rigid. They can be changed. What must not be changed, but needs to be strengthened, is the determination of nations to accomplish the objectives that sovereign governments have written into the FAO constitution. ■

IRON IN MARITIME SOILS

UMESH C. GUPTA

Des recherches ont démontré que la couleur rouge caractéristique du sol de l'Ile-du-Prince-Édouard n'est pas due à une haute teneur en fer comme on le croit généralement mais plutôt à la nature du fer présent dans le sol.

The soils of the three Maritime Provinces show differences in their external appearance. For example, the characteristic red color of the soil in Prince Edward Island has always amused tourists and puzzled scientists. This red color is generally attributed to the quantitative presence of iron in the soil. However, in the absence of any analytical data on the iron content of the Island soils, it is difficult to prove this common belief.

Dr. Gupta specializes in soil chemistry and fertility at the CDA Research Station, Charlottetown, P.E.I.

Actually we have found that this is a *form* of iron mineral called Fe_2O_3 (hematite) which imparts a red color to the soil. Iron minerals are largely responsible for the various colors of igneous rocks. Dr. P. C. Stobbe, former Director of the CDA Soil Research Institute, Ottawa, observed that the red color of the Island soils is inherited from the parent material and is not related to the total iron content of soil. In nature, at a sufficiently high temperature such as in very hot and dry climates, all iron oxides transform to hematite (a red color producing mineral). It is doubtful, however, that temperatures in P.E.I. are sufficiently high to produce such transformations and these changes probably took place at the time of parent rock formation.

Iron is one of the important micro-nutrients required for the optimum growth of crops. It is necessary for the synthesis of chlorophyll, and a lack of iron produces, in its moderate and acute stages, a characteristic and easily recognizable type of leaf chlorosis in most plants. When chlorosis in plants becomes severe, leaf tissues devoid of chlorophyll

RED COLOR OF P.E.I. SOIL PUZZLES SCIENTISTS

commonly die. Because of the importance of iron in plant nutrition, several soils from the three Maritime Provinces representing different series and a range of soil texture were chosen for the conduct of this study. Total iron was determined by fusing the soils with sodium carbonate. Studies were also made on the free iron oxides and water-soluble iron contents from a limited number of soils.

In general, our research showed that soils with coarser textures contained lower quantities of iron compared to the fine-textured soils (Table 1). Riverbank sandy loam, a very coarse-textured soil was, however, an exception and contained the largest quantities of iron. Analysis of a limited number of soils indicated that approximately 19 to 36 percent of total iron oxides were in the form of free iron oxides (Table 2). The content of free iron oxides appeared to be lower in the coarser-textured soils than in the finer-textured soils. However, the water-soluble iron was present in only micro-quantities of 0.8 to 2.9 ppm in these soils. Numerous investigators have reported that plant chlorosis bears no general relation to total iron content of soil. The various forms of extracted iron from soils have also not been found to be correlated satisfactorily with the iron content of the plants. In the light of these facts it is difficult to interpret the results of this study with regard to deficiency and sufficiency levels of iron in the soils. However, it must be pointed out that to date there are no results available on the iron content of the Maritime soils. Therefore values of iron reported in this paper should prove a useful guideline for future work.

Analysis based on more than 100 soil samples indicated that Prince Edward Island soils actually have a lower iron content than soils of New Brunswick and Nova Scotia (Table 1). The average iron content (1.81%) in Island soils is only 23 and 75% of that in the Nova Scotia and New Brunswick soils (2.22 and 3.17% Fe). It is obvious therefore that the red color of Island soils is not related to their total iron content. ■

FREE IRON OXIDES AND WATER-SOLUBLE Fe CONTENT OF SOME SOILS

Soil Series	Texture	Free iron oxides: % Fe_2O_3 in soil	Free iron oxides: % of total Fe_2O_3	Water soluble iron (ppm)
Culloden	Sandy loam	1.41	20.8	1.6
Dunstaffnage	Sandy loam	1.41	32.9	2.2
Charlottetown	Fine sandy loam	1.60	28.3	3.2
Alberry	Fine sandy loam	1.84	30.0	1.7
Haliburton	Fine sandy loam	1.54	31.7	0.8
O'Leary	Sandy clay loam	1.78	28.8	2.1
Egmont	Clay loam	1.68	36.5	2.1
Queens	Clay loam	2.14	30.4	2.1
Acadia	Silty clay loam	1.66	18.6	2.9
Nappan	Clay loam	1.82	21.0	2.1
Tormentine	Sandy loam	1.86	32.2	1.5

TOTAL Fe CONTENT OF SOILS OF EASTERN CANADA

Soil Series	Texture	No. of Samples	% Fe	
NEW BRUNSWICK				
Interval	Loam to silt loam	8	2.82	mean 3.17
Queens	Clay loam	6	3.17	
Caribou	Silt loam	6	3.33	
Tracey	Sany clay loam	6	3.48	
Riverbank	Sandy loam	8	3.17	
NOVA SCOTIA				
Acadia	Silty clay loam	8	3.08	mean 2.22
Nappan	Clay loam	8	2.33	
Pugwash	Sandy clay loam	8	2.13	
Queens	Clay loam	8	1.94	
Tormentine	Sandy loam	8	1.98	
Truro	Sandy loam	8	1.83	
P.E.I.				
Charlottetown	Fine sandy loam	6	1,80	mean 1.81
Haliburton	Fine sandy loam	4	2.08	
Alberry	Sandy loam	5	1.93	
Dunstaffnage	Fine sandy loam	4	1.55	
Culloden	Sandy loam	4	1.55	
O'Leary	Sandy clay loam	3	1.96	
Kildare	Sandy loam	3	1.78	

Fig. 1. Treatment of wheat with deodorized malathion provides protection from infestation during storage.

INSECTICIDES PROTECT STORED FOODS

F. L. WATTERS

L'entreposage de la nourriture quelle qu'elle soit attire les insectes qui souvent la rendent impropre pour la consommation humaine ou animale. Des mesures d'hygiène appropriées renforcées par l'usage judicieux des insecticides empêchent les infestations et préservent également la qualité de la nourriture.

The storage of grain and grain products always involves risk of infestation. This risk can be almost eliminated by application of proper store hygiene and insecticides. Hygiene and good management of food stocks involve a good deal of common sense. Insecticides must also be used. But the use of insecticides poses many problems. Questions on how, when and where an insecticide should be used, and the amounts and times of application can be answered only by research. Part of the program at the CDA Research Station, Winnipeg, is to find simple, safe, and effective ways of using insecticides, and to make this information available to growers and the food industry.

Insecticide research at Winnipeg emphasizes studies to determine how minimum quantities of suitable insecticides can be used to prevent or control infestations of stored grain and grain products.

Dr. Watters specializes in insect biology and control at the CDA Research Station, Winnipeg, Man. He is currently on an assignment at FAO headquarters, Rome.

Stored-product insecticides include both contact insecticides and fumigants. This article deals only with contact insecticides that are used to kill insects or repel them from treated surfaces. Fumigants are gas poisons such as methyl bromide, ethylene dibromide, phosphine, and carbon tetrachloride. They are used primarily to control insects that have become established in stored grain or foodstuffs.

Contact insecticides that are used on or near foods must meet special requirements. These are: 1. low mammalian toxicity and high insect toxicity; 2. freedom from taint or other adverse effects upon the product; 3. economic to use and easy to apply. These requirements are difficult to attain and consequently, the number and kind of insecticides that may be used to control storage pests are limited.

There are three main classes of contact insecticides used to protect stored foods: organochlorine compounds, organophosphorous compounds, and pyrethroids.

Organochlorine compounds–Lindane and methoxychlor are the main organochlorine compounds used to control stored-product insects. DDT has also been used to a limited extent in past years but it has recently aroused considerable controversy because of its persistence, stability, and possible toxic effects on aquatic organisms and some birds. This has resulted in its restriction for use as a stored product insecticide. DDT is no longer registered in Canada for such purposes. But since its introduction as an insecticide in 1942 it has been credited with saving millions of lives in Asia and Africa through control of mosquitoes that carry malaria.

With methoxychlor, as currently recommended, rooms may be treated at a rate of 10 seconds spray per 1000 cu ft for stored product insects.

Lindane (gamma-BHC) was discovered in Britain in 1942 and has been widely used to spray food storage warehouses. It is used in Europe and Africa for the treatment of stored grain, groundnuts and other types of stored foods. Because it is stable at high temperatures, it can be applied from smoke generators. It imparts a slightly musty odor to foodstuffs which contact treated surfaces and its use is therefore restricted in many countries.

Methoxychlor is not as effective against stored-product insects as are DDT and lindane but in Canada it has provided satisfactory control of spider beetles in flour warehouses. It is less persistent than either DDT or lindane and therefore must be applied more often.

Organophosphorous compounds–The first insecticides of this group were discovered in Germany during World War II, as a biproduct of the search for lethal chemicals. Malathion, one of the best-known insecticides of this group, has provided us with one of the most useful stored-product insecticides ever developed. It combines high insect toxicity with low toxicity to man and livestock. Malathion controls insects in warehouses and empty granaries and may be applied directly to stored grain to protect it from infestation. Because of its rapid breakdown at high temperatures and at high humidities, warehouses must be retreated about every 4 weeks during the summer.

Bromophos and dichlorvos, also, have given promising results in both laboratory and field tests against stored-product insects. Bromophos is more stable on alkaline surfaces than malathion. Dichlorvos combines high toxicity in both the vapor phase and in its action as a contact insecticide. Its vapors can penetrate into cracks and crevices which other insecticides cannot reach.

Fig. 2. Comparison of effectiveness of residual insecticides on different surfaces. Most insecticides last longer on wood B and metal C surfaces than on concrete A.

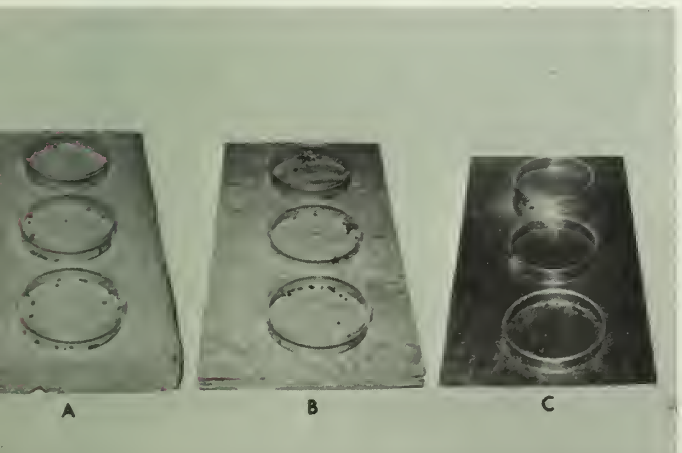
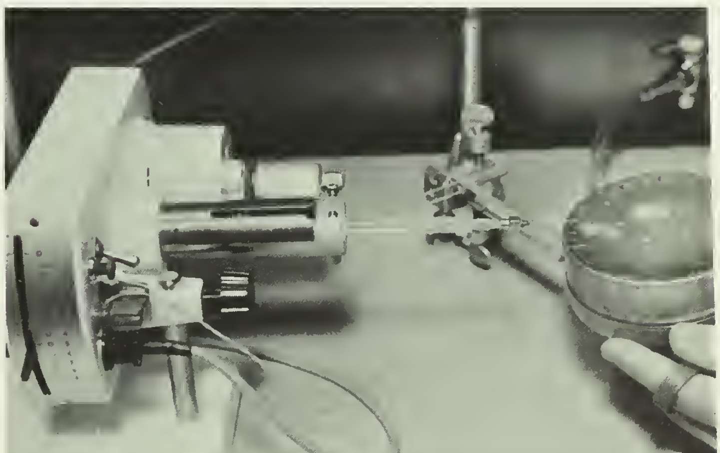


Fig. 3. Testing susceptibility of insects to insecticides with a micro-drop applicator which applies a single drop of insecticide to individual insects.



Pyrethroids—Pyrethrum, the most important member of this group, has been used as an insecticide for centuries. It is an extract of chrysanthemum flowers, and controls a wide range of insect pests. Its low mammalian toxicity, rapid knockdown of insects and absence of tainting properties, make it extremely valuable for insect control in houses, warehouses and food processing plants. The high price of pyrethrum is offset to some extent by addition of a synergist, usually in the ratio of 1:8 or 1:10 (insecticide-synergist), which reduces the cost of pyrethrum formulations by about 50 percent or more, depending on the insect species to be controlled. Pyrethrum breaks down rapidly when exposed to heat, light, air and moisture, and must be reapplied every 4 to 6 weeks in warm warehouses in Canada, depending on the insecticide concentration that is used. An important advantage of pyrethrum over many other insecticides is that sublethal deposits on surfaces repel insects.

PROTECTION OF STORED GRAIN

Good management of grain stocks combined with proper use of insecticides will prevent infestation and subsequent storage losses. Good management consists of harvesting grain as dry as possible and storing it in a clean, carefully prepared granary or bin that is weatherproof. A number of small granaries is better for grain storage than one large building because small lots of grain cool more rapidly and evenly during winter. Insects do not cause problems in cold grain.

Insects and mites infest most empty granaries and must be controlled to prevent infestation of newly-harvested grain. The insecticide required to treat a 1000-bushel granary costs only about one dollar. Additional protection can be obtained by direct treatment of stored grain with special formulations of malathion or pyrethrum. Recently we have found that malathion can be used as an alternative to fumigation for controlling insects in stored grain. Malathion protects dry, cool grain from infestation for 9 to 12 months. The insecticide breaks down more rapidly and is less effective in tough or damp grain than in dry grain. Cost of the treatment is less than half a cent per bushel.

PROTECTION OF CEREAL PRODUCTS

Infested warehouses cause infested foods. Therefore, warehouse infestations must be controlled. When this is not possible, foods must be packaged in containers that resist insect infestation.

Good warehouse management, which emphasizes clean, tidy premises, combined with proper use of insecticides will prevent infestations of stored foods. Food stocks must be rotated to ensure that old stocks will not accumulate. Broken sacks or cartons must be removed and food debris destroyed to eliminate insect breeding sites. Dunnage racks must be used to raise food stocks above the floor level. Insecticides applied to floor and wall surfaces will control insects and provide a toxic barrier to insects that may invade the warehouse.

Food processors have shown much interest in the use of insect-resistant packages for protecting foodstuffs from infestation. Insects may chew holes through cardboard and paper packages but the most common place of entry is through closures. Bags made of polycarbonate or other types of plastic that have pinched or sealed closures provide physical barriers against insect penetration. Certain multi-wall paper bags have an inner liner treated with synergized pyrethrins which form a repellent barrier to insects and protect the food from infestation for several months. The development of insect-resistant packages provides a way to protect processed foods from infestation during transportation and storage under a variety of conditions.

LIMITATIONS OF INSECTICIDES

Repeated applications of persistent insecticides may lead to residues that are dangerous to humans, farm animals, and wildlife. Several persistent organochlorine insecticides have already been removed from general agricultural use in certain Canadian provinces as well as in several countries in Europe and in several States of the U.S.A. The current trend is to replace highly persistent toxic insecticides with those of moderate or short persistence.

The development of resistant strains of insects has frequently resulted from intensive use of an insecticide. Though the ability of insects to develop resistance has been known for many years, widespread resistance became prevalent only after introduction of DDT and other synthetic insecticides. Control of resistant strains of insects has sometimes proved difficult because resistance to one insecticide resulted in resistance to others. Fortunately, the stored-product insects that have become resistant to organochlorine insecticides such as lindane and DDT can readily be controlled with malathion. However, recent reports have shown that an African strain of the red flour beetle, *Tribolium castaneum* (Herbst), an important pest of stored peanuts and cereals in West Africa has become tolerant to malathion. The higher dosages that are required to control resistant insects increase the risk of higher insecticide residues in stored foods.

Though there have been no reports in Canada of resistance among stored-product insects we are aware of this possibility. Therefore, one of our projects at the Winnipeg Research Station is to monitor insecticide susceptibility of stored-product insects collected from various regions of Canada. In this way we can anticipate the development of resistance and take appropriate action. ■

OBJECTIVES, GOALS AND PRIORITIES IN RESEARCH

K. RASMUSSEN

The setting of Objectives, Goals, and Priorities for research is one of the most challenging but difficult tasks faced by any research organization. It is particularly difficult for a mission-oriented organization such as the Research Branch which must consider the problems of producers in all parts of Canada. How do you compare the significance of a problem of the strawberry grower in New Brunswick with a problem of the wheat producer in Saskatchewan, or the dairy producer in Quebec with the honey producer in Alberta? To the individual producers concerned, the problems may well be equally critical but in the national picture their significance may be quite different.

The broad, primary objective of the Research Branch is to maximize solution of critical agricultural production problems with the research resources available. Under the modern concept of management by objectives, this is much too broad a statement for operational purposes and must be broken down to more specific, limited objectives and goals. The outcome of all of this is to present to all research managers in the Branch the question: Are you sure that you are spending your research resources on the most important problems and in the most effective and efficient manner? Only by taking this question seriously and designing procedures for analytical review of programs designed to achieve the Objectives and Goals can we hope to develop and maintain a vital research program that will provide the answers of greatest value to producers.

What are the criteria one should use? What are the most important problems? How does one know what is the most efficient approach to the solution of the problem? Much thought and effort has been given to finding answers to these questions by re-

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Dr. Rasmussen, until his retirement last October, was Associate Director General, CDA Research Branch, Ottawa, Ont. He also represented that Branch on the Editorial Board of *Canada Agriculture* and its predecessor, *Research for Farmers*.

OBJECTIFS, BUTS ET PRIORITES DE LA RECHERCHE

K. RASMUSSEN

Toute institution de recherches doit définir des objectifs, des buts et des priorités. C'est une tâche ardue mais exaltante. Elle est particulièrement difficile lorsque la mission est déterminée. A la Direction des recherches il faut considérer les problèmes des agriculteurs de tout le Canada. Comment peut-on comparer l'importance des problèmes du producteur de fraises du Nouveau-Brunswick à ceux du producteur de blé de la Saskatchewan, du producteur de lait au Québec ou de l'apiculteur de l'Alberta? Isolément, chacun peut revêtir, pour le producteur en cause, un caractère critique. Mais, replacé dans le cadre national, leur importance relative peut être très différente.

Dans ses grandes lignes, l'objectif principal de la Direction des recherches est de résoudre les problèmes agricoles aigus par le plein emploi des moyens disponibles. Suivant la conception moderne, prônant la gestion par objectif, la déclaration ci-dessus est beaucoup trop vaste pour servir de base de travail. Il faut la ramener à des objectifs et buts plus spécifiques et plus délimités. La question qui, dès lors se pose à tout directeur de recherches de la Direction, est de savoir si les moyens à sa disposition s'attaquent aux problèmes les plus importants et s'ils sont employés de la manière la plus efficace? Seule une réponse sérieuse à cette question et la mise sur pied de révisions analytiques constantes des programmes, permettra d'atteindre les objectifs et les buts visés, c'est-à-dire développer et maintenir un programme de recherches viable, offrant les meilleurs résultats aux producteurs.

Quels sont les critères? Quels sont les problèmes les plus importants? Qu'est-ce qui indique que notre choix de moyens est le meilleur? Les directeurs de recherches de nombreux pays consacrent temps et réflexion à ces questions. Des systèmes complexes ont été imaginés pour analyser et évaluer problèmes et

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Jusqu'en octobre dernier, date à laquelle il prit sa retraite, M. Rasmussen était le directeur général adjoint de la Direction des recherches du ministère de l'Agriculture à Ottawa (Ont.). Il représentait en outre la Direction au Conseil de rédaction de la revue *Canada Agriculture*, comme il l'avait fait précédemment à la rédaction de la publication *Research for Farmers*.

search managers in many countries. Some rather elaborate systems have been developed for analysing and evaluating problems and research projects proposed for their solution. These have been useful but in the final analysis human judgement is the basis for decision.

In the Research Branch, we work from the knowledge that there are more production problems than can be tackled at any one time. We know that a problem may be very critical to producers in one area but of little or no concern to producers in other areas. Contrariwise, we have a problem such as cereal diseases that is of concern throughout most of the country. Does this then mean that the local problem has to be ignored because it is local? Not at all, but it will be a factor in determining the proportion of resources that should be assigned to it.

This then leads to the next major question. What proportion of resources should be spent on crops as compared to livestock? Within crops how much should be spent on potatoes compared to wheat, or apples compared to alfalfa? What resources should go to learning how to control diseases as compared to control weeds, or to increasing production by improved fertility and cultural practices? These are all simple questions to ask but difficult ones to answer. In fact, the correct answer today may not be the correct answer tomorrow as priorities change with change in problems.

One criterion for judgement could be the value of the crop or product. On the surface, it would seem logical to relate research expenditure to the value of the product. This cannot be ignored completely but in itself can be very misleading. Take the case of rapeseed. When research was first started on rapeseed production problems in Canada the crop was of no real importance. One might well have said that no research should be done on it. However, research was started with the result that today rapeseed constitutes a major crop in western Canada. This development took place because consideration was given to the potential of the crop, not merely to its status at the time.

Another criterion that may be used is the threat of a problem either locally or nationally. A case in point is the wart disease of potatoes in Newfoundland. Considered simply in terms of the value of the potato crop in that province it might be argued that no attention should be given to the problem. But when viewed in terms of the possible impact of this disease on potato production in other parts of Canada it assumes much greater significance.

How then does the Research Branch establish priorities for its programs? It starts with an evaluation of problems. But you may ask: "How do we know what the problems are?" We know because the scientists and directors at our establishments are in constant touch with producers in their areas. In addition, they have close liaison with provincial extension per-

solutions projetées. Ils ont été utiles mais, en fin de compte, la décision s'appuie sur le jugement de l'homme.

Nous savons, à la Direction des recherches, qu'il y a plus de problèmes que nous n'en pouvons étudier. Nous savons qu'un problème crucial pour les producteurs d'une région, intéresse peu ou pas les producteurs d'autres régions. Au contraire, les maladies des céréales intéressent presque tout le pays. Est-ce dire qu'un problème doit être négligé parce qu'il n'est que localisé? Certes non, mais on tiendra compte de ce caractère dans la répartition des ressources.

Ceci mène à la seconde question importante. Quelle proportion des ressources faut-il attribuer aux cultures, comparativement aux élevages? Dans l'ensemble des cultures, quelle part faut-il accorder à l'étude des pommes de terre par rapport à celle du blé, aux pommes, ou à la luzerne? Faut-il donner la préséance à la lutte contre les maladies plutôt qu'à celle contre les mauvaises herbes ou à l'accroissement de la production par la fumure et les pratiques culturales? Toutes ces questions sont faciles à formuler mais difficiles à résoudre. En fait, la solution d'aujourd'hui ne sera peut-être pas la bonne demain. Les problèmes évoluent et avec eux les priorités.

Comme critère on pourrait, par exemple, prendre la valeur de la récolte ou du produit. De prime abord, il semble logique de lier les dépenses de recherche à la valeur du produit, mais même s'il est loin d'être négligeable, ce facteur, pris à part, risque de nous égarer. Quand par exemple on a commencé les recherches sur le colza, la valeur de la récolte était insignifiante. On aurait pu dire alors que toute recherche sur cette culture était superflue. Cependant, ces recherches furent à l'origine de l'expansion considérable du colza dans l'Ouest. Les possibilités virtuelles de la culture et non son importance économique au moment des recherches avaient été prises en considération.

Un autre critère serait la menace qu'un problème peut faire peser sur une région ou sur tout le pays. C'est le cas de la gale de la pomme de terre à Terre-Neuve. Si l'on considère uniquement la valeur de cette récolte dans cette province, on pourrait soutenir qu'on ne doit pas s'en occuper. Mais si l'on pèse les répercussions possibles de cette maladie sur la production des autres régions du Canada, elle revêt une importance beaucoup plus considérable.

Comment alors la Direction des recherches établit-elle ses priorités? Tout d'abord on commence à faire une évaluation des problèmes. Nous les connaissons parce que nos chercheurs et les directeurs de nos établissements de recherche sont en contact permanent avec les producteurs de leur région. En outre, ils sont en relations étroites avec le personnel des services provinciaux de vulgarisation qui travaillent avec les producteurs et sont au fait des difficultés que ceux-ci rencontrent.

Les directeurs d'établissements, sur avis des chersonnel who work closely with producers and are aware of problems.

The directors of establishments, in consultation with their scientists, make the first evaluation of problems in their areas and set priorities for action in relation to their immediate resources. Based on this, they develop proposals for programs to be undertaken to provide solution to the priority problems. These proposals are submitted to Branch headquarters for review in the context of program proposals from all establishments and the national picture.

The programs are reviewed annually at all levels of management to ensure as much as possible that necessary changes are made to meet the changing circumstances. It is in the annual program review by headquarters staff that decisions are made on overall priorities and allocation of resources. It is at this stage that unnecessary duplication of effort is eliminated, that local versus national priorities are weighed and decided. It is here too that long-term shifts in emphasis are developed and consideration is given to new major problem areas such as pollution.

When the annual review has been completed and decisions have been made, no one is completely satisfied because there never are enough resources to deal with all of the problems in an adequate manner. But there is satisfaction in knowing that the combined judgement of scientists and research managers throughout the Branch has been brought to bear and the final decisions reflect this judgement. ■

cheurs, font une première évaluation des problèmes de leur région et établissent les priorités dans l'attribution de leurs ressources immédiates. Sur cette base, ils proposent des programmes visant à résoudre les problèmes prioritaires. Ces propositions sont soumises à la Direction qui les examine à son tour dans le contexte des propositions venant de tous les établissements et en fonction de l'ensemble des besoins nationaux.

Les programmes sont passés en revue annuellement, à tous les échelons, afin de s'assurer que, dans la mesure du possible, les modifications dictées par les changements de circonstances sont apportées. C'est à l'occasion de cette revue annuelle des programmes que le personnel de la Direction détermine les priorités essentielles et fait l'allocation des ressources. C'est à ce stade que le chevauchement des efforts peut être éliminé, que les priorités locales sont pesées et établies en regard des priorités nationales. C'est ici aussi que prennent naissance les déplacements d'accent à longue échéance et que sont pris en considération les nouveaux facteurs d'importance majeure, telle la pollution.

Quand la revue annuelle est terminée et que les décisions ont été prises, personne n'est entièrement satisfait puisque les ressources ne suffisent jamais aux besoins existants. Mais on sait néanmoins que l'avis des chercheurs et des directeurs de recherche de toute la Direction a été pris en considération et que les décisions finales reflètent leur jugement. ■

DR. KARL RASMUSSEN RETIRES

Dr. Karl Rasmussen, Associate Director General of CDA's Research Branch, retired recently. He was a member of the Editorial Board of this magazine, *Canada Agriculture*, from 1968 to the fall of 1970, and served in the same capacity on its predecessor, *Research for Farmers*, from 1962 to 1966.

Dr. Rasmussen played a significant role in the development of a sound livestock research program for Canada in his 40-year career with the department. In his research he advocated the use of crossbreeding to optimize livestock production. His emphasis on selection of all classes of stock, based on performance and economic traits, led to the acceptance of this procedure as standard practice.

Dr KARL RASMUSSEN PREND SA RETRAITE

Le Dr Karl Rasmussen, adjoint au directeur-général de la Direction de la recherche du ministère de l'Agriculture, vient de prendre sa retraite. De 1962 à 1966 il a été membre du Bureau des rédacteurs du magazine *Research for Farmers*. Lorsque *Canada Agriculture* a pris la relève de 1968 jusqu'à nos jours, il a continué d'assumer les mêmes fonctions.

Au cours des 40 années qu'il a passées au Ministère, le Dr Rasmussen a joué un rôle déterminant pour la mise en œuvre d'un programme de recherche sûr pour le bétail du Canada. Au cours de ses recherches il a recommandé les croisements de race afin de maximiser la production du bétail. Parce qu'il a mis l'accent sur la sélection de toutes les classes d'animaux d'après la production ou les caractères économiques, nous avons maintenant accepté ce processus comme pratique normale.

SOME FLOWER— THE SUNFLOWER

BUT BEWARE OF VERTICILLIUM WILT

J. A. HOES

Etant donné que la verticilliose du tournesol peut réduire le rendement de 90% et par conséquent rendre la récolte inutile, des recherches ont été menées à la Station de recherches de Morden au Manitoba, sur les symptômes, le cycle évolutif et la lutte contre cette maladie.

In Manitoba—mainly the Red River Valley in the southern part of the province—the sunflower (*Helianthus annuus* L.) is some flower! This year acreage was expected to hit an all-time high of 80,000—up 20,000 acres from the previous high. This area is well suited to sunflowers because of the relatively large number of frost-free days. The crop is also grown in Saskatchewan, Alberta and Ontario but acreages are much smaller.

In Manitoba, the sunflower has an enemy—wilt disease, often called 'leaf mottle', and prevalent since it was first recognized in the province in 1948. In our investigations at the CDA Research Station, Morden, Man., we have been studying wilt disease, causal organism of which is *Verticillium dahliae* Klebahn, a fungus characterized by resting structures (microsclerotia). Since 1948 wilt disease has become increasingly more important because it took several years to diagnose the actual cause of the disease and because earlier cultivated varieties (cultivars) were all highly susceptible, and furthermore because the pathogen is soil-borne and crop rotations were short.

Our research has revealed that *Verticillium dahliae* is an important pathogen because it can reduce yield 90 per cent or more, thereby making the sunflower crop worthless for harvesting. We have found that most fields in southern Manitoba are infested. The extent of yield reduction will depend primarily on the cultivar and to a smaller extent on conditions of soil moisture, temperature and precipitation.

The Disease Cycle—The fungus, as our studies showed, produces great numbers of spores. It overwinters as microsclerotia inside plant refuse. These germinate in spring and infect the roots of seedlings. The germinating microsclerotia may penetrate directly by means of mycelium or they may produce spores which penetrate the roots. The pathogen reaches the vascular tissue of the roots and then spreads into the xylem of the stem, either by mycelial growth or by spores produced inside the vessels and transported upwards. We found that the pathogen infects both susceptible and resistant plants. We have yet to discover the reason for resistance versus susceptibility but have learned that factors such as temperature, light and nutrition do affect wilt disease development in sunflowers. We discovered too that, at the end of the season, microsclerotia are returned to the soil in the dead plant tissue. The pathogen is seedborne and it can also spread by windblown soil or on implements.

Disease Symptoms—In our investigations at Morden, we found that symptoms appear on the leaves just before flowering and develop rapidly in susceptible plants. Usually, areas between the veins of the leaves turn yellow and as they increase in size the center portion dies and turns brown. Several such areas may occur on one leaf, hence the earlier term 'leaf mottle' for the disease. Eventually the areas coalesce and the whole leaf dies. Our study showed that the symptoms appear on the lowest leaves first and as the pathogen progresses from bottom to top of the plant, symptoms appear in leaves progressively higher up the stem. The closer to the top of the plant, the less severe the symptoms on individual leaves (Fig. 1). Severely diseased plants are stunted and often produce no seed. Affected plants may wilt suddenly in hot weather but they may recover and appear quite normal next morning. Internally, diseased plants show browning of the vascular system, and in severe cases the interior of the taproot looks black because of the masses of microsclerotia.

Sources and Inheritance of Wilt Resistance—Commercial cultivars and introductions, particularly of Russian origin, are heterogeneous and wilt-resistant lines are rather easily selected from them. Wild annual sunflowers provide another source of resistance. In our investigations we collected seed of species of wild annual sunflower, mostly *H. annuus* in Manitoba and Saskatchewan, and in the United States. We found that resistance to *Verticillium* wilt occurred in all 22 collections. Interestingly, collections from South Dakota, Nebraska, Colorado, Kansas and Oklahoma contained about 50 per cent or twice as many resistant plants as those from Wyoming, North Dakota, Manitoba and Saskatchewan. Apparently, resistance is widespread over the North American continent. The data also suggest that resistance is more common in the central and southern U.S. than in the northern United States and in Canada. Sunflowers are native to North America. Thus, in our opinion, the occurrence of factors for wilt resistance is not unexpected assuming that the pathogen also is native.

Dr. Hoes is a plant pathologist, CDA Research Station, Morden, Man.

We found that different resistant and susceptible inbred lines may differ in their degree of resistance and susceptibility and there is evidence that several genes govern resistance to wilt. Lack of dominance, dominance for resistance and dominance for susceptibility were evident in crosses between resistant and susceptible lines. A dominant gene V_1 that exercises major control of resistance in one cross has been postulated, and hybrids of susceptible lines and lines with gene V_1 were as resistant as the resistant parent. Heterosis for resistance has also been demonstrated.

Control of Verticillium Wilt—Our research has shown to date that resistant cultivars are the best means of control. For example, the cultivars Admiral, Advent, Commander and Mennonite were found to be susceptible, while Peredovik was resistant and Armavirec, Krasnodarets and Valley were moderately resistant. In breeding programs, material can be screened for resistance in a wilt nursery, which is a field heavily infested with the pathogen. Wilt-resistant plants can also be selected in the greenhouse where seedlings are injected with a spore suspension of the pathogen or roots of seedlings are dipped in a spore suspension and replanted (Fig. 2).

Crop rotation is another important and practical means of control. In Manitoba sunflower is the only crop which shows disease as a result of infection. We have found that other crops may become infected, however, without showing symptoms and, if yield reductions occur, they are small. We grew beans, buckwheat, cotton, eggplant, flax, mustard, peas, peppers, potatoes, safflowers, soybeans and sunflowers in our wilt nursery and the roots of all plants contained *V. dahliae* but only sunflowers showed the symptoms of the disease. Broadleaved (dicotyledonous) crops and weeds are as a rule more easily infected than monocotyledonous plants such as cereals, corn, grasses and onion.

Our research also revealed that a *Verticillium*-infected plant increases the soil-borne inoculum and for this reason sunflowers should be rotated with crops such as cereals while beans, peas, potatoes and such should be avoided. How many years should elapse between crops of sunflowers on the same land? The answer depends on the crop history, the cultivar to be planted and the degree of infestation of the field. The writer knows one farmer who planted a susceptible cultivar on land which had not grown sunflowers for ten years; *Verticillium* wilt and yield reductions were severe. If this farmer had used a resistant cultivar, however, yield reductions would have been much smaller. Our studies have shown that with resistant cultivars five years between sunflowers crops gives satisfactory results. As for growing susceptible cultivars, we found that these should only be grown when there is no history of sunflower wilt on the farm or in the area, and then only after monocotyledonous crops.

Fig. 1. Verticillium-*diseased sunflower with moderately severe symptoms.*

Fig. 2. Selection of resistant plants by immersion of the roots in a spore suspension. Inoculated plants on the right, non-inoculated on the left.

Since seed may carry *Verticillium*, we treat the seed of cultivars that are susceptible to wilt, using approved chemicals. In weed control by cultivation, we try to avoid injury to roots of the crop, particularly sunflowers subject to attack by *Verticillium*, otherwise plant resistance to wilt is decreased. ■

PESTICIDE APPLICATION

. . . new developments

K. S. McKINLAY

Ce présent projet de recherches étudie les moyens d'améliorer l'application des pesticides par l'uniformité de la taille des gouttelettes afin d'en maximiser l'efficacité et de réduire les dérives.

At present chemical pesticides are still our best defence against the insects, weeds and fungi which damage our crops.

While much work has been done on finding and developing chemicals that combine economy, effectiveness and safety, relatively little has been done to ensure maximum effectiveness in the application of the pesticides. To overcome this deficiency a new program has been developed in the Research Branch with the work centering at the Research Station, Saskatoon.

When we apply pesticides we are trying to spread a small amount of chemical over a large area and it is not easy to spread a few ounces of pesticide evenly over an acre of crop. This problem can be simplified by diluting the active chemical with a large volume of water or inert dust so that there is a greater bulk of material to spread. Alternatively there is ultra-low-volume spraying, a more recent approach where a small volume of highly concentrated liquid insecticide is broken into very large numbers of very small drops and dispersal facilitated in this way.

Whatever the method of application the aim is to deposit as much of the spray as possible on the target. Any pesticide not hitting the insect or weed target is wasted and any spray drifting out of the field in which the application is made represents a potential hazard. There is no need to stress the complications which may arise if a herbicide drifts onto a neighbor's susceptible crop, or if an insecticide drifts and causes a residue on a pasture being grazed by cattle.

Now the behaviour of the spray, whether it settles on the target or lifts up in the air and drifts 10 miles away, is largely determined by the size of the droplets produced by the spraying machine. These droplets are usually measured in terms of "microns" (one thousandth of an inch equals 25 microns). The droplets produced by a spraying machine can be caught and measured in a variety of ways to produce a "drop-spectrum" which shows the numbers of drops of different sizes which make up the total spray.

Table 1 shows a typical drop-spectrum produced by an ordinary hydraulic spray nozzle (TeeJet, 650067, water, 40 p.s.i.). It is obvious that this nozzle produces a mixture of drops of many different sizes with the numbers of drops fairly evenly distributed over the whole size range. Now, it is reasonable to assume that for any given combination of crop and pest there will be an optimal drop size which will give the best

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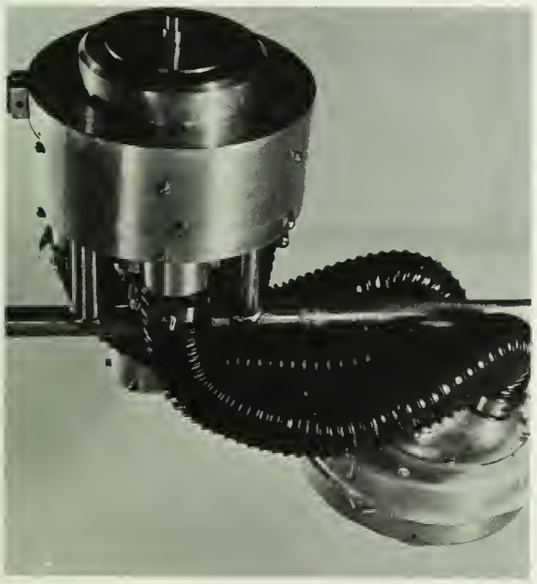
compromise between effectiveness, safety and economy. For the sake of argument let us say that for a given herbicide application a drop size between 177 and 250 microns would result in effective control with minimal drift. Looking at the drop spectrum in Table 1 only 16% of the drops are in this desired range, 68% are smaller and likely to drift while 16% are larger, contain 30% of the spray volume and reduce coverage.

Unfortunately none of the commercial spraying equipment on the market is capable of producing sprays of really uniform droplets of any chosen size. Without equipment of this kind it is not even possible to do field experiments to see what the optimal drop sizes might be for various pests and crops let alone do this in commercial practice. In an attempt to meet this need a group at Canada Agriculture Research, Saskatoon, has been working on the development of a field sprayer which would produce sprays of uniform drop size. A prototype nozzle for this equipment is shown in the photograph.

The basis of this device is a spinning disc for it has been found previously that liquids are thrown off rotating discs as remarkably uniform droplets, particularly at low flow rates. However, the spinning disc alone will not do the job for the production of each main drop from the edge of the disc also entails the production of one or more much smaller satellites. Thus the disc really produces two populations of droplets, the larger, relatively uniform main drops whose size depends upon the speed of rotation of the disc and widely separated, much smaller satellite droplets. If the disc is placed in the mouth of a tube or shroud and air sucked in through the gap between the disc and the surrounding shroud then it is possible to trap the more easily deflected small satellites and release only a fairly homogeneous population of the larger drops.

This device is still under development. In its present form it is much better than the hydraulic nozzle discussed before and could certainly be used to produce pesticide sprays which could be guaranteed not to drift. This would be of considerable benefit, especially for the application of herbicides. However, the droplets produced are not absolutely uniform but usually differ by a factor of two, for example, 100 to 200 microns, 150 to 300 microns, etc., depending upon the speed at which the disc is rotating. Narrow drop spectra such as this should be adequate for many field studies but it is hoped that it will be improved during further development.

The development of a controlled-drop-size field sprayer is only a first step. To optimize its usefulness much research must be done to determine the drop size and volume of spray needed for different applications. Each combination of pest and crop represents a different problem. Some insects are very mobile, live on the top of the crop and are very vulnerable to almost any kind of spray. Other insects live static, sheltered lives within a dense crop and here droplet size could be critical. If the spray droplets were too large they would deposit on the outer leaves of the crop and never penetrate where the insects live. Too small a drop would be difficult to handle and very prone to drift. One needs a drop small enough to follow the airflow around the leaves, penetrate the crop and impact upon the insect within. Similar considerations apply to any other combination of pest and crop; each one tends to be a special case. A controlled-drop size field sprayer would make it pòssible to carry out the field experiments to discover the optimal combination of dosage of pesticide per acre, volume of spray per acre and drop size for each crop and pest. ■



Scientists are working on the development of a field sprayer which will produce insecticide sprays of uniform drop size. A prototype nozzle for this type of equipment is shown here.

TABLE 1. TYPICAL DROP-SPECTRUM PRODUCED BY HYDRAULIC SPRAY NOZZLE

Drop Size (Microns)	11-16	16-22	22-32	32-44	44-64	64-88	88-125	125-177	177-250	250-354
% of drops in class	0.8%	2.3%	11.7%	18.7%	8.0%	17.9%	8.5%	14.0%	16.1%	2.0%

Canada Agriculture
Winter '71

ECHOES
FROM THE FIELD AND LAB

Imported chrysanthemums are quarantined for 60 days by the Canada Department of Agriculture's Plant Protection Division to keep white rust disease out of the country. Chrysanthemum growers are worried that the spread of the rust to Canada could destroy trade with the U.S. So far, no cases of the disease have been found. (see story below.)

Les chrysanthèmes importés sont gardés en quarantaine 60 jours par la division de la protection des végétaux du ministère fédéral de l'Agriculture afin de prévenir l'introduction de la rouille blanche au pays. Advenant l'apparition de cette maladie chez nous, nos producteurs auraient raison de redouter la cessation de nos échanges avec les États-Unis. Jusqu'ici, on n'à décelé aucun cas de rouille blanche au Canada. (voir texte à droite).

CHRYSANTHEMUM QUARANTINE A quarantine on chrysanthemum plants and cuttings is keeping white rust, a fast-spreading fungus infection of these plants, out of Canada.

Imported chrysanthemums must be quarantined for 60 days by the Plant Protection Division of the Canada Department of Agriculture before they are released for commercial production. New varieties of imported mums are propagated by cuttings from a mother plant which may have been infected with white rust.

Plants from the United States, cut flowers and seeds can be imported without the quarantine restriction.

White rust (*Puccinia horiani*) was first seen in Japan. From there it has spread to Australia, Asia, South Africa, most of Europe, and to Britain. So far it has not appeared in the Americas.

Because of the importance of the chrysanthemum industry in the U.S., a quarantine was declared to prevent the spread of the rapid-growing fungus in that country. Canada quickly followed suit to protect its brisk trade in chrysanthemums with the U.S.

Few realize that chrysanthemums are as important economically to Canadian horticulture as the tomato crop. The many varieties, forms and colors of the long-lasting blooms are ideal for gardening, potting and cut arrangements. The CDA inspectors handle two or three hundred varieties every year, mostly hardy garden varieties developed in Britain.

It is these British and other European varieties that may bring white rust into the country.

QUARANTAINE POUR CHRYSANTHÈMES Grâce à une quarantaine imposée aux plants et boutures de chrysanthèmes, on réussit à prévenir l'introduction au Canada de la rouille blanche, maladie cryptogamique qui se propage rapidement.

Les chrysanthèmes importés doivent être gardés en quarantaine durant 60 jours par la Division de la protection des végétaux du ministère fédéral de l'Agriculture avant d'être homologués pour la production commerciale. Les variétés nouvelles de chrysanthèmes sont multipliées par des boutures prises sur un plant-mère exposé à l'infection de la rouille blanche.

On peut cependant importer des plants, des fleurs coupées et des semences des États-Unis sans recourir à la quarantaine.

La rouille blanche (*Puccinia horiani*) a d'abord fait son apparition au Japon. De là, elle s'est étendue à l'Australasie, l'Asie, l'Afrique du Sud, la plus grande partie de l'Europe et la Grande-Bretagne. Jusqu'ici, on ne l'a pas signalée en Amérique.

A cause de l'importance de l'industrie des chrysanthèmes aux États-Unis, on y a imposé une quarantaine pour prévenir l'introduction du champignon en ce pays. Le Canada a rapidement suivi l'exemple des États-Unis pour protéger le commerce actif de chrysanthèmes qu'il entretient avec son voisin.

Peu de personnes se rendent compte que les chrysanthèmes ont l'importance de la culture des tomates dans l'économie de l'horticulture canadienne. Les nombreuses variétés, formes et couleurs de ces fleurs de longue durée sont idéales pour le jardin, la culture en pot et comme fleurs coupées. Le ministère de l'Agriculture du Canada examine chaque année de deux à trois cents variétés, la plupart de type rustique créées en Grande-Bretagne.

Ce sont les variétés britanniques et d'autres d'origine européenne qui peuvent introduire la rouille blanche au pays.

SPRING LAMB FOR CHRISTMAS? The technology of sheep production is changing so rapidly that when you plan your next visit to a farm to see spring lambs—perhaps you better go at Christmas time.

Or Easter—or any other time of year, for that matter.

Why? Because it's now possible to treat ewes with hormones so that they can produce lambs at any time of the year. Also, they could produce two crops of lambs a year, instead of the traditional spring crop, without any undue strain on them.

To sheep producers, prospects of year-round lamb production bring visions of larger profits. With lamb available any time of the year, much more might be eaten.

That would stabilize the market and reduce the cost of raising lamb by spreading overhead costs over two crops a year instead of the traditional one crop.

The gestation period of ewes is a little under five months, allowing plenty of time for a ewe to produce two sets of lambs a year, provided she can be induced to breed at any time of the year.

Young lambs can be weaned at a very early age and reared on milk replacers, so the stress of lactation can be removed from the ewe. And the remaining stress of two pregnancies per year should not be too great for normal, healthy ewes.—J. W. G. NICHOLSON, CDA RESEARCH STATION, FREDERICTON, N.B.

ANTS HAVE INTERESTING HISTORY

Ants are among the oldest of the insects, and number about 8,000 different species.

Their ancestors are believed to have been solitary burrowing wasps.

Ants have a long life-span. Individual worker ants have been known to live up to seven years; queens from 10 to 17 years. They are prolific and build up immense colonies which may be found wherever there is shelter and protection. As many as three-quarters of a million ants have been counted in a single hill.

There are several queens and numerous workers in each colony. During certain seasons, depending on the species, winged males and females emerge from the colony and mate. This is called swarming. After mating, the male dies, and the queen flies away to establish a new colony.

When she had found a suitable nesting site, she lays her eggs. After they hatch she cares for the larvae and pupae until mature workers appear. These then take over all duties except reproduction.

Most ant nests are made outisde, often under rocks. Some species don't nest at all, but live a completely nomadic existence. Some ants establish themselves indoors—the

ECHOS
DES LABOS ET D'AILLEURS

Pharoah ant, for instance, confines itself to heated buildings and the carpenter ant tunnels in buildings.

However, often the ants seen in buildings are merely workers looking for food to carry back to an outside colony. When these worker ants forage for food, they leave a scent trail for other ants to follow. This trail is also their road home.

PRODUCTION DU VEAU DE LAIT Le coût d'alimentation des veaux laitiers en surnombre pour en faire des veaux de boucherie doit être déterminé avec précision par les producteurs de lait.

On peut facilement démontrer que les excédents de lait ne constituent pas nécessairement l'aliment le moins cher pour l'engraissement des veaux.

En certains cas, il est plus avantageux de vendre le lait aux laiteries ou aux établissements de transformation et d'acheter des succédanés de lait pour l'engraissement des veaux.

D'après des expériences faites récemment aux États-Unis, des rations de grains seraient encore moins chères.

Une livre de bonne formule à veaux équivaudrait à 10-15 livres de lait entier.

Les cultivateurs de la région atlantique trouvent dans le commerce, pour la production des veaux de lait, des aliments d'une prix de $25 le quintal (100 livres) et moins encore, soit au plus 25 cents la livre; or 10 livres seulement de cet aliment auraient une valeur alimentaire égale à 100 livres de lait.

Dès lors, si le cultivateur reçoit moins de teneur en matières grasses d'environ 20% au $2.50 les cent livres de lait, il peut être avantageux de le donner aux veaux. Par contre, s'il en obtient plus de $2.50, il serait probablement plus rentable de vendre le lait aux usines et d'acheter d'autres aliments du commerce pour l'engraissement des veaux.—M. A. D. L. GORRILL, STATION DE RECHERCHES, FREDERICTON, N.B.

MILKING MICE Animal geneticists in the Canada Department of Agriculture are turning to mice for answers on how larger animals inherit traits.

Genetic experiments with mice are not new, but they are gaining in popularity.

For example, at the CDA Animal Research Institute, Ottawa, Ont., mice are being used to study the genetics of milk production. The results should be applicable to everything from dairy cattle to nursing sows. Also, by testing theories about the inheritance of milk production, this research should contribute directly and substantially to improving Canadian livestock production efficiency.

Mice have become popular as test animals for two basic reasons. They multiply quickly, and are much smaller than livestock.

Because they multiply quickly, theories can be tested faster. And because they are small, capital costs for housing, feed and maintenance are low.

However, working with mice is not without challenges.

For example, how can you test theories about the inheritance of milk production traits without measurements?

A milking machine presently being used hinders milk production of a mother mouse.

So some other method had to be found to measure performance.

The method found was measurement of the weight gain of mother's offspring. The litters that gain weight rapidly would have mothers with plenty of milk—those that perform poorly would have mothers producing less milk.

Tests demonstrated that weight gain before weaning can be used as an indirect measure of mother's milk production, and that weight gain is closely related to the weight of mammary glands of the suckling mother.

Other CDA geneticists have used mice to provide a wide range of information about inheritance.

Once a theory is proven with mice, it can be applied to livestock—J. NAGAI, OTTAWA, ONT.

WHEAT GRADING Protein grading of Canadian wheat will not replace the traditional standards of quality. Rather, the intention is to add a new criterion, and in this way to supplement and improve the present system.

The House of Commons is currently studying a new Canadian Grains Act which would empower the government to introduce protein grading.

As buyers of Canadian wheat have adopted new milling and baking techniques, notably the Chorlywood process, there has been a demand for guarantees of protein content. The Chorlywood process enables bakers to use relatively large amounts of cheaper, home-grown, lower-quality wheats when mixed with high-quality wheat with a guaranteed minimum level of protein.

This emphasis on protein content has caused some mistaken impressions, even among experts in the Canadian wheat industry. Some people believe that we can scrap our current grading system and replace it with a simple system of protein guarantees. But there is no single test, including protein analysis, which completely characterizes wheat quality.

Although the quality of protein is a good indicator of baking strength, there are many other important aspects.

Two wheats may have identical protein contents, but one may have a mixing time for proper dough development that is far too long. This would make it unacceptable for modern high-speed bakery schedules.

Or two wheats of identical protein could produce entirely different types of bread—one loaf of high quality, the other with a sticky or gummy crumb and texture. A high level of alpha amylase produces the poor quality product.

These differences apply to other factors as well as protein content.

It is for these reasons that quality evaluation of new varieties and wheat grades is based on a comprehensive series of tests covering many aspects in addition to protein content.—G. N. IRVINE AND ISADORE HLYNKA, CDA GRAIN RESEARCH LABORATORY, WINNIPEG, MAN.

WEEDS AS POLLUTERS Weeds are one of nature's most potent polluters. In fact, scientists generally agree that losses to weeds total more than the combined losses to insect pests, plant and animal diseases.

As polluters, weeds can cause a number of problems. Humans suffer from hay fever or direct poisoning, as with poison ivy. Farmers suffer yield losses because weeds compete for moisture, sunlight and nutrients.

Weeds can harbor diseases and insect pests.

And they blight the landscape.

But it is the farmer who best appreciates the full impact of weed pollution, because it hits his pocket book.

Recent experiments at the CDA Research Station, Harrow, Ont., indicate exactly how severe losses can be.

In newly-planted peach orchards, weed competition decreased tree growth by 93 per cent during the first year. And the weeds weakened trees so badly that half were wiped out by winter injury before the second year. By the third year, orchards kept free of weeds were producing 39 pounds of fruit per tree; weed-infested plots produced no fruit.

Losses were similar with other crops tested at Harrow and Woodslee.

The trials compared plots full of weeds with those that were hand-weeded and those treated with herbicides.

The use of commonly-recommended herbicides usually gave yields similar to those obtained by keeping crops weed-free by hand weeding.

However, most herbicides fail to control one or more important weeds.

Scientists are currently studying the use of herbicide mixtures and split application schemes to ensure complete weed control.

The research should lead to savings for growers.—W. J. SAIDAK, HARROW, ONT.

M. E. ANDAL

> To increase income in the future, farmers will operate larger and more mechanized farms. In 1975, $150,000 will buy no more land than $40,000 in 1964. Both lenders and borrowers will have to be better informed. English article in Fall 1970 *Canada Agriculture*.

LE CREDIT AGRICOLE DES ANNEES 70

Les changements que subira l'agriculture décidera en grande partie de l'évolution des besoins des fermes en crédit et en capital au cours des années 70.

Nous assisterons sans doute à la continuation, sinon à l'accélération, d'un grand nombre de changements qui se sont produits au cours des dix dernières années. Les changements, qui comportent des conséquences particulières pour le crédit et le capital en agriculture, ont trait à la commercialisation, à l'organisation de la production, et aux finances des fermes.

On étudie de plus en plus la nature et l'étendue des marchés futurs à tous les niveaux de planification de la production. Les perspectives de marché à long terme présagent une réduction considérable de la production céréalière en regard des dernières années, une hausse sensible de la production des viandes, surtout le bœuf, et une hausse de certaines récoltes telles la graine de colza, le soya, le tournesol et le maïs à grain. Il est possible de faciliter la coordination de la production en fonction des besoins du marché en améliorant la recherche sur les marchés et la vulgarisation des informations sur les perspectives agricoles. On peut aussi faciliter la coordination en intensifiant l'application des offices de commercialisation et des contingents de vente.

La production agricole se regroupe progressivement sur un nombre toujours moindre de fermes qui sont de plus en plus efficaces. Les fermes continuent à s'agrandir, à devenir de plus en plus automatisées, et requerront encore plus de capitaux. Le manque de travailleurs spécialisés, la compression du coût de revient, et le désir des cultivateurs d'accroître leurs revenus, continueront d'encourager l'application de la nouvelle technologie et l'usage d'équipement et d'outillage modernes afin d'accroître la superficie des fermes et leur efficacité. Le désir des cultivateurs d'avoir des heures de travail et des conditions comparables aux autres secteurs devrait conduire à un plus grand nombre de fermes gérées par deux ou trois exploitants groupés au sein d'une association, d'une société ou d'une ferme incorporée. La poussée ascendante sur le prix des terres agricoles qu'exerce la demande des citadins pour des terres agricoles, a d'importantes conséquences pour les besoins de capitaux agricoles. L'intérêt de plus en plus grand que l'on porte à la pollution de la terre, de l'air et de l'eau, influe également sur l'expansion économique des fermes.

L'augmentation constante des besoins en capitaux des fermes les plus grandes et les plus avancées en technologie pousse les cultivateurs à emprunter encore plus de capitaux. Il se peut qu'ils en viennent à économiser leur propre capital et leurs emprunts en recourant davantage à la location de terres, de bâti-

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ments, de machines et d'outillage, et en achetant des services qu'ils produisaient eux-mêmes par le passé. La pression qu'exerce l'inflation, l'insuffisance relative des fonds accessibles aux emprunteurs, et l'effet qui en découle sur les taux d'intérêt, pourraient aussi continuer d'influer sur le financement des fermes au cours des années 70.

Les cultivateurs devront être bien instruits et posséder des capacités gestionnaires naturelles ou acquises afin d'exploiter les techniques modernes de commercialisation, de production et de financement.

Voilà donc les principaux événements du monde agricole qui auront une influence sensible sur la situation du crédit et du capital sur les fermes au cours des années 70. Plus précisément, que signifient ces événements par rapport au crédit agricole, si le crédit doit continuer à faciliter les ajustements que les cultivateurs doivent faire?

Le facteur le plus important est sans doute le besoin accru de capital et de crédit par ferme. Le montant maximal des prêts en vertu de la Loi sur le crédit agricole est de $40,000 sur les prêts ordinaires et de $55,000 sur les prêts surveillés. Ces limites furent établies en 1964 mais déjà le prix de l'immeuble agricole a grimpé à tel point que $40,000 en 1969 auraient acheté l'équivalent de $26,000 en 1964. Le recensement de 1966 dénombrait plus de 10,000 fermes déclarant un revenu brut de $35,000 ou plus, et plus de 12,000 fermes affichant un placement de capital de $150,000 ou plus.

Les données du recensement agricole de 1966 ont déjà quatre ou cinq ans, et, lorsque nous établissons des prévisions pour les années 70, il nous faut tenir compte des changements rapides qui se sont produits et continueront de se produire. En nous fondant sur le changement qu'a subi la valeur des terres agricoles de 1965 à 1969, nous pouvons prévoir que vers la mi-70, $100,000 achèteront l'équivalent de $40,000 en 1964. En plus de la hausse qu'a subie la valeur des terres, il y a eu une hausse considérable de la grandeur des fermes et de la valeur monétaire constante de capital (sans l'inflation) par acre sur les fermes. Entre les deux dernières années du recensement, la grandeur moyenne des fermes s'est accrue, en moyenne, de 2.4 pour cent par année. Il y a également eu une hausse annuelle de $0.70 l'acre (valeur constante du dollar en 1949) dans le capital investi par acre. En tenant compte de la hausse des besoins en capitaux, en 1975, il faudra $150,000 pour faire le financement qu'aurait fait $40,000 en 1964. Ces chiffres ne tiennent pas encore compte des études faites au Canada et aux États-Unis qui démontrent qu'en moyenne les cultivateurs emprunteront à peu près 30 pour cent de leur besoin total en capitaux, en 1980, au regard d'environ 18 pour cent à l'heure actuelle.

Les prévisions et les extrapolations peuvent, bien sûr, s'avérer inexactes. Il est difficile, par exemple, de concevoir que le prix des terres agricoles puisse continuer à s'accroître au même rythme qu'au cours des années 60. Les marchés de certains produits ont diminué et la concurrence internationale est à la hausse. Mais même si les besoins en capitaux augmentaient à un rythme bien plus lent que par le passé, ils n'en seront pas moins bien supérieurs au cours des années 70.

Les changements agricoles prévus pour les années 70 conduiront à une complexité accrue des fermes et à plus grande diversité des exploitations. Ce nouveau facteur ajoutera aux difficultés du crédit car si, par le passé, il était passablement facile de déterminer les besoins en capitaux et en crédit d'une ferme gérée par un seul homme, il est bien plus difficile de le faire pour la structure d'organisation très compliquée des nombreuses fermes multifamiliales qui naissent maintenant. En outre, le crédit hypothécaire standard, qui a bien servi par le passé, pourrait fort bien se voir obligé d'offrir des options additionnelles pour répondre aux besoins futurs. Il s'ensuivrait que les dispositions du crédit agricole devront être flexibles pour que les prêteurs puissent répondre aux besoins légitimes des emprunteurs agricoles. Ces prêteurs devront être mieux informés que par le passé en matière de crédit agricole car ils seront appelés à offrir un meilleur service en vue de permettre de prendre des décisions plus difficiles.

Même si le nombre de fermes a diminué et continuera à diminuer, le nombre de fermes commerciales s'accroîtra. Au ministère de l'Agriculture du Canada, Purnell et ses collègues prévoient qu'en 1980 il y aura 189,000 fermes qui auront des ventes de produits agricoles de $10,000 ou plus en regard de 95,000 en 1966. Ce sont ces fermes qui ont le plus recours au crédit.

En même temps, de nombreux cultivateurs ne peuvent ou ne veulent pas agrandir leur exploitation de cette façon. Plusieurs des cultivateurs à faible revenu demandent du crédit pour apporter certaines améliorations à leur revenu et à leurs conditions de vie, et pourraient sans doute en faire bon usage. Même s'il est admis que le crédit constitue une partie relativement minime des programmes que requiert ce groupe de cultivateurs, il semble qu'un programme spécial, mais essentiellement non subventionné, de crédit rural, comblerait une lacune dans ce domaine.

Le progrès du niveau de vie, des communications et des connaissances accroit les aspirations des habitants ruraux qui désirent maintenant participer pleinement aux bénéfices d'une économie de production moderne. La nouvelle technologie de la production et de la commercialisation des produits de ferme permet de combler cette aspiration et influe sur le mode d'expansion de l'agriculture. Des facilités de crédit bien adaptées aideraient les agriculteurs à combler leurs aspirations et permettrait d'atteindre le potentiel de cette nouvelle technologie. Les années 70 offriront au crédit agricole de nombreuses occasions de contribuer à ce but. ■

LA POLITIQUE SCIENTIFIQUE ET LA

B. B. MIGICOVSKY

If science allows us to stage our own evolution and that of numerous biological systems, there is no doubt that it should be subject to the will of man. Should this control be absolute or relative? Of what nature will it be? Who will inform it? This is the very essence of the science policy. English article in Fall 1970 *Canada Agriculture.*

La science, qui pourrait bien nous permettre de régir notre évolution et celle de nombreux systèmes biologiques, a atteint aujourd'hui une telle puissance que la société envisage le contrôle de l'activité scientifique, contrôle qui sans aucun doute s'avère indispensable. Les questions brûlantes qui se posent à ce sujet sont: jusqu'où doit-on aller? quelle nature doit-il avoir? à qui le donner? Voilà l'essence même d'une politique de la science.

Une politique de la science doit trancher la répartition des efforts entre ce que l'on appelle la recherche fondamentale, la recherche appliquée ou orientée et le développement. La grande diversité d'opinions ne fait que l'envelopper d'un brouillard de confusion.

La simultanéité des événements porte souvent à prendre des coïncidences pour des causes et fonder des politiques sur des observations incomplètes. Ainsi la création de variétés de céréales à rendements élevés, l'énergie nucléaire et l'exploration de l'espace sont des résultats bien connus de la recherche orientée. On pourrait donc conclure qu'en contrôlant toute

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l'activité scientifique, on pourrait en tirer plus de profits en moins de temps et à moins de frais. Ceci revient à ne voir que la partie de l'iceberg qui émerge. La plus grande partie des recherches ayant permis ces réalisations exceptionnelles n'étaient ni dirigées, ni contrôlées.

Quand on remonte aux sources de découvertes comme celles du blé résistant à la rouille, de la télévision, des greffes cardiaques, du nylon, des antibiotiques ou de la pilule, on constate qu'une faible partie des études, souvent très chères, ont été réalisées sous contrôle. La plus grande partie des renseignements nécessaires ont été le fruit du talent et de la recherche libre d'individus ou de petits groupes. Je ne sache pas d'idée ou de concepts originaux qui soient nés d'un comité, d'un conseil d'administration ou du bureau d'un directeur général.

Je suis convaincu que le Canada doit adopter une politique scientifique qui puisse, d'une part canaliser et diriger les efforts vers le développement pratique d'idées originales, et de l'autre, encourager et rendre possible le jaillissement d'idées et de concepts originaux. Il faut donc une politique souple; la recherche ne pouvant se partager arbitrairement en catégories fondamentale, appliquée et de développement.

Toute tentative de définir les termes «fondamentale» ou «appliquée» en recherche nous égare dans les ergotages sémantiques. A mon avis, la recherche est un spectre d'activités qui au début ne permet pas de prédire ni quand, ni comment les renseignements que l'on possède seront utilisés. D'autre part à la fin, on a une idée très nette de ce que l'on veut et que l'on peut faire des connaissances acquises. Entre ces deux stades, on ne peut se borner qu'à des prédictions. Ensuite on peut parler de contrôle et de direction organisée. Ainsi, les travaux de recherche en biologie cellulaire ont été la source d'expériences sur la culture et la fusion des cellules et nous pouvons maintenant envisager la création d'espèces synthétiques. La recherche fondamentale devient appliquée lorsqu'on peut, de façon courante, créer une nouvelle espèce de plantes au moyen d'une technique établie. L'exploitation plus poussée de cette technique conduit à la recherche de développement.

Bien entendu, la phase la plus rémunératrice, la plus facile à accepter, est celle du développement, située au bout du spectre, mais j'espère sincèrement que nous n'adopterons pas une politique scientifique qui négligerait les expériences du début, sous prétexte que les avantages sont encore imprévisibles.

RAPPORT ENTRE LE COÛT ET LES BÉNÉFICES

Un autre point de la politique scientifique qui me préoccupe, ce sont les considérations de rentabilité décidant des sortes de recherches à soutenir. Ce concept risque de limiter la recherche à des domaines à court terme et d'étouffer l'activité imaginative source de développements prometteurs. Semblable attitude dans le passé aurait entraîné l'abandon de bien des projets qui furent à la base de découvertes importantes.

Présentement, le Canada est en plein débat à ce sujet et il est réconfortant de voir que c'est le Gouvernement qui en a pris l'initiative. Je suis particulièrement intéressé à savoir quel sera le rôle des chercheurs dans l'élaboration de cette politique. Je crains que la multiplicité des cercles scientifiques et de leurs intérêts particuliers ne fasse prendre des décisions auxquelles n'auront pas réellement participé les chercheurs.

Alors que les progrès de la science et de la technique se font à une rapidité alarmante, il est évident qu'une politique de *laissez faire* n'est plus de mise. Il est essentiel de s'organiser pour orienter et soutenir la science dans les directions voulues, tout en créant, en même temps, un climat favorable à la recherche imaginative.

SOCIETE

Toute politique doit éviter de trop diriger, contrôler, voire étouffer la vitalité indispensable à la science. En même temps, elle doit permettre de décider des domaines d'application ou de développement à encourager et de l'importance des fonds à leur consacrer. Il s'agit là de décisions importantes et délicates. Il est très stimulant de voir le Gouvernement utiliser conseils et comités pour obtenir continuellement les meilleurs avis et opinions scientifiques disponibles des universités, de l'industrie et du gouvernement. En dépit de ces bonnes intentions, toutefois, de nombreuses pressions risquent d'avoir une influence néfaste sur la politique scientifique.

Outre le contrôle par le gouvernement ou des institutions paragouvernementales, il y a une autre forme de contrôle indirect exercé par un secteur réduit, mais très loquace: l'opinion publique et les moyens de diffusion. Il peut être à la fois utile et désirable en même temps que dangereux et nuisible. S'il peut engendrer et susciter des activités utiles, il peut aussi les orienter de façon disproportionnée dans des directions particulières.

ATTENTION AUX DEMI-VÉRITÉS

Même si j'apprécie l'attention accrue accordée par les moyens de communication à la science, je refuse les demi-vérités et les fausses déductions, surtout lorsque l'on dispose de toute la vérité et qu'elle suffit pour appuyer l'appel légitime que l'on présente au public.

J'éprouve une crainte instinctive de l'opinion populaire, celles des «honnêtes gens», fondée sur l'ignorance ou une connaissance incomplète. Je me méfie de tous ceux qui, s'érigeant en grands-prêtres utilisent sciemment et de façon convaincante des demi-vérités pour en arriver même à des fins désirables. Je crains enfin cette émotivité irraisonnée qui, tournant à l'hystérie, risque de précipiter des décisions prématurées.

Je ne mets pas en doute l'efficacité ni l'honnêteté des campagnes publicitaires. Je les supporte même chaleureusement. Certes il faut combattre la maladie, la pollution, le racisme. Bien sûr, toute l'humanité devrait disposer d'une nourriture abondante et saine, et il est essentiel de préserver notre milieu. D'accord, mais ce qui est dangereux et préjudiciable, c'est le recours aux demi-vérités et aux conclusions fausses pour arriver à ces objectifs désirables.

Les souvenirs des demi-vérités et fausses déductions qui circulaient durant les années 30 et 40, particulièrement dans le domaine de la génétique, sont encore trop frais à la mémoire pour qu'on ne fasse pas appel à la prudence.

A la suite de la publicité dont ils ont fait l'objet récemment, les pesticides sont pratiquement devenus tabou. Dans l'esprit de plusieurs, ils sont responsables de la destruction de l'écosystème ou du milieu. On n'oublie cependant de rappeler au public que les virus, les bactéries, les champignons, les insectes, la vermine et les mauvaises herbes font tout autant partie de l'écosystème ou du milieu que les pigeons, les bisons, les faucons, les poissons, la flore indigène et l'homme. Ce même écosystème n'est pas statique mais en évolution constante. Souvent, pour assurer la survie d'une espèce particulière, qu'il s'agisse d'un arbre, d'un insecte, d'un oiseau, d'un poisson ou de l'homme, nous sommes obligés d'entraver et même de menacer l'existence et jusqu'à la survie d'une autre espèce, virus, champignon, insecte, oiseau ou mauvaise herbe. Toute atteinte au système en quelque point que ce soit, a des répercussions sur d'autres. Les pesticides font partie des nombreux produits chimiques destinés à agir sur l'écosystème à l'avantage de l'homme, mais parfois leur intervention n'est pas parfaite.

Certes les chercheurs ont fait des erreurs qui ne sont apparues qu'en rétrospective. Quand on se base sur les connaissances présentes, on doit reconnaître que les produits et les méthodes du passé n'ont pas toujours été bien étudiés ni évalués. Néanmoins, il serait ridicule de juger la science seulement sur ses erreurs en négligeant l'écrasant dossier de ses réussites.

Il faut certainement que nous combattions la pollution sur tous les fronts, mais pas au détriment de la lutte contre la famine et la maladie. Comme population et pollution vont de pair, tous nos efforts seront vains si nous ne réussissons pas à endiguer la marée sans cesse croissante de la population.

Jamais nous n'avons eu autant besoin d'un effort interdisciplinaire concerté. Celui-ci éclipsera tous ceux que l'on met en œuvre dans les autres domaines, par exemple les voyages dans l'espace. Il s'agit d'éviter la catastrophe de la surpopulation et ses conséquences inévitables: la pollution, la détérioration du milieu et la famine généralisée.

La nature possède ses propres moyens pour restreindre l'expansion des espèces et en assurer la survie, notamment par la famine ou, dans le cas des lemmings, l'auto-destruction. Espérons que l'humanité saura recourir à d'autres techniques que celles-là.

Nous ne possédons pas encore la solution de ce problème, et à moins d'orienter tous les efforts possibles vers la recherche, nous ne la posséderons pas encore demain.

On se demande souvent «jusqu'où faut-il pousser la recherche»? La seule réponse logique est: «Tant qu'on n'aura pas utilisé tous les chercheurs qualifiés disponibles dans toutes les disciplines susceptibles de contribuer à la solution des problèmes de l'accroissement démographique, de la famine, des maladies, de la pauvreté, de la guerre et de la qualité du milieu».

Si nous faisions la guerre, voilà comment nous nous y prendrions. Il est grand temps que nous fassions de même pour combattre ce qui menace notre survie. ■

THE ECOLOGY OF WESTERN ENCEPHALITIS

J. McLINTOCK

Le présent article décrit les problèmes découlant de la modification par l'homme de l'écologie d'une région et son action sur l'encéphalomyélite du type ouest.

Western enchepalitis (WE), often called sleeping sickness, is a virus infection of the brain and spinal cord in both man and horses. The disease is transmitted by mosquitoes who become infected by feeding on wild birds and domestic fowl that have the virus in their blood (see *Canada Agriculture,* Winter 1969, p. 24-25). The disease can occur at any time in midsummer throughout the prairie provinces in the Great Central Plains of North America.

Since 1941, when 1094 human cases of WE with 103 deaths were reported in the prairie provinces, hardly a year has gone by without some human or horse cases being reported in Saskatchewan. In some years human cases have gone as high as 100, and even higher in horses.

In 1958, when it was learned that construction was to start on the South Saskatchewan River Development Project, those of us familiar with the disease became concerned. Here was an engineering development, unprecedented on the prairies, that could alter the ecological balance of a large area. Mosquitoes and WE components were in the ecological balance. It was decided to determine what the ecological situation was in relation to mosquitoes and WE before the River Development Project was completed so that if a change did occur following completion, we would at least be able to recognize the change, understand it and perhaps be able to deal with it.

Dr. McLintock is a medical entomologist at the CDA Research Station, Saskatoon and responsible for studies on the ecology of the western encephalitis virus in Saskatchewan.

Consequently in 1962, the Research Branch of the CDA, the Biology and Veterinary Science Departments (now the Western College of Veterinary Medicine) of the University of Saskatchewan and the Saskatchewan Department of Public Health, with Federal and Provincial support were able to begin a multidisciplinary study of the ecology of the virus and epidemiology of the disease in Saskatchewan. Later, the U.S. Public Health Service also became interested in our work and provided additional support, for WE is a continental problem.

One of our first objectives was to determine the host range of the virus. Since 1962 we have collected and examined thousands of blood specimens from wild and domestic vertebrates to determine if their blood contained the virus or antibodies to the virus. Antibodies are the protective substances that the animal body produces in response to invasion by a foreign substance or organism. Each foreign organism stimulates production in the blood of a specific antibody for that organism. The WE virus stimulates the production of WE antibodies and the presence of these antibodies in the blood indicates that the animal had been infected with the virus at some unknown time in the past. We have also collected and examined thousands of mosquitoes for the virus. These studies revealed an astonishing host range that includes, apart from man and horses, nine species of mosquitoes, 16 or more species of birds, muskrat, skunk, ground squirrels, mice, pigs, cattle, buffalo, garter snakes and frogs.

The next objective was to determine which of these hosts were important in the spread and multiplication of the virus. In nature, the usual route of infection is subcutaneous (under the skin) when a mosquito bites. Apart from man and horses, the virus on subcutaneous inoculation produces clinical symptoms in very few of its hosts and only in the very young, e.g. some very young nestling birds, in 'wet' chicks and in suckling mice. For these animals the infection is usually fatal. In all other hosts, subcutaneous inoculation of the virus produces viremia (virus circulating in the blood) of varying intensity followed by parallel titres (concentrations) of antibodies. In general, the larger the animal species the lower the concentrations of virus and antibodies it is capable of developing in its blood following subcutaneous inoculation. Man and horses are 'dead-end' hosts because the virus titres they develop are of very short duration and too low to infect a mosquito.

To be an effective reservoir of the virus, the vertebrate host must not only have a sufficiently high titre of viremia, but the viremia must occur at a time when mosquitoes are active. It is only then that the mosquito can acquire an infective dose of the virus in the blood that it takes up when it bites. The activity of the casual organism in the blood of its host must coincide with the activity of the adult mosquitoes.

This, of course, also assumes that the vertebrate and the mosquitoes are together in the same environment.

In Saskatchewan, adult mosquitoes are usually active from about the middle of May until the end of September. During this period we have isolated the WE virus from the blood of birds, frogs, ground squirrels and garter snakes. All of these hosts, on initial infection, usually develop titres of viremia sufficient to infect mosquitoes. But among these hosts the highest infection rates were in birds. In the other hosts the infection rates were so low that they indicated the infections were casual or accidental. Furthermore, the majority of our isolations from birds were made from nestlings. In adult birds the viremia persists for only two days whereas in nestlings the viremia persists for more than five days and the titre of viremia is much higher than in the adults. These observations, plus the fact that nestling birds make more available targets for mosquitoes, indicate that nestling birds are the primary reservoir hosts for multiplication of the virus during the summer.

The thousands of mosquitoes we have examined for virus have included 25 different species, but we have found the WE virus in only nine of these. The nine are also the most abundant species in the agricultural area of the Province. But merely finding a mosquito carrying a disease organism is not sufficient evidence to incriminate the mosquito in the transmission of the organism. After a mosquito has acquired the virus of WE in an infected blood meal, the virus must migrate and multiply within the mosquito before the virus can be transmitted when the mosquito bites again, hence all mosquito species are not equally efficient transmitters. However, if a mosquito species that has been found infected in nature can be shown to be an efficient transmitter of the virus under experimental conditions, it can be assumed to be capable of transmitting in nature. Following such a demonstration we must depend on ecological and epidemiological observations to determine the actual role played by the mosquito in the spread of the virus and the production of epidemics.

Fig. 1. Culex tarsalis, *the principal epidemic transmitter of the western encephalitis virus in Saskatchewan.*

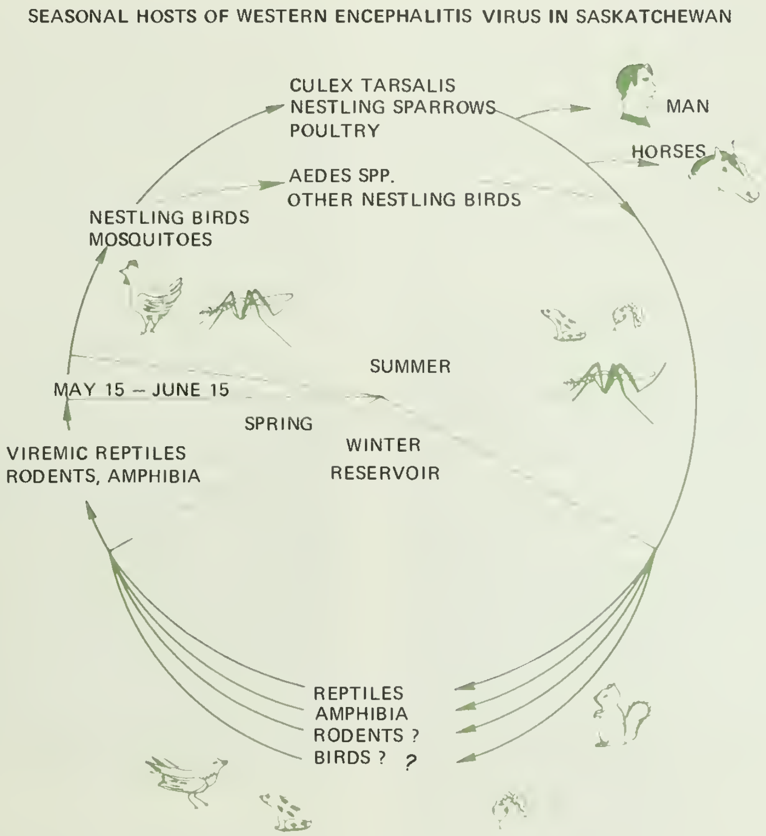

Fig. 2. Seasonal hosts of western encephalitis virus in Saskatchewan.

In the seven years following 1962, horse and human epidemics of WE occurred in Saskatchewan in 1963 and 1965. From the association of WE virus infection rates in the nine mosquito species found infected and in nestling birds, during epidemic and non-epidemic years, we have been able to show that during epidemic years the bird-mosquito-bird infection cycle involves mainly House Sparrows and domestic poultry and the mosquito, *Culex tarsalis* (Fig. 1). This mosquito has been shown to be an efficient transmitter of the WE virus in the laboratory. In non-epidemic years the bird-mosquito-bird infection cycle can still operate, but the birds involved in the cycle are mainly species with not as close an association with man, such as Shrike, Magpie and gulls and the mosquitoes involved are mainly the other 8 species. Man and horses become infected in epidemic proportions from the first cycle involving *C. tarsalis.* Man and horses only occasionally become infected from the second cycle (Fig. 2).

The preceding is a brief outline of the ecological events that take place in relation to WE during the summer months. How the virus manages to survive from one year to the next in temperate climates is the major unsolved problem in the ecology of the WE virus. In Saskatchwan we have obtained evidence to support the theory that the virus survives over winter as a hidden, or latent, infection in some of its vertebrate hosts such as garter snakes, frogs, rodents and birds. The latent infection could become active with viremia following physiological stress. Stress would accompany arousal from the hibernating state in garter snakes, frogs and ground squirrels, egg-laying in birds, or the birth of the young in ground squirrels and other rodents. This and other problems still require further investigation.

It is clear that the virus of WE has been present in western Canada for many years as an inapparent infection in wildlife. Man's intrusion into the prairie environment with his horses and poultry, accompanied by House Sparrows, widened the range of hosts available to an indigenous mosquito population in years when that mosquito population became superabundant. Any alteration in the environment that tends to increase the abundance of *C. tarsalis,* such as the introduction of irrigation, will also increase the probability of a WE epidemic. ■

WOLFGANG BAIER

> A tous les niveaux de l'agriculture, du fermier progressif au planificateur national, on se rend compte du rôle déterminant de la météorologie à la planification. L'agrométéorologie peut améliorer la planification nationale, régionale ou individuelle.

"If we can seize this opportunity and become active rather than passive, the field of applied meteorology in Canada will know no limitations and rewards, both nationally and internationally, will exceed our wildest dreams, but it will only happen if we get off our back-sides and get to work."

This recent message by Dr. P. D. McTaggart-Cowan, Executive Director of the Science Council of Canada, stimulated the writer to demonstrate how Canadian expertise in the field of agricultural meteorology can be employed for making the most efficient use of climate in agricultural production and resource development.

Agricultural planning, whether it is on an international, national or local farming level, includes the probable influence of climate and weather on long-term as well as year-to-year production of agricultural crops.

Climate has always been a limiting factor to crop production in most of Canada's agricultural areas. Farmers indeed did very well to overcome problems caused by drought, flooding, frost and wind by using common sense, intuition and experience. However, this approach is no longer adequate to ensure the most efficient use of climate as a natural resource in planning a modern agricultural industry.

Field experiments provided useful information on the response of crops to various treatments under the local soils and climates. Canadian researchers have taken an active part in developing relationships between crop yields and climatological data from either standard weather observations or special techniques generating such climatic data.

By using this knowledge and the vast amount of climatic data available in the National Archives of the Canadian Meteorological Service, we are indeed fortunate to have available the necessary tools to classify existing and prospective agricultural areas, to estimate the potential production of established and newly introduced crops, and to assess future economic benefits of farming systems specially tailored to comply with national requirements and international market trends.

The following examples for the efficient use of standard climatic data in crop-weather simulator models and their applications are taken from the work by staff members of the Agrometeorology Section, Plant Research Institute.

Basic Techniques—Three techniques, each using standard climatic data as input, form the backbone of our agroclimatic research and applications:

1. A multi-variable equation for estimating daily potential evapotranspiration (PE) from daily maximum and minimum temperatures and tabulated total solar energy data.
2. A computerized physical model, Versatile Soil Moisture Budget (VB), for estimating daily soil moisture in six or less divisions in the soil profile from daily precipitation and PE.
3. A mathematical model relating rate of crop development towards maturity to photoperiod and to day and night temperatures thereby providing a Biometeorological Time Scale (BMTS) which synthesizes daily crop development data that are otherwise not available.

Climatic Estimates of Water Deficiencies—Data on average and probable crop water requirements are essential for determining future agricultural water needs for planning and designing irrigation systems and for evaluating the climatic potential for agricultural resource development. Long-term measurements of consumptive water use by crops suitable

METEOROLOGY IN AGRICULTURAL

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for a probability analysis are lacking. It is, however, relatively simple to compute daily water deficiencies from standard precipitation records and potential evapotranspiration estimates. These amounts of water (called "irrigation requirements") have been calculated from 30-year climatic data at 59 stations across Canada for soils with different capacities to hold readily available water (called "storage capacity") and for various values of consumptive water use by crops (called "CU" or consumptive use factors). The requirements are given for selected "risks" which are the complements to probabilities. The term risk was employed to stress the possibly harmful effect of inadequate irrigation water on agricultural production. A 10% risk means that in 10% of the time or in one out of 10 years the requirement exceeds the value given in the table. Similarly, irrigation requirements for 50% risk (or on the average) are inadequate in five out of 10 years. This information has been published in a series of technical bulletins available from the author and is now being prepared for inclusion in the Canada Land Inventory (ARDA) data bank and for publication in a series of maps (1: 5 mill.).

Figure 1 illustrates average (50% risk) weekly irrigation water requirements for 1-, 2-, 3-, 4-, and 5-inch storage capacities and a CU-factor of 1.00 at Lethbridge (Alberta). Probable seasonal requirements for a 4-inch storage capacity and a CU-factor of 1.00 at six stations are compared in Figure 2. These data provide answers to questions concerning the need for irrigation in different areas, the amount of water needed in extreme years and the time when these requirements occur.

For irrigation water supply and system design purposes, the percentage difference in irrigation requirements at 50% and 10% risks serves as a relative measure of the necessary irrigation expansion to meet the seasonal requirements which occur beyond the averages at least once in the remaining four out of 10 years when planning is based on 10% rather than 50% risk (Table 1). For example, the relative increase in cost for additional equipment and water storage would probably be higher in an area such as Agassiz (46%) with low average but infrequently high water requirements than in drier climatic areas, such as Brandon (33%), Lethbridge (23%) or Outlook (20%), where the average as well as the extreme water requirements are higher.

Soil Moisture and Dryland Crop Production—The basic agroclimatic techniques have been used to generate from 30-year standard climatic records the average and probable spring soil moisture and seasonal water comsumption of a crop such as wheat. Figure 3 shows average (50% probability) spring soil moisture contents in fallow (4.23 inches) and stubble (3.51 inches) wheat fields in a 2-year rotation and in continous wheat fields (2.62 inches) at Swift Current. A spring soil moisture content of four inches or less can be expected 40% of the time in fallow, 70% in stubble and 90% in continuous wheat.

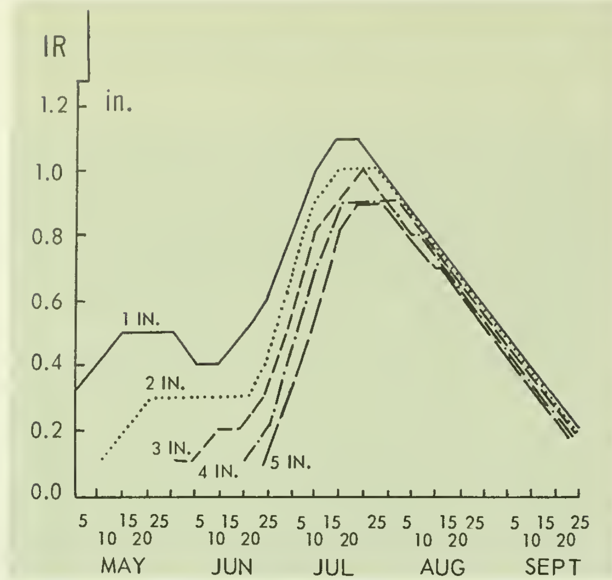
Consequently, more than four inches occur 60% of the time, or in six years out of 10 in fallow, 30% or three years in stubble and 10% or one year in continuous wheat.

Combining the estimated variations of spring soil moisture and seasonal rainfall with results from field experiments on soil water usage at Swift Current and from economic surveys of production costs, it is now possible to generate probable net returns for a variety of crops and management systems. For example, average net returns per cultivated acre with a wheat price of $1.65 per bushel were $9.53 from fallow-

TABLE 1. SEASONAL IRRIGATION REQUIREMENTS (INCHES)

Location	Storage Capacity Of: 1.00 inches				4.00 inches			
	Risk 50%	Risk 10%	Difference Inches	Difference %	Risk 50%	Risk 10%	Difference Inches	Difference %
Agassiz, B.C.	5.6	8.2	2.6	46	0.7	4.5	3.8	543
Kentville, N.B.	6.8	9.4	2.6	38	2.4	4.7	2.3	96
Brandon, Man.	12.0	16.0	4.0	33	6.6	11.2	4.6	70
Lethbridge, Alta.	14.9	18.3	3.4	23	10.1	14.5	4.4	44
Outlook, Sask.	17.1	20.6	3.5	20	12.8	17.2	4.4	34

PLANNING



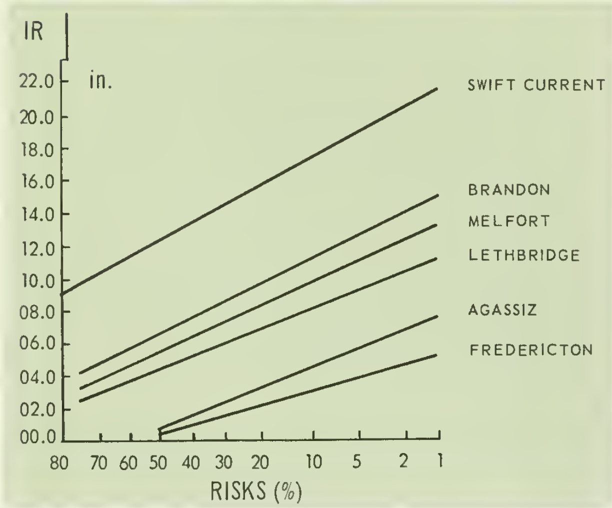
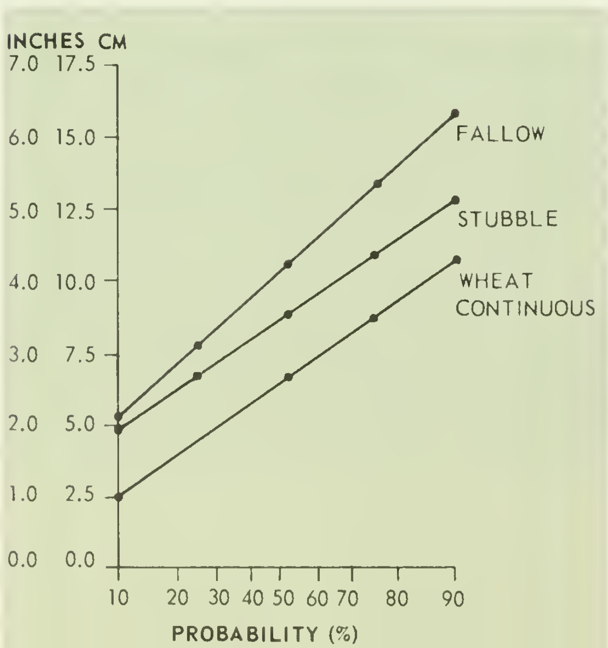


Fig. 1. Weekly irrigation requirements (IR) for 1-, 2-, 3-, 4-, and 5-inch storage capacities estimated for a 50% risk at Lethbridge.

Fig. 2. Risks of seasonal irrigation requirements (IR) for 4-inch storage capacity and CU-factor 1.00 at six stations.

Fig. 3. Probable spring soil moisture estimates in fallow and stubble wheat in 2-year rotation and in continuous wheat being less than indicated amounts at Swift Current: 1931-60.



wheat with half the area under fallow as compared with $13.23 from continuous wheat grown over the total area. Although the average net return is higher from continuous than from fallow wheat farming, in three out of 10 years net returns from continuous wheat were less than those of fallow wheat for any wheat price. These figures substantiate the higher risk involved in stubble wheat farming.

Within the range of available water from six to 14 inches, each additional inch of water in terms of net returns from fallow wheat was worth $2.53 for a farm wheat price of $1.65 per bushel, ranging from $2.07 to $2.99 for farm wheat prices from $1.35 to $1.95. For continuous wheat grown over the whole cultivated area, each inch of additional water in terms of net returns per cultivated acre yielded on the average $5.05 varying between $4.13 and $5.97 depending on wheat prices.

These benefits are based on water use only and do not account for yield reductions caused by an increase in diseases, pests and weed infestations usually encountered in continuous wheat farming. But probable economic benefits or losses, which will result from any change in crop rotation programs, can be estimated in advance by projecting climatic data in the future and by using agrometeorological techniques as demonstrated.

Land-use and Plant Zonation—Techniques have been developed and applied to the production of maps for the regional interpretation of climate in relation to land-use, soil classification, crop production and plant zonation. These include:

1. A climatic moisture index $\frac{P}{P + IR + SC}$ X 100 which relates reasonal precipitation (P) to the amount of water available to crops from seasonal irrigation (IR), precipitation (P), and water available in the soil at the beginning of the season (SC) employed in a Soil Climatic Map proposed by the Soil Research Institute.
2. Equations for estimating annual prairie wheat production by crop districts from monthly precipitation and estimated potential evapotranspiration.
3. A method for generating normal air temperatures on the prairies for crop stages as determined by the BMTS used for the classification of areas in terms of their climatological suitability for the growing of wheat or alternative crops.
4. A model for evaluating site suitability for the winter survival of ornamental trees and shrubs from climatic normals from which a Canadian plant hardiness map has been prepared.

The foregoing examples, selected from the work of the Agrometeorology Section, Plant Research Institute, together with the numerous contributions by other federal, provincial and university departments, demonstrate that Canadian researchers have developed an expertise in this area of applied climatology resulting in an increasing input to national and international food production planning. ■

ALTAI WILD RYEGRASS

AN ALTERNATIVE TO HAY

Fig. 1. Cattle foraging Altaï wild ryegrass out of the snow in a winter pasture.

T. LAWRENCE

Le présent article considère la valeur de l'élyme d'Altaï en Sibérie, séché sur pied en remplacement du foin. Le principal problème actuel est la difficulté de se procurer des semences, difficulté qui devrait être résolue par le programme de recherches en cours.

Animals kept for breeding make up 60 to 70 per cent of the total cattle population in western Canada. Wintering these animals is one of the main costs in maintaining a year-round herd. Consequently, one of the aims of the forage research program at the Swift Current Research Station is to provide agronomically desirable grasses with sufficient yield and quality so that the pasture season can be continued into the late fall and winter period to minimize the need for the harvesting, preservation, and feeding of hay. This search for productive pasture grasses adapted to the arid climate of the prairie is an important part of this research program. In addition to being winter-hardy and drought tolerant these grasses must remain highly nutritive over a long grazing period. This property known as 'curing' is especially important in forages used for fall and winter grazing.

At about 1886 to 1888 bromegrass was introduced from Germany. Seed samples were distributed throughout Canada, and it gradually found a place in western agriculture.

Crested wheatgrass brought in by the University of Saskatchewan in 1915, and tested at various locations, had gained a strong foothold in western agriculture by the 1930s. However, both of these grasses tend to produce a flush of growth in May and June and then deteriorate rapidly in nutritive value. In other words, they do not cure well and for this reason are not adequate for fall and winter pasture.

In the 1950s, due largely to efforts of the Swift Current Research Station, Russian wild ryegrass was introduced into western agriculture. It cures well and provides good pasture for spring, summer, and late fall grazing, and has now become the main pasture grass in this region. However, because of its lax basal leaves, Russian wild ryegrass plants are readily buried by snow and when used as winter pasture is not easily accessible to cattle.

Altai wild ryegrass, *Elymus angustus* Trin., a relatively recent introduction from Siberia, displays very useful characteristics as a potential winter and summer pasture crop for western Canada. Presently, seed yields of this grass are so low that it is uneconomical for the seed producer to grow it and until higher seed yields are obtained it will not be grown extensively. This problem of seed yield is under intensive study at the Swift Current Research Station.

Altai wild ryegrass is a winter-hardy, drought-tolerant, long-lived perennial grass. The coarse basal leaves vary from light green through blue-green to blue in color. These coarse leaves stand erect in contrast to the leaves of Russian wild ryegrass which tend to be only semierect (Fig. 2). The seed heads,

Dr. Lawrence specializes in grass breeding at the CDA Research Station, Swift Current, Sask.

Fig. 2. The author examining a seed increase plot of Altai wild ryegrass seeded in rows three feet apart (left) and a space planted nursery, 3 × 3 feet, of Sawki Russian wild Ryegrass (right).

six to eight inches in length, are borne on nearly naked culms two to four feet long. The seed of Altai wild ryegrass is about three times as large as that of Russian wild ryegrass (Fig. 5). The seedlings are very vigorous (Fig. 6) and can tolerate deep seeding in a range of soil types. The roots are fibrous and are only weakly rhizomatic (Fig. 4).

Two seed samples, one from Moscow and the other from Woronesch, U.S.S.R., were received at Swift Current in 1950. Seed increase plots were established and small lots of seed were gradually built up for evaluation of this species. By 1953 sufficient seed was on hand and the species looked sufficiently promising to establish two tests in which Altai wild ryegrass was compared with Russian wild ryegrass, crested wheatgrass, and intermediate wheatgrass. These preliminary studies showed Altai to equal Russian wild ryegrass in yield, to excell the other species in crude protein content throughout the growing season, and to contain similar amounts of fiber and fat as the other species.

In a preliminary digestibility trial the aftermath forage from seed increase plots was compared to a standard oat-alfalfa (50:50) hay when fed to lambs. The results showed that Altai wild ryegrass compared favorably with this standard feed for dry matter digestibility, dry matter intake, digestible energy, and animal gains.

Another study compared Altai wild ryegrass with eleven other *Elymus* species, two *Stipa* species, and crested wheatgrass. Altai wild ryegrass was similar to Russian wild ryegrass in yield, protein content, drought tolerance, and winterhardiness. It was somewhat higher than Russian wild ryegrass in cellulose content and cellulose digestibility, and gave a better

Fig. 3. Cattle grazing on Altai wild ryegrass in the fall.

quality hay than most other species at both the flower stage and the mature or cured stage in both years of the study. It was concluded that of the twelve *Elymus* species, Altai wild ryegrass showed the best possibilities of becoming a useful forage crop on dry land for late fall and winter grazing. This experiment also pointed out the need for further studies on this species to determine its acceptance by animals other than sheep, and to obtain comparative weight-gain data with other grasses.

Preliminary and as yet unpublished data from fall (Fig. 3) and winter grazing showed that cows made good gains when grazed on Altai wild ryegrass during September and October, and maintained their weight when kept on this grass during November, December, and January. These same studies indicate that the erect leaves of Altai wild ryegrass are not flattened by snow in the winter. They project above the snow when the snowfall is light. When the snow gets deep it bridges over the top of the leaves so that they are still readily accessible to the cattle (Fig. 1).

A number of grazing trials are required to assess the total potential of Altai wild ryegrass for pasture, not only in the fall and winter but throughout the whole year. Present knowledge suggests that when seed yield problems have been overcome this grass will make a significant contribution to western agriculture by allowing livestock producers to extend the grazing season.

Unfortunately, seed yields are so low that Altai wild ryegrass cannot be released for commercial production until this deterrent has been overcome. Present seed supplies are limited and restricted to research requirements. ■

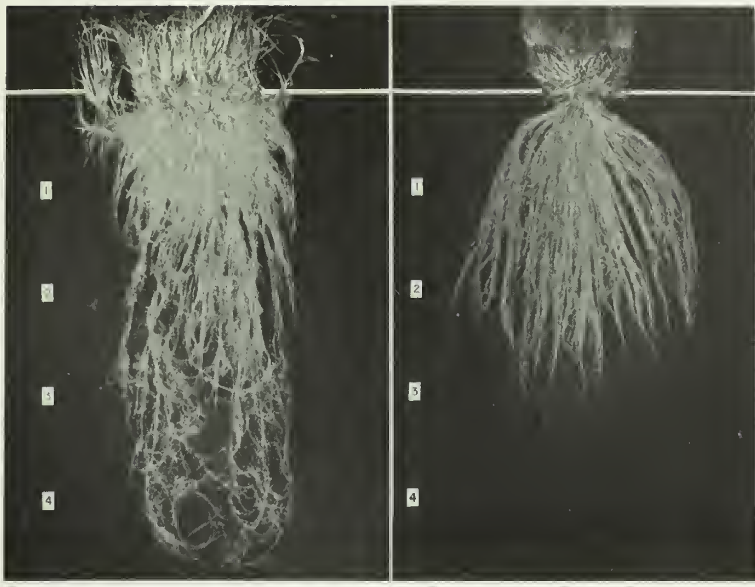


Fig. 4. Root systems of two-year-old plants of Altai wild ryegrass (left) and Russian wild ryegrass (right).

Fig. 5. Seed of Russian wild ryegrass (left) and Altai wild ryegrass (right). Rule is in cm.

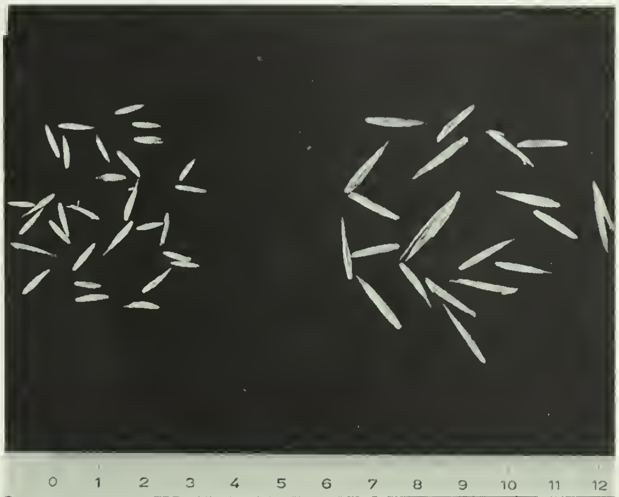


Fig. 6. Four-week-old seedlings of Altai wild ryegrass (left) and Russian wild ryegrass (right) seeded at a 3-inch depth.

THE BLACK VINE WEEVIL ON HIGHBUSH BLUEBERRY

W. T. CRAM

Le charançon noir de la vigne est le principal fléau des bleuets en corymbe de Colombie-Britannique. Des recherches tentent de découvrir les facteurs variés qui conditionnent ses capacités de reproduction.

The black vine weevil is the largest of several species of root weevils that destroy a wide range of perennial economic crops (Fig. 1). The legless larvae or grubs live in the soil and eat the roots of strawberry, blueberry, cranberry, grape, yew, azalea, rhododendron, and primula, to mention only a few of the many hosts. The black vine weevil is considered to be a European import and is found across Canada. It is the main pest of the highbush blueberry grown in well-drained peat bogs in the Vancouver area. Young bushes are easily killed by a very few grubs that girdle the stems just below the soil surface. Older plants can withstand much larger populations of grubs because their more extensive root system provides enough food for the grubs to mature without girdling main stems. Nevertheless, even large bushes may be killed outright.

In peat bogs mature grubs pupate in the soil in mid-May, transform to adult weevils by mid-June, then work their way to the soil surface.. All adults are females and they cannot fly. They feed mostly at night on the leaves of blueberry and weed plants. Adults feed for about one month before they are ready to lay eggs. Egg laying begins about early July and continues until mid-September. Most of the adults then die but those that overwinter begin to lay again in early May. When the eggs hatch, the tiny grubs move into the soil and feed first on rootlets. They remain in the soil over winter and feed voraciously in the spring before pupating.

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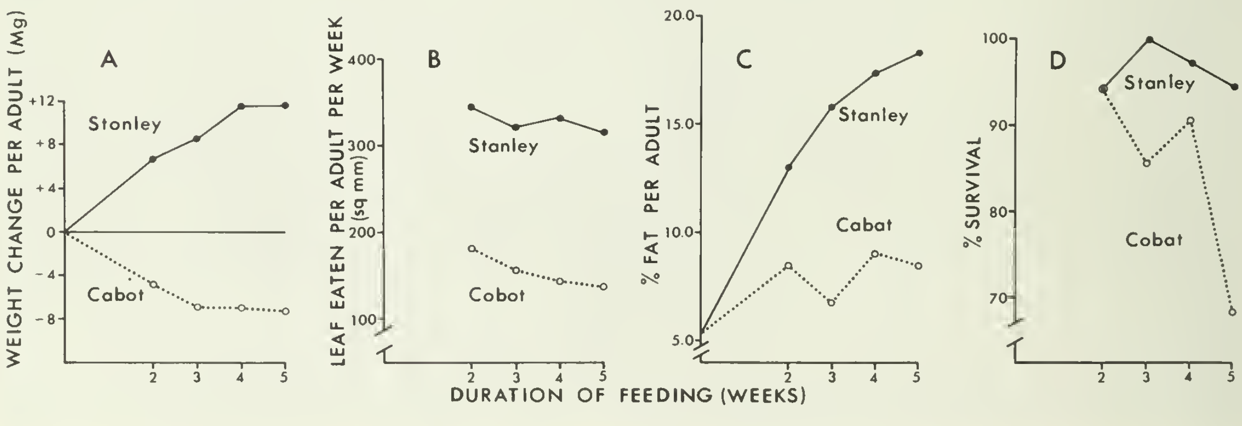
Besides searching for chemicals to control this pest, we have been interested in discovering the various factors that influence its reproductive capacity. With no mating needed, a new infestation can begin from a single egg, grub, pupa or adult.

First we wondered how the various food sources affected egg laying. By keeping freshly transformed adults in separate vials in the laboratory and feeding them exclusively on leaves of particular weeds, we found that salal and blackberry, for instance, were more nutritious than blueberry. This led us to wonder if the many varieties or cultivars of highbush blueberry also had different nutritional values. We found that the cultivar Weymouth actually caused the adults to lose weight and die before any eggs could be laid. Later, we found that one of the parents of Weymouth, named Cabot, had the same effect. Adults fed normally at first on these unacceptable cultivars but within about two seeks reduced their feeding to mere nibbling, which resulted in fine serrations of the leaf edge instead of deep notches (Fig. 2). On all the other cultivars the adults survived and laid eggs normally.

Next we speculated on whether the cultivars Weymouth and Cabot were immune to attack by the grubs. A greenhouse experiment with artificially infested potted plants soon answered this question: Weymouth plants were killed as readily as others. Field observations verified this finding. Inconsistency such as this between adults and grubs is not unusual in insects. In other insects' species the free-moving



adult often has a more restricted host range than the less mobile larva. Generally adults are endowed with complex sensory systems for detecting food, mates and egglaying sites, whereas larvae discriminate mainly between foods. A subterranean larva would be at a greater disadvantage than an adult if it could not accept most cultivars. Another example of inconsistency in this species is in its reaction to the weed, sour grass or sheep sorrel. Adults die when fed exclusively on the leaves, whereas grubs mature normally when fed on the roots.

Many blueberry plantings are drained by open ditches which may limit the movement of the adults. However, they usually manage to invade a planting and since there are no known effective parasites and the value of predators is limited, they must be controlled by chemicals. The larger grubs are often eaten by the common coast mole but the control is too little and far too late, the damage to the roots had already been done. Moreover, the mole adds to the damage by its numerous tunnels which dry out the remaining roots.

Malathion is the recommended chemical to kill the invading or emerging adults. Growers are advised to watch for severe notching of blueberry foliage in late April and late June and to apply a dust or spray to the affected area. Further applications may be necessary to border areas in August. ■

Fig. 1. Adult, pupa and mature grub of the black vine weevil.

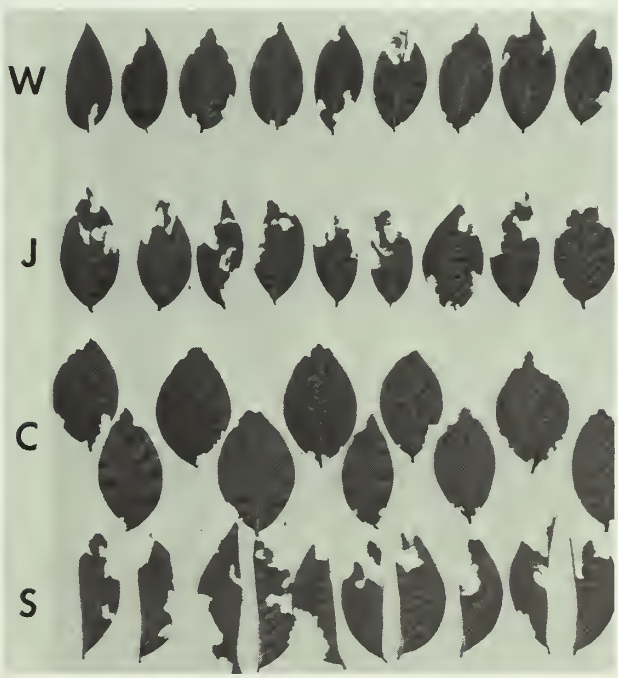


Fig. 2. Leaf feeding by individual adults of the black vine weevil on blueberry leaves of W-Weymouth and C-Cabot (unacceptable cultivars) and J-June and S-Stanley (half leaf) (acceptable cultivars).

NATIVE FESCUE GROWS SLOWLY

D. B. WILSON and A. JOHNSTON

La croissance de la fétuque indigène, lors d'un essai dans une serre de l'Alberta, s'est ralentie et sa production a baissé par rapport à celle de la fétuque des prés. Ceci indique que si les herbes indigènes perdent de leur productivité, elles pourraient être remplacées par des espèces améliorées.

The Fescue Grassland is the characteristic prairie of the black soils and parkland of Alberta and western Saskatchewan. Much of its former area is farmed, but about 5 million acres of rough, stony, and sandy fescue prairie is still grazed.

The dominant species of the fescue grassland is rough fescue, *Festuca scabrella,* a tall-growing, productive bunchgrass. The species cures on the stem and, so, can be used for winter grazing. It is sensitive to grazing, however, and tends to disappear when used heavily, especially during the summer season. When this happens, the space formerly occupied by rough fescue is taken over by less useful grasses, weeds, and woody plants. And, while rough fescue is a productive native species, it still requires about 16 acres of fescue grassland range to produce enough feed for one animal unit—defined as a 1,000-pound cow with or without a calf at foot.

Climate of the fescue grassland is subhumid without marked deficiency of precipitation at any season. Average annual precipitation is about 22 inches, about 65 per cent of which is received between May and September.

We thought that, with 22 inches of precipitation and a subhumid climate, carrying capacity of the region should be greater than 16 acres per head per year. We questioned whether rough fescue was capable of taking full advantage of growing conditions. We wanted to see how growth of rough fescue compared with other species of fescue.

We decided to compare rough fescue with tall fescue, *Festuca arundinacea,* which was chosen because it is adapted to about the same moisture conditions as rough fescue. The comparison was made under optimum growing conditions in the greenhouse.

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Cattle on fescue grassland in the Porcupine Hills of southwestern Alberta. The nearly continuous grass phase, which is dominated by rough fescue, is shown. Elsewhere trees may make up a considerable percentage of the cover.

We filled small pots with an inert rooting medium, perlite, and planted single seeds of rough fescue in half the pots, and tall fescue in the remainder. We watered these plants with a complete nutrient solution and provided the best possible growing conditions. During the next ten weeks we compared growth rate of the two species.

The method we used was to harvest 20 plants of each species each week. At each harvest we measured total leaf area, total weight of topgrowth, and, after washing and drying, total weight of roots. Harvests began when plants were in the 2-leaf stage and continued for 10 weeks.

Three measures of growth were calculated: leaf area ration (LAR), the ratio of leaf area to total plant weight; net assimilation rate (NAR), the net increase in dry weight per unit leaf area per unit of time; and relative growth rate (RGR), the change of dry weight per unit dry weight already present per unit of time. LAR is descriptive of the plant's potential for photosynthesis in relation to the size of the plant that must be supported, NAR is essentially an index to the photosynthetic efficiency of the leaf, and RGR is a measure of the rate of increase in weight. These measures tell how fast the plant is growing, and how its growth is achieved. Also, rate of appearance of new leaves and tillers was recorded.

WEEKLY DRY WEIGHT OF 20 PLANTS OF ROUGH FESCUE AND 20 PLANTS OF TALL FESCUE

At end of week	Dry weight (g)		
	Top	Root	Total
Rough fescue			
1	0.03	0.02	0.05
2	0.06	0.04	0.10
3	0.10	0.07	0.17
4	0.16	0.10	0.26
5	0.25	0.12	0.37
6	0.39	0.19	0.58
7	0.62	0.28	0.90
8	0.85	0.40	1.25
9	1.08	0.44	1.52
10	1.76	0.61	2.37
Tall fescue			
1	0.04	0.04	0.08
2	0.16	0.06	0.22
3	0.43	0.16	0.59
4	1.04	0.35	1.39
5	2.76	0.74	3.50
6	4.75	1.40	6.15
7	8.50	2.51	11.01
8	13.98	3.91	17.89
9	22.71	6.49	29.20
10	30.19	9.25	39.44

The most striking difference between the species was in the size of the leaves, which were much larger in tall fescue than in rough fescue. Also, tall fescue had a greater number of leaves. Tiller numbers were about the same in both species, which surprised us in view of the greater size of the tall fescue plants. By the end of 10 weeks, tall fescue had produced about 17 times as much total dry weight as rough fescue.

We looked at the various measures of growth to see why tall fescue produced so much more dry weight than rough fescue. Net assimilation rate was about the same, that is, both species had about the same efficiency in photosynthesis. Leaf area ratio was much higher in tall fescue than in rough fescue. This meant that tall fescue had a higher proportion of the plant in leaf, and was better able to carry on photosynthesis, an advantage it gained soon after germination and never relinquished. Relative growth rate of tall fescue was higher than that of rough fescue, because of the fact that it had more leaf area, and was just as efficient at photosynthesis. This advantage was particularly noticeable during the first few weeks after germination.

In summing up the results of our study, we noted that, although rough fescue is recognized as one of the most productive native grasses, tall fescue produced 17 times as much dry matter during 10 weeks of growth. This was probably close to the maximum potential difference between the species because growing conditions were near optimum. Under natural conditions, where growth may be restricted by adverse environmental conditions, a smaller difference would be expected.

In grassland, yield depends upon the extent of the photosynthetic surface and the efficiency of the photosynthetic process, as long as other factors are not limiting. Practices that increase leaf area will help to increase yield, provided the species in question is adapted to the region. Although the work reported here was done on seedlings and under optimum growing conditions, an indication of the potential for increasing grassland yields was shown. We do not suggest that tall fescue is the best grass for reseeding fescue range. It serves only as an example and we know there are several other promising cultivated species.

Some will argue that the evolution and persistence of our native grasses over millennia is proof that they are the ones best adapted to the region. We feel that, in the new ecological environment created by man, persistence must be matched by greater production. Where the native grasses are deficient in productive potential, they must make way to improved types. We suggest that, in western Canada generally, the best approach to increased yields from rangeland will be to increase leaf area by converting existing stands of native grass to adapted tame grasses. ■

COVER: Weather and climate have always been risk factors in most of Canada's agricultural areas. To assist farmers in coping with this pervasive problem national programs are being directed toward using climatic data more efficiently for agricultural planning and farming operations (Article on page 30).

COUVERTURE: Climat et température ont toujours été des variables «endurées» par l'agriculteur. Pour que, au contraire, il puisse en tirer profit, des programmes nationaux ont été mis en œuvre afin d'utiliser efficacement les données climatiques tant pour la planification que pour les opérations agricoles. (voir article page 30).

CANADA AGRICULTURE

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