Spring 1977
Printemps 1977

Biologists reveal new technology of water management in Western Canada. See story page 3.

Des biologistes d'Agriculture Canada nous font part d'une bonne gestion des eaux dans l'Ouest du Canada. Voir article page 3.

CANADA AGRICULTURE

CANADA AGRICULTURE

VOLUME 22 SPRING 1977 No. 2
VOLUME 22 PRINTEMPS 1977 Nº 2

JOURNAL OF THE CANADA DEPARTMENT OF AGRICULTURE–OTTAWA
REVUE DU MINISTÈRE DE L'AGRICULTURE DU CANADA–OTTAWA
MINISTER, HON. EUGENE WHELAN, MINISTRE **DEPUTY MINISTER, GAÉTAN LUSSIER, SOUS-MINISTRE**

CANADA AGRICULTURE is published quarterly to inform extension workers and agri-businessmen of developments in research and other federal agricultural responsibilities.

Any article may be reproduced without special permission provided the source is given credit. If excerpts only are to be used, authors' permission should be obtained.

Reprinted articles must not be associated with advertising material. The use of trade names published in this journal implies no endorsement of the products named nor any criticism of similar products not mentioned.

Contributors may submit articles in either English or French to the Secretary, Editorial Board, Information Division, Canada Department of Agriculture, Ottawa.

La revue trimestrielle *CANADA AGRICULTURE* renseigne les vulgarisateurs et représentants du négoce agricole sur les développements de la recherche et des autres services agricoles du gouvernement fédéral.

La reproduction des articles est permise en indiquant l'origine. Pour reproduire des passages d'un article, l'autorisation de l'auteur est nécessaire.

Les articles reproduits ne doivent pas servir à des fins de réclame. La mention de marques de fabrique ne signifie pas que la revue garantit ces produits ni qu'elle déconseille d'autres produits non mentionnés.

Les articles en anglais ou en français doivent être adressés au secrétaire du Comité de rédaction, Division de l'information, ministère de l'Agriculture du Canada, Ottawa.

Agriculture Canada

WATER QUALITY AND THE FARM POND

J. R. ALLAN

La production agricole intensive accroît les teneurs en éléments nutritifs des lacs, étangs et canaux de ferme et favorise une croissance excessive de la végétation aquatique. La première étape dans la lutte contre cette végétation luxuriante est la compréhension de l'écosystème aquatique et l'identification du type de végétation en cause. L'eau, tout comme la terre, se prête à une gestion rationnelle.

Aquatic ecosystems are dynamic systems and their physical and biological properties are slowly but continually changing, going through a natural aging process called eutrophication. Lakes and ponds go from infancy, where nutrients and organic content are low and aquatic vegetation and fish are scarce, to maturity, where the environment is rich in nutrients and organic content, vegetation is abundant, and there is a mixed population of game and coarse fish. Left unchecked, aging will continue until the nutrients and organic compounds are overabundant, aquatic macrophyte and algal vegetation is excessive, and oxygen levels fluctuate widely. Only coarse fish will be able to survive at this last stage.

Farm ponds can be viewed as small worlds (microcosms) composed of abiotic, or environmental, components of physical and chemical factors and biotic, or living, components bound and organized by interactions. However, although the ponds are microcosms, they are acted on by their surrounding watershed which man may have altered greatly.

Dr Allan is an aquatic plant physiologist at the Agriculture Canada Research Station, Lethbridge, Alberta

Figure 1 The right way to 'landscape' a farm pond. Shallow slopes and grass prevent erosion and ensure pure, vegetation-free water

The management of aquatic ecosystems depends on the nutrient relationships and energy flowing through the microcosms. These involve interactions between the physical and chemical properties of the water and the surrounding land and the biological community of the aquatic ecosystem. Large lakes are self-sustaining and their ecosystems function with only radiant energy and a set of organisms that act as producers, consumers, and decomposers. However, small farm ponds are not self-sustaining and require outside help. We can control their development by manipulating the system to prevent excesses or correct deficiencies. Each body of water is part of a larger watershed. For example, the drainage area on a farm is made up of heavily fertilized cropland, grazed grassland, the farmyard, and possibly areas for feedlot waste drainage and livestock watering. Each area can contribute nutrients and topsoil through irrigation or natural runoff.

All components interact through this intricate system. For example, sunlight strikes the surface and penetrates the water to reach the primary producers (aquatic macrophytes) where it is converted by photosynthesis to organic matter and free oxygen. The sunlight also warms the water, causing accelerated vegetative growth. The excessive vegetation decays and supplies unwanted amounts of organic matter for bacterial decomposition. Recycled into the water, this organic matter can cause more excessive vegetative growth (algal scums).

The control depends on managing the level of nutrients reaching the farm pond.

With growing urban populations, there is pressure on agriculture to produce more food on less land. As a result, practices that maximize crop production have been adopted. Marginal land that once acted as a buffer between cultivated land and aquatic environments is often now cultivated. Thus, the lakes, ponds, and canal systems can now receive increased nutrients that stimulate excessive aquatic vegetation. The first step in controlling this excessive growth is to understand the aquatic ecosystem and know the aquatic vegetation that is causing the trouble. Then management practices can be applied to water as they are to land.

Chemicals are always available for use as cosmetic controls. They are, however, short-term corrective measures and will have no effect on the cause of the excessive aquatic growth.

Pond construction should follow the guidelines set out by the Prairie Farm Rehabilitation Administration or provincial agricultural engineering divisions. Slopes, minimum depths along shore lines, and pond-bed sealing to prevent seepage are important. The banks must be leveled and excess earth removed. A shelterbelt or tree line can serve as a snow fence that will contribute much needed water. It will also allow for slow melting in the spring and provide shade in the summer. Protecting the pond from wind will reduce wave action and thus prevent bank erosion. Landscaping the pond to prevent wind action and allow shading will reduce evaporation. The area between the shelterbelt and pond must be grassed. Sod acts as a biological filter, catching water and allowing it to move slowly to the pond during spring thaw. As the water moves down the gentle slopes, nutrients are retained and soil erosion is prevented.

Livestock must be kept out of the pond. The expense of pumping water to the fenced livestock will be recovered by lack of bank destruction, reduced soil erosion, and little or no phosphorus and nitrogen enrichment of the pond by livestock waste. Also, if chemical control of vegetation is necessary, the livestock will not be able to drink the treated water. Even on rangeland, the catch basin or dugout should be fenced to keep the cattle out.

If the dugout or pond is kept clean, it can be stocked with trout for fishing, or used for swimming, irrigation, and general farm use. During unusually hot or long summers, simple aeration, by bubbling air through the water, can correct algal problems and save on chemical costs.

Many of the same prescriptions apply to irrigation delivery and drainage canals. The banks should be seeded to low growing grasses to prevent erosion and silting-in. By keeping the canal banks stable, the chance of nutrient-rich topsoil reaching the canal beds is reduced. If siltation occurs and chemicals have been applied to the bottom of the canal beds, they will be inactivated and thus aquatic vegetation will be able to grow above the chemically treated zone.

It is very critical that terrestrial weed seeds from plants growing on the canal banks are prevented from entering the water and being spread on the fields during irrigation.

Great care is given to cropland to maximize production. The same amount of care should be exercised to provide good quality water and efficient use. Unfortunately, water is often taken for granted. ■

Figure 2 The wrong way to leave a farm dugout

FERTILIZERS FOR MAXIMUM PRODUCTION OF CAULIFLOWER

J. A. CUTCLIFFE and
D. C. MUNRO

On a étudié à Charlottetown les effets de l'application de N, P et K sur les rendements de choux-fleurs. Les résultats obtenus ne valent peut-être pas également pour toutes les régions maraîchères du pays mais, dans la mesure où ils permettent une meilleure compréhension des besoins en engrais du chou-fleur, on estime qu'ils peuvent servir de guide pour l'amélioration des rendements.

Cauliflower is a cool season vegetable that is well adapted to the Maritime provinces and other areas throughout Canada. It is considered a delicacy by many and is well adapted to home freezing. The crop has long been considered to be one of the most difficult to grow successfully. Unless there is uninterrupted growth, the plants will tend to prematurely form small heads that are of little value. To avoid this, the soil should be properly fertilized to provide an adequate supply of plant nutrients throughout the growing season.

There has been very little experimental work done on the fertilizer requirements of cauliflower. Consequently, an effort has been made at the Charlottetown Research Station to determine the effects of nitrogen, phosphorus and potassium on the yield and maturity of this valuable crop.

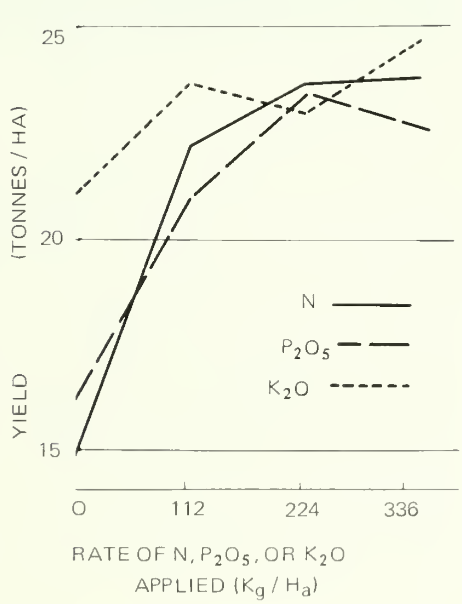
Results of experiments conducted at a total of nine locations in Prince Edward Island over a 3-year period where all fertilizer treatments were applied broadcast and worked in prior to transplanting, indicate that both nitrogen and phosphorus are very important to continuous growth.

We found that the addition of nitrogen increased yields at all but one location. Added phosphorus increased yields at six of the nine locations, with the greatest yield responses usually occurring on the soils containing the least amount of phosphorus. However, there was no benefit in adding more than 224 kg P_2O_5/ha (200 lb P_2O_5/ac) at any of the locations studied.

Our research revealed that applied potassium had the least effect of the nutrients studied and significantly increased yields at only three of the nine locations. However, at the other six locations, the mean yield was greater than where none was applied.

Maturity of the crop was affected to a greater extent by added phosphorus than by nitrogen. The number of heads mature by mid-harvest were 30% greater where phosphorus was applied, at 224 kg P_2O_5/ha (200 lb P_2O_5/ac) than where none was applied. The effect of added nitrogen was not statistically significant. Added potassium had very little effect on maturity.

The results indicate that cauliflower grown in Prince Edward Island should receive nitrogen at 112 – 168 kg N/ha (100 to 150 lb N/ac), phosphorus at 112 – 224 kg P_2O_5/ha (100 – 200 lb P_2O_5/ac) and potassium at 56 – 112 kg K_2O/ha (50 – 100 lb K_2O/ac). The rates of added phosphorus and potassium can be varied in keeping with soil tests. Growers are warned that the addition of the optimum level of one nutrient will not necessarily increase yields as indicated unless all three major nutrients and micronutrients, such as molybdenum and boron, are in adequate supply. While these results may not apply equally well in all vegetable-producing areas of Canada, they may be used as a guide to increase yields through better understanding of the fertility requirements of cauliflower. ■



Mr. Cutcliffe is head of the Horticulture Section and Mr. Munro is a soil fertility specialist at the Agriculture Canada Research Station, Charlottetown, P.E.I.

MECHANIZATION R & D

M. FELDMAN

Canada has another national DREAM. Beginning in 1973, Agriculture Canada's Research Branch increased expenditure for research and development (R & D) of agricultural mechanization by nearly one million dollars annually.

DREAM stands for Development, Research, and Evaluation in Agricultural Mechanization. The program funds projects designed to improve mechanization for farmers and the industry through contracts with industry, universities, and other non-Federal Government organizations. It elevates considerably the level of Research Branch input to agricultural engineering R & D. Of the total annual cost, $800,000 is allocated for contracts. The remainder pays for in-house support staff, including new engineering positions with regional responsibilities in the Atlantic, Central, and Western regions. Besides assisting with the program, regional researchers establish R & D programs on mechanization of their own.

The DREAM program resulted from a growing recognition for the need for more R & D related to equipment in Canada; its format was decided by a coincidence of situations. The Smallman, and Hudson Reports, but especially the Barber Royal Commission on Farm Machinery documented the needs and argued for solutions. In particular, Barber pointed out the lack of research and development in agricultural engineering in relation to the size of the industry and farmers' expenditures on mechanization. He suggested suitable levels of R & D effort. At the same time, the federal government was firming up its "Make or Buy" policy on contracting out research.

Mr. Feldman is Section Head, Mechanization and Systems Section, Engineering Research Service, Ottawa

Mr Feldman and Dr Downing, with Canada Agriculture's Engineering Research Service, discussing contracts for new developments in farm mechanization

Messieurs Feldman et Downing du Service de recherches techniques d'Agriculture Canada, discutent des contrats pour l'amélioration de la mécanisation agricole.

Against this background, Dr. Glenn Downing, Special Advisor on Agricultural Engineering for the Research Branch, was able to visualize a suitable procedure. He estimated a reasonable expenditure level, recognizing that existing organizations and specialists could carry out the work under program management and coordination. The federal government was finally convinced. At the Western Economic Opportunities Conference in Calgary, July 1973, the Minister of Agriculture announced a commitment to expand engineering capability. Before the end of the fiscal year, $90,000 was allocated for three contracts for research on major problems. By 1975-76 the full program had been phased in.

Opportunities available under the DREAM program were communicated across the country through the membership of the Canada Com-

RECHERCHE ET DÉVELOPPEMENT EN MÉCANISATION AGRICOLE

M. FELDMAN

En 1973, la Direction de la recherche d'Agriculture Canada décidait d'accroître d'environ un million de dollars par année sa contribution au programme DREMA (Développement, Recherche et Évaluation en Mécanisation Agricole) qui finance, par des contrats accordés à l'industrie, aux universités et d'autres organismes ne relevant pas du gouvernement fédéral, des projets axés sur l'amélioration de la mécanisation agricole au profit des agriculteurs et de l'agriculture canadienne. La Direction de la recherche a ainsi sensiblement accru son apport à la recherche et au développement en génie rural. Les contrats accaparent le gros des coûts annuels totaux du programme, soit $800 000, l'autre partie étant affectée au personnel de soutien, y compris de nouveaux postes d'ingénieur dans les régions de l'Atlantique, du Centre et de l'Ouest. En plus de collaborer au programme, ces chercheurs régionaux élaborent des programmes autonomes de recherche et de développement en mécanisation agricole.

Le programme DREMA a été créé pour donner suite aux rapports Smallman et Hudson, et plus particulièrement aux recommandations de la Commission Barber relative aux machines agricoles qui exposait les besoins et réclamait des solutions. On y relevait notamment la pénurie de la recherche et du développement en génie rural, compte tenu de la taille de l'industrie et des dépenses des agriculteurs à ce poste. La Commission proposait donc d'intensifier les efforts de recherche et de développement dans ce domaine. Parallèlement, le gouvernement fédéral précisait sa politique du "faire ou faire faire" en ce qui concerne les recherches contractuelles.

C'est dans ce contexte que M. Glenn Downing, conseiller spécial en génie rural à la Direction de la recherche, s'est employé à élaborer une solution originale. Après estimation de ce que devrait être un niveau de dépenses raisonnables, il en est venu à la conclusion que les organismes et chercheurs en place pourraient mener la tâche à bien grâce à la gestion et à la coordination du programme. Le gouvernement fédéral s'est finalement laissé convaincre. En juillet 1973, le ministre de l'Agriculture annonçait, à l'occasion de la Conférence des perspectives économiques de l'Ouest, tenue à Calgary, un accroissement des ressources affectées au génie rural. Avant la fin de l'année financière, une somme de $90 000 était répartie en trois contrats de recherche portant sur des problèmes importants. Dès 1975-1976, tous les éléments du programme étaient en place.

Les nouvelles possibilités offertes par le programme DREMA ont été véhiculées à travers le pays par les membres du Comité canadien de génie rural. Divers organismes ont soumis des propositions au sujet des problèmes de l'heure. Chaque année, le comité, composé d'ingénieurs du génie rural des gouvernements fédéral et provinciaux, des universités et d'associations professionnelles, classe celles-ci par ordre de priorité, et l'exécutif de la Direction de la recherche s'assure qu'elles sont conformes à ses objectifs. La négociation du contrat proprement dit est laissée au ministère des Approvisionnements et Services, mais c'est le Service de recherches techniques qui est le centre névralgique du programme.

Puisqu'il s'agit d'établir les propositions prioritaires, et vu que la recherche maison est à l'origine des contrats, le programme est axé sur les besoins suivants:

(1) Modification et amélioration du matériel en vue d'en accroître l'efficacité et de découvrir de nouvelles applications.

(2) Information sur la recherche fondamentale en mécanisation agricole et sur ses applications.

(3) Évaluation des données sur la mécanisation de pointe à l'étranger en vue de leurs possibilités d'adaptation aux conditions canadiennes.

(4) Conservation de l'énergie et amélioration de l'efficacité des machines.

(5) Élaboration de données sur le rendement des machines à l'appui des décisions de gestion et le travail d'analyse des systèmes.

(6) Recherche sur l'amélioration de la santé et de la sécurité des utilisateurs des machines agricoles.

Des recherches contractuelles réunissant des équipes de génie rural des gouvernements provinciaux, les départements de génie rural des universités, des experts-conseils et des petites entreprises ont été complétées ou sont en cours dans chacun des domaines susmentionnés. On espère que, conformément aux objectifs principaux du financement de la recherche et du développement dans le secteur privé, la participation de l'industrie s'intensifiera encore.

M. Feldman est le chef de la Section de mécanisation et des systèmes du Service de recherche technique à Ottawa.

mittee on Agricultural Engineering. Proposals dealing with the current problems were submitted by various organizations. Each year this same committee, made up of agricultural engineers from provincial and federal governments, universities, and industry associations, ranks the proposals according to priority. The executive of the Research Branch ensures that the proposals agree with its mission. Negotiation of the actual contract is performed by the Department of Supply and Services. Central responsibility for the program rests with the Engineering Research Service.

In establishing proposal priorities, and as in-house research generates contract opportunities, the thrust of the program is aimed at these presently recognized needs:

(1) Modification and development of equipment for improved performance, or new applications.
(2) Basic research information on agricultural mechanization and its use.
(3) Evaluation information on new mechanization, developed abroad, for suitability to Canadian conditions.
(4) Conservation of energy, and improved efficiency of machinery.
(5) Machine performance data to support management decisions and systems analysis work.
(6) Research to improve health and safety for mechanization users.

Completed and ongoing contracts exist on each of the above. Provincial government engineering groups, university agricultural engineering departments, consultants, and small industries are all involved. Hopefully, the future will bring more industry involvement in keeping with the main objectives of funding non-government R & D.

Some equipment developments have been classic success stories as the ideas are smoothly implemented. A tomato harvester suitable for up to 60 acres of production annually is now available to Southern Ontario growers. An improved pressure meter and pump for corrosive chemical preservatives has been completely designed and implemented. Two problems defined by Research Station work in Western Canada were resolved by equipment developed under industry contracts. The production potential of vast acreages of solonetzic soils can now be improved using a special 3-layer plow to mix soil horizons down to 3 feet deep. The special flexibility designed into a grass seeder allows, for the first time, mechanized seeding of the complete contour of irrigation ditches.

Complex, long-term studies are under way, as well: the production of methane from animal wastes; fruit mechanization systems; ways to battle wild oats; soil compaction and traction of powered wheels. Equipment has been imported and evaluated for harvesting raspberries, lifting baby carrots, drying and storing chopped forage, and for cutting and hauling hay. Data has been gathered on forage equipment performance, tillage power requirements, and seeding fababeans. New ventures such as the application of doppler radar to measure wheel slip, meters to indicate tractor performance, and computer models of combining and grain harvesting promise practical future application. Of course, this list is not complete.

Not every contract produces the hoped-for results. This is inherent in research work. But even negative results can have value. Each year's program makes its contribution to engineering progress for agriculture, and contains the potential for important new developments and breakthroughs. Once again in Canada, a DREAM has become a reality. ■

Certaines idées se sont matérialisées sans heurt pour devenir des succès retentissants. Par exemple, les producteurs du sud-est de l'Ontario peuvent maintenant compter sur une récolteuse de tomates adaptée à des superficies allant jusqu'à 60 acres. On a aussi conçu et fabriqué un manomètre et une pompe améliorés pour les préservatifs chimiques corrosifs. Dans l'ouest du pays, deux problèmes cernés aux stations de recherche ont été résolus grâce à du matériel mis au point dans le cadre de contrats de recherches accordés à l'entreprise privée. L'utilisation d'une charrue spéciale à 3 paliers qui mélange les horizons du sol jusqu'à une profondeur de 3 pi permet d'améliorer la productivité de grandes superficies de sols solonetziques. Grâce à la création d'un semoir à graminées spécial doté d'une grande souplesse, il devient enfin possible de mécaniser les semis sur la surface entière des fossés d'irrigation.

De complexes études à long terme sont également en cours. Mentionnons par exemple la production de méthane à partir des déchets animaux, les systèmes de mécanisation de la production fruitière, la lutte contre la folle avoine, le tassement du sol et la traction des roues motrices. On a importé et évalué du matériel servant à la récolte des framboises, à l'arrachage des mini-carottes, au séchage et au stockage du fourrage haché, ainsi qu'à la fauche et au transport du foin.

Enfin, des données sur le rendement du matériel utilisé en production fourragère, la puissance motrice nécessaire au travail du sol, et les méthodes de semis de la féverole ont été recueillies. De nombreuses innovations, comme l'utilisation du radar Doppler pour mesurer le glissement des roues, de compteurs indiquant la performance du tracteur, et de modèles informatiques pour le moissonnage-battage et la récolte des céréales trouveront sans doute des applications pratiques dans un proche avenir. Cette liste n'est évidemment pas exhaustive.

Les contrats ne produisent pas toujours les résultats escomptés. Les échecs sont partie intégrante des recherches, mais même les résultats négatifs peuvent parfois s'avérer utiles. Chaque programme annuel apporte quelque chose au progrès des techniques agricoles et permet d'explorer de nouvelles avenues de recherche. Le programme DREMA contribue à l'essor de l'agriculture canadienne. ■

HERBICIDE MIXTURES — BANE OR BLESSING

H. A. FRIESEN

Il y a certains avantages à composer des mélanges d'herbicides, mais chaque produit étant homologué pour des usages particuliers, le fait de les combiner rend plus complexe l'évaluation des dangers possibles de leur utilisation.

Mr Friesen, as Head of Crop Management and Soils, Agriculture Canada Research Station, Lacombe, Alberta, was a well-known weed control specialist in western Canada. He passed away in January, 1977, shortly after preparing this article for Canada Agriculture

In 1944 the phenoxy herbicides 2,4-D and MCPA were hailed as the "death knell" to weeds in grain and forage crops. However, it was soon discovered that these herbicides do not selectively kill or control grassy annual weeds. In a few more years it was also learned that a number of broad-leaved weeds were nearly as tolerant as the host crop.

Chemical companies rose to the challenge and, by 1960, had developed two herbicides Carbyne (barban) and Avadex (triallate) which selectively remove wild oats from wheat, barley, rapeseed and flax. Later, other chemists developed Banvel (dicamba), Buctril and Brominal (bromoxynil) which effectively control the phenoxy tolerant buckwheats and smartweeds. However, they do not control chickweed, corn

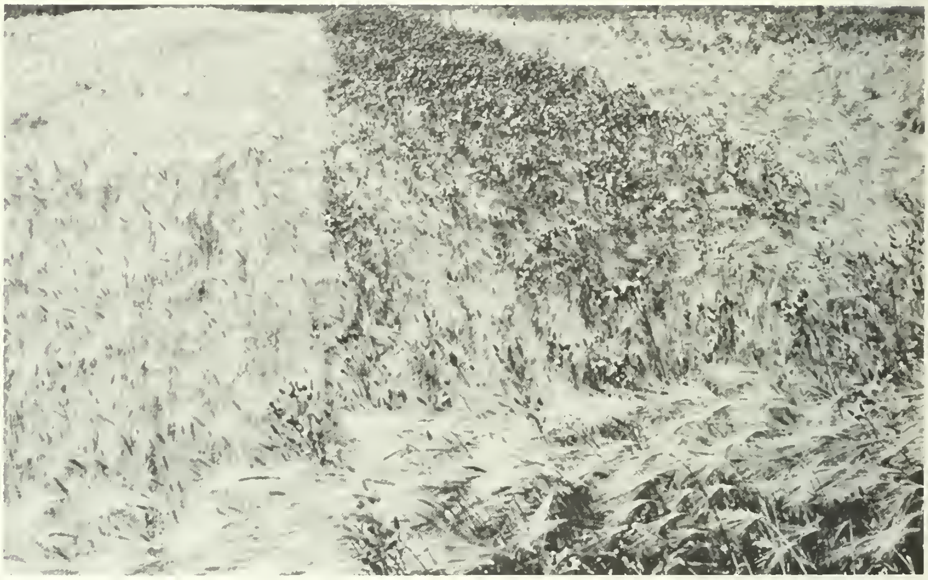


Figure 1 Note the excellent control of Canada thistle top growth with Banvel 3 (dicamba + mecoprop + 2, 4-D amine)

spurry or hemp nettle. But the licensing of Sencor (metribuzin) for use in 1977 has solved this problem. (At present, the use is limited to barley in Alberta only.)

The different herbicides rely largely on enzyme or biochemical differences between plant species to selectively kill or control. Differences in penetration, translocation and other physical facets also can be important. Unfortunately, most grain fields are infested by many species of weeds. For example, grain crops in the Alberta Parkland frequently contain wild oats, green foxtail, stinkweed, green smartweed, hemp nettle and chickweed in varying densities in the same field. To control all species would require four different herbicides meaning four trips over the same field. This is the farmers' number one reason for interest in "herbicide cocktails."

Other reasons for the keen interest in herbicide combinations are: 1) synergism; 2) the possibility of the mixtures requiring a lower application rate with a consequently lower risk of crop injury and 3) significant savings in crops trampled by repeated sprayer passings as well as savings in herbicide and application costs.

There are five types of mixtures of interest to prairie farmers: 1) a mixture that kills both grassy and broad-leaved annual weeds; 2) mixtures that control a wide spectrum of broad-leaved weeds; 3) mixtures that control grassy weeds e.g. wild oats; 4) mixtures of herbicides and fertilizers; and 5) mixtures of herbicides and insecticides. Here, we are concerned chiefly with mixtures of herbicides for broad-leaved and grassy weeds. When two or more of these herbicides are mixed in the same tank the weed killing properties may be dramatically changed. The effect of tank mixing may be simply additive, i.e., the mix has the properties of each of the individual components. It may be synergistic which means that the weed killing activity of the mix is greater than the total effect of ingredients applied separately. The components may be antagonistic resulting in a net loss of activity in one or all. Concocting herbicide cocktails can be fraught with an element of risk so caution is advised.

Cocktails which involve the mixing of one or more herbicides with 2,4-D or MCPA have been with us for a number of years. MCPA ester effectively controls mustards and pigweeds but when bromoxynil is added to make Buctril M or Brominal M, the buckwheats and smartweeds are also controlled. Similarly, the addition of Banvel (dicamba) to 2,4-D amine and mecoprop or to MCPA-K extends the spectrum of weeds controlled by the phenoxy herbicides to include buckwheats and smartweeds. These products are pre-mixed so that tank mixing on the farm is not required. The mixtures are additive with no evidence of real synergism or antagonism. There are numerous other mixtures of broad-leaved herbicides in use on prairie farms.

The most exciting area for the development of mixtures is with the wild oats herbicides. Carbyne (barban) at 0.3 kg/ha (4 ounces per acre) presents application problems because it is active only at the early 2-leaf stage of wild oats. Endaven (benzoylprop ethyl) at 1.1 kg/ha (16 ounces per acre) is highly effective against wild oats particularly if applied at the 4- to 5-leaf stage. Tank mixing the two at one half the quoted rate for each herbicide resulted in excellent control of 2- to 4-leaf growth at the University of Alberta and field tests at other institutions. Wheat yields were significantly increased due to removal of the wild oats. Figures 1 & 2. Note: Registration of this mixture for use as tank mix in 1977 is currently being sought by Shell, the makers of Endaven.

Combinations of Carbyne and Avenge (difenzoquat) also have controlled the 2- to 4-leaf stages of wild oats, permitting a much extended spray period for this weed in barley. However, the mixture is more additive than synergistic; more work is needed before it is registered. The possibilities for mixing the nine herbicides now registered for wild oats are too extensive to pursue here.

Extending the above compounds and mixtures to include control of both wild oats and broad-leaved weeds has been the goal of many researchers and farmers. Unfortunately most wild oats herbicides have shown antagonism in mixtures with phenoxyies, Buctril M and Banvel. However, Avenge is compatible with the ester forms of 2,4-D, MCPA, and Buctril M and Brominal M and so affords relief to the barley grower. In depth research to throw some light on the causes of this antagonism may also develop the means to overcome it. Such research is now under way at the Universities of Manitoba and Alberta. At the former, significant progress has been made toward explaining the cause of antagonism between Hoe Grass (dichlorfop methyl) and 2,4-D.

With so many apparent "blessings" from the concocting of herbicide cocktails how can they be a "bane?" The Pest Control Products (PCP) Act states, "This control product is to be used only in accordance with the direction on this label. It is an offence under the PCP Act to use a control product under unsafe conditions." Any farmer who is tempted to buy two fully registered herbicides and apply them as a tank mix is technically in violation of the act if tank mixing is not on the label. Also, the companies who produced the individual ingredients are not responsible for any damage that might result from use of the mixture. User grievance is justified because most mixtures with market potential have been researched in part at public expense. However, public funds do not stand behind the products or mixtures should the user sustain injury to his crop. Companies on the other hand have the agonizing task of deciding who will pick up the tab for the development work (field efficacy, toxicology, residue determinations, etc.). Who will be stuck with the bill should crop injury be sustained? In the event of high return per acre with small acreage crops the risk would be too great to entice any company to proceed with registration. However, collaborative efforts between the Canada Weed Committee and the Canadian Agricultural Chemicals Association are now under way in an attempt to solve this problem. ■

Figure 2 Mixture packs real punch on wild oats! The photo, courtesy of University of Alberta, shows left to right: untreated control, Endaven at 8 oz/ac, Carbyne at 2 oz/ac. Each has little effect due to low dosage, but when the two are combined (right), a real knockout blow!

IMPROVING SOIL PHYSICAL CONDITIONS

G. R. SAINI and E. A. GRANT

Les mauvaises propriétés physiques des sols limitent la production agricole dans les provinces Maritimes. On procède à des essais en ambiance contrôlée à Fredericton (Nouveau-Brunswick) pour vérifier les avantages éventuels de l'ameublissement de la couche compacte formée par le till de fond.

Poor soil physical properties limit agricultural production in the Maritime Provinces. Naturally occurring compact layers in basal till, fragipans and orstein soils restrict water movement and root growth. Therefore, in years of heavy rainfall, plants suffer because of excessive moisture in the root zone and, in dry years, roots cannot penetrate to sufficient depths to draw water (see the bent tap root in Figure 1). This situation hinders the expansion of forage crops such as alfalfa and corn. Consequently, the Maritime Provinces continue to depend predominately on western feed grains which, in turn, limits development of livestock production based on home-grown feed.

Deep sub-soiling (c. 90 cm) to shatter the compact layer may be the answer. It increases the water storage capacity of the soil and facilitates root penetration. Experiments were undertaken early in 1976 to ascertain the beneficial effect of loosening the compact layer of a basal till in New Brunswick.

Basal till (Bt horizon) used in the experiment was taken from a field at a depth of 29-63 cm. It was naturally compact (bulk density 1.82 g/cm^3) and poorly aerated (oxygen diffusion rate 0.44$\mu g/cm^2/min.$) These conditions were simulated in specially-constructed boxes, (5 x 20 x 75 cm) having one side (20 x 75 cm) made of glass. The glass side had another sliding board for viewing root length periodically. In other boxes, the compact B_t layer was loosened (bulk density 1.40 g/cm^3 and oxygen diffusion rate 0.86 $\mu g/cm^2/min.$). The B_t horizon was overlain by topsoil (Ae and Ap horizons) as in the field. Lime and fertilizer (N, P, K with B) were mixed with the topsoil at the usual recommended rates. Inoculated alfalfa seed was planted in the boxes and thinned to three plants per box which were placed in a growth chamber where temperature, light and day length were controlled to simulate the growing season (May through August). Watering was done on a schedule to follow the rainfall pattern of the growing period of 1975.

Figure 1 Bent root (arrow) due to mechanical impedence of hard subsoil pan

Figure 2 Improved growth of alfalfa plants in loosened subsoil

At the end of the growing period, the dry matter yield of alfalfa was about 125% higher in boxes in which the B_t (the compact horizon) was loosened (Table 1 and Figure 2). In loosened B_t horizon, plant roots penetrated to about 63 cm, whereas, in the naturally compact condition of the B_t horizon, root penetration was about 35 cm (Figure 3). Soil moisture content readings were

TABLE 1 EFFECT OF LOOSENING BASAL TILL SUBSOIL ON ALFALFA YIELD

Replication	Yield of dry matter (gm/box)	
	Compact	Loose
1	5.90	10.10
2	5.55	15.00
3	5.75	13.00
4	6.10	14.20
Mean	5.83	13.08

Dr. Saini is a specialist in soil physics and Mr. Grant is an agronomist at the Agriculture Canada Research Station, Fredericton, N.B.

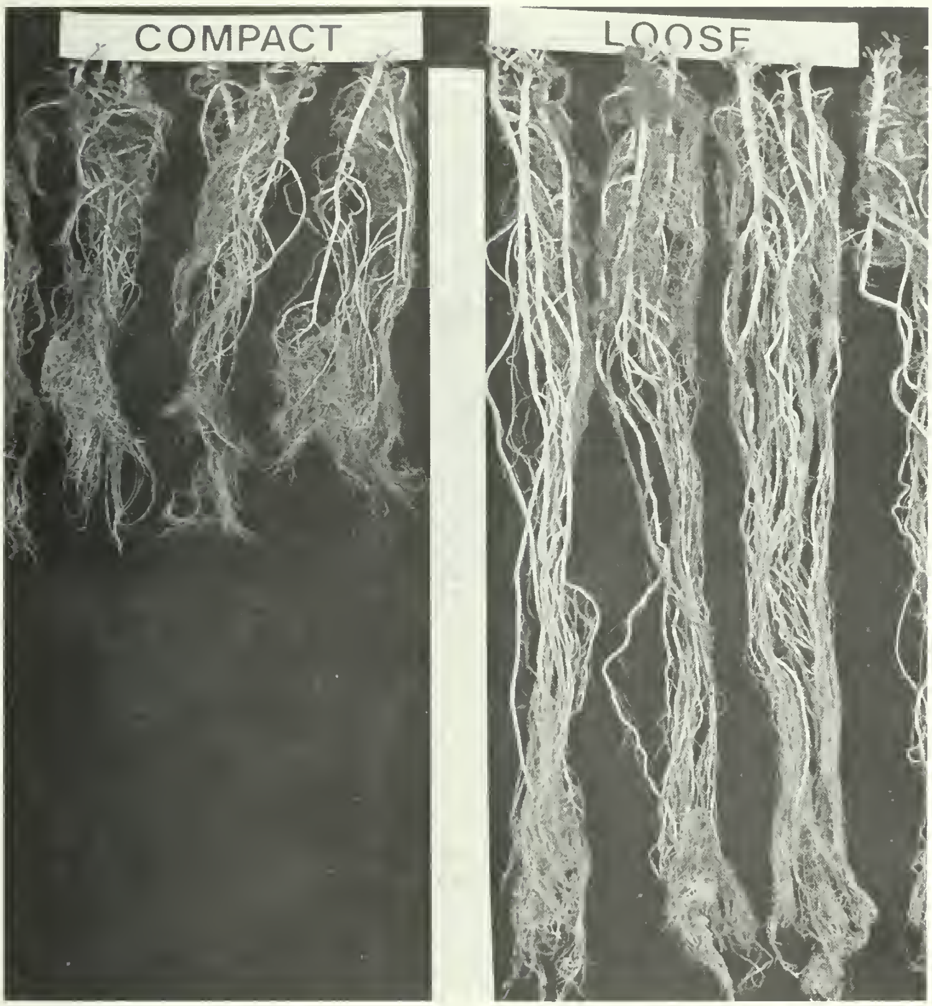


Figure 3 Depth of alfalfa root in loosened and naturally compact subsoil

taken 24 hours after application of 4.75 cm of water. Both soils had the same moisture content (28%) in the topsoil. The disturbed subsoil had 23% and 10% moisture at the 45 cm and 70 cm depth respectively, as compared with only 10% and 5% at the same depths in the undisturbed subsoils.

It is apparent from this study that loosening of the compact subsoil greatly improves yield of alfalfa by permitting deeper root penetration and improving the moisture regime to a greater depth. This, in turn, is conducive to improved nutrient uptake by the plant roots.

The next question is how effectively can this deep tillage be applied in the field. Reports from Nova Scotia[1], after several years of field trials with deep tillage have indicated improved forage yields up to 30%. Although controlled study in the growth chamber and the field studies to date show much promise, there are still many unanswered questions which prompt additional research. For example, what type of equipment is the most economic and efficient in shattering the deep impermeable layer. Other questions relate to the spacing and depth of tillage in relation to soil type; the time of year and the optimum soil moisture condition for tilling; the impact of various crop species in soil conditioning. Above all, it is important to determine how long deep tillage remains effective. These issues provide the focus for continued research in soil physics at Fredericton. ■

[1]Jan Van der Leest and John Hilchey Subsoiling tests in Nova Scotia Soils Farm Focus Update, March 24, 1976, pages 20S and 21S

CONTROL OF PVX AND PVS IN SEED POTATOES

N. S. WRIGHT, F. C. MELLOR, E. F. COLE and CONNIE M. HYAMS

Il existe plusieurs méthodes pour déceler les viroses causées par les PVX et PVS. A Vancouver, la préférence va à une technique sérologique d'agglutination du latex qui s'avère sûre et très sensible. Les producteurs et les chercheurs sont confiants que grâce à cette technologie, ces viroses seront bientôt éliminées des régions productrices de pommes de terre de semence de la Colombie-Britannique.

Sign on highway to Pemberton designating Seed Potato Control Area authorized by British Columbia Ministry of Agriculture

Potato improvement agencies and seed potato growers quickly adopt new technologies to control diseases. Leaf roll, caused by an aphid-borne virus, is controlled in basic seed stocks by using seed control areas. These are usually interior valleys surrounded by mountains and wilderness and beyond the flight range of aphids from areas where table stock and processing crops are grown and where the major sources of inoculum occur. Tuber indexing and unit planting, winter testing, roguing, aphid control, top killing and family selection have all contributed to the health and productivity of the potato. None of these practices, however, has controlled potato viruses X (PVX) and S (PVS) which, until 10 years ago, were universal in North American varieties.

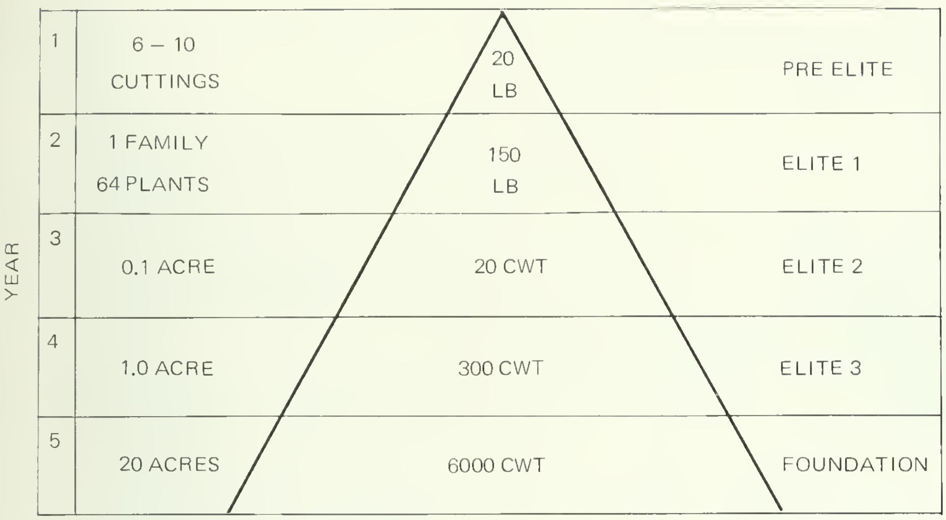
During the last decade, the technologies of heat therapy and meristem tip culture have been used to eradicate these viruses from our major varieties and most promising seedlings. In six Canadian provinces and at least 10 American states, programs have been developed to propagate these virus-free stocks and to detect reinfection. The objective is total replacement of infected stock by virus-free plants in each seed growing area. The project takes several years because both PVX and PVS are extremely infectious. They are spread by mere contact, not only between diseased and healthy plants, but by hands, clothing, sacks and equipment.

This article describes the production and testing methods currently used in the Pemberton and Cariboo areas of British Columbia and illustrates the technology needed to control viruses which, while capable of reducing yield by 20%, cause such mild symptoms that they are visually difficult to detect.

The production system starts with stem cuttings of a virus-free clone. Six to ten of these, multiplied for 3 years, will provide 2000 lb of tubers, enough to produce an acre of Elite 3 seed. Each year, in our program, the acreage of Elite 3 that will be required 3 years hence is estimated. The appropriate number of cuttings is supplied to the growers by the Vancouver Research Station and transplanted to the field in June.

During the summer, each plant is tested for PVX and PVS. At harvest time, the tubers, classed pre-Elite, are stored in groups of sufficient size to provide 64 seed pieces (about 16 tubers). Each group constitutes a family and is planted by hand in an isolated block, usually in four adjacent rows, separated from other families by at least 6 feet. Knives and rubber gloves used in planting are sterilized with quaternary ammonia before each tuber

Dr Wright and Ms Mellor are plant pathologists and Connie Hyams is a technician, with the Agriculture Canada Research Station, Vancouver, B.C. Mr Cole is an agricultural officer with the Plant Quarantine Division, Agriculture Canada, Vancouver.



Increase of virus-free cuttings over 5 years.

is cut. Again, during the second summer of propagation, each plant is tested for PVX and PVS. If either is found, the entire family is discarded. The tubers from the non-infected families are bulked and classed Elite 1. The following year they are planted in tuber units and their progeny become Elite 2. The progeny of this class become Elite 3 which are sold for the production of Foundation seed.

Virus-testing of Elite 2, Elite 3 and Foundation classes is confined to samples of leaflets collected according to a predetermined pattern. The growers collect 250 leaflets (5 cm diam.) from each plot or field up to 10 acres, and additional samples of 250 for each additional 10 acres to a maximum of 1,000 leaflets. These are packed in labelled plastic bags, 25 to a bag, and shipped to the Vancouver Research Station. There they are tested for virus infection.

Several methods are available for detecting PVX and PVS infection. At Vancouver, latex agglutination serology is preferred because it is reliable, fast and exceedingly sensitive. For this test, latex (polystyrene) is mixed with the combined antisera of PVX and PVS before adding the plant sap. The clumping together of the white latex beads greatly increases the visibility of the virus-antiserum reaction. A positive test can be seen within 15 minutes, and the test is so sensitive that one infected leaflet in a group of 25 will be detected.

The 25 leaflets from each bag are stacked and two sets of discs are removed with a 15 mm cork borer. One set is ground in a blender and tested as a composite sample. If this sample gives a positive test, the discs in the second set are tested individually with the antiserum of each virus. The number of infected leaflets in each sample is used to estimate the extent of infection in the field.

Because the plants sampled are such a small proportion of the plants in the field (0.2% in a 10-acre field), the tests provide only an

CORRELATION BETWEEN INFECTED LEAVES IN A 250-LEAF SAMPLE AND THE PROBABLE RANGE OF INFECTION IN THE FIELD

Infected leaves/250	% infection in field
0	0.0 - 1.0*
1	0.0 - 1.0
2	0.0 - 1.6
3	0.0 - 2.4
4	0.4 - 2.8
5	0.4 - 3.6
6	1.0 - 4.2
7	1.0 - 4.8
8	1.0 - 5.4
9	1.3 - 5.9
10	1.6 - 6.4
11	2.2 - 7.7
12	2.5 - 8.2
13	2.8 - 8.7
14	3.1 - 9.2
15	3.4 - 9.7
20	5.0 - 12.0
25	6.6 - 14.4
30	8.3 - 16.7
35	10.0 - 18.9
40	11.7 - 21.1
45	13.5 - 23.3
50	15.2 - 25.5

*Confidence intervals (P=0.05) based on Poisson and Binomial distributions.

VIRUS-TESTING* IN ELITE 3 AND FOUNDATION SEED POTATOES IN PEMBERTON AND CARIBOO, B.C., 1969-76

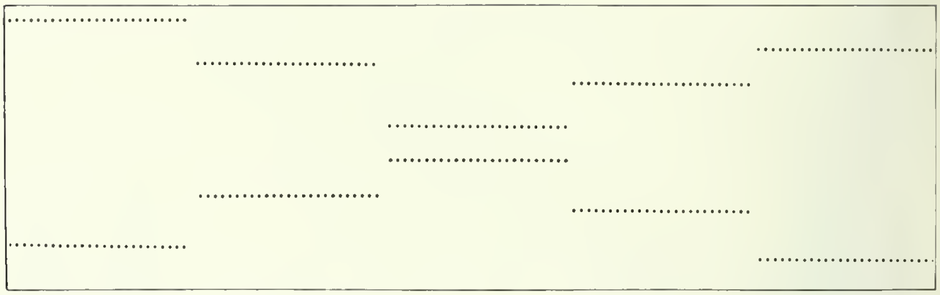
Year	No. of farms involved	No. of acres sampled	Sampled acres as % of total
1969	2	7	1.4
1970	6	64	12.7
1971	9	95	18.3
1972	14	192	48.0
1973	14	183	52.7
1974	22	348	73.9
1975	26	416	82.7
1976	30	482	85.1

*1969-72 tests for PVX in Elite 3
1973 tests for PVX in Elite 3 and Foundation
1974-76 tests for PVX and PVS in Elite 3 and Foundation

estimate. Determining the relationship between the incidence of disease in the sample with that in the field requires the technology of statistics. Confidence intervals from statistical tables assure that the rate of field infection probably lies within a specified range; the disease incidence in the field may be more or less than in the sample, but it will usually fall within the corresponding confidence interval. Thus, if five leaves in a sample of 250 are infected (2.0%), there is a 95% chance that 0.4 to 3.6% of the field plants are infected.

In 1976, 4994 pre-Elite stem cuttings, 549 Elite 1 families, 27 acres of Elite 2, 373 acres of Elite 3 and 109 acres of Foundation were tested for PVX and PVS. Neither virus was detected in the pre-Elite or Elite 1 classes and neither in 91% of Elite 2, 88% of Elite 3 or 36% of Foundation acreage. After 5 years, the highest incidence was 11% in one sample (indicating 6.6 - 16.7% infection in the field).

Growers and officials are confident that through the use of technology, PVX and PVS will soon be eradicated from the seed potato areas of British Columbia. ■



Pattern used to locate plants for sampling; a sample of 25 leaflets is taken from 25 plants within each designated block; the 10-sample pattern is repeated for each 10 acres up to a maximum of 40 samples.

PERFORMANCE PAYS IN SWINE

D. W. MacDONALD

La production porcine est à la hausse au Québec, et les producteurs semblent bien déterminés à concurrencer les autres régions productrices pour répondre à la demande de carcasses de qualité dans la province.

Mr. MacDonald is Head, Periodicals Services Unit, Information Division, Ottawa

Like other parts of the country, Quebec doesn't have an ideal climate for swine. Extreme changing temperatures, snow cover, and variable moisture make production difficult.

But Quebec farmers have invested heavily in swine housing. And with money tied up in specialized, insulated, and ventilated buildings, they appear to be in the hog business to stay.

"Pork production is in decline in some provinces," observes Charles M. Lalonde, Agriculture Canada's officer in charge of Swine Record of Performance (R.O.P.) for the province, "but it's on the increase in Quebec. Farmers produce only 80% of requirements at the present time and they plan to increase their slaughter to make the province more self-sufficient."

Weekly slaughter figures show Quebec has surpassed Alberta in production, and is in a position to overtake Ontario in the coming months.

Any increase in hog production will depend on quality carcasses and efficient production. Quebec farmers know that hogs pay off on rapid growth, and a minimum of fat. They need a testing service to identify superior sires and dams that will upgrade the performance of their market hogs.

Charles Lalonde serves on a committee of farmers, provincial livestock specialists, and a representative of the Meat Packers' Council that administers the Federal-Provincial R.O.P. program in Quebec. The committee sets the standards for production and performance in the province.

Close to 70 breeders test swine on the farm or at the central test station at Lennoxville, Que. Some raise more than one breed, but they have to have a minimum of 25 sows of any one kind. Yorkshire and Landrace predominate making up over 80% of the total. About 7% of the breeders raise Durocs, and another 7% raise Hampshires. The province has five Lacombe breeders.

The number of boars on test has increased significantly. There has also been a marked improvement in backfat on the larger number of boars tested. Figures show Quebec boar performance averages over three years (1973-75) compared to the national average (in brackets) on a number of economic traits.

"The emphasis in swine testing today is on boar performance", states Hans Grieger, Head of swine production, Agriculture Canada Livestock Division, Ottawa. "But breeders must first participate in the Home Test, administered jointly by the federal and provincial departments of agriculture. All pigs in litters of potential breeding stock must be weighed and ultrasonically measured for backfat thickness and estimated loin eye area under supervision of an R.O.P. technician. Traits evaluated in the home test include adjusted backfat, adjusted age to 200 lb live weight, estimated loin eye area and average daily gain where pigs are weighed on test."

Year	No. of animals	Adjusted age	Adj. av backfat thickness (in.)	Adj. est loin area (sq in.)	Av daily gain (lb)	Feed conversion
1973	131 (1,603)	151 (147)	.80 (.76)	5.13 (4.96)	1.88 (1.88)	255 (254)
1974	259 (2,169)	153 (148)	.72 (.74)	4.82 (4.94)	1.81 (1.87)	262 (262)
1975	338 (2,688)	154 (148)	.71 (.69)	4.83 (4.90)	1.90 (1.89)	259 (263)

Breeders receive a quarterly herd summary report listing all animals tested, litter and herd averages, updated sire averages, provincial and national averages by breed. Home tests evaluate sires and dams within a herd for more meaningful selection. It also shows the breeder what progress he is making as a result of his selection.

Two boars per litter from home tested stock can be sent to a central test station. The same traits are measured as in the home test, however, since pigs of approximately the same age from a number of different herds in the province are housed and fed the same, the growth rate, backfat and feed conversion can be compared. R.O.P. station testing gives breeders and buyers a basis for evaluating the potential of boars from different herds.

Over the years, swine geneticists have recommended methods of improving the basis for selection by establishing contemporary breed averages to which the breeder could compare his herd or individual records. Changes were believed necessary to give the breeder a more accurate or meaningful base to measure his progress.

"Too many market hog producers select a boar on price", says Paul Lambert, a purebred swine breeder at St. Jerome, Que. "They forget that half the boars in a herd are below average in breeding performance and should be culled".

An index, based on a boar's or sow's growth rate, backfat and feed conversion is a more reliable indicator of breeding performance. In Quebec, breeders have established a base price of about $200 for boars and sows averaging, or indexing, 100. Boars or sows usually command an additional $5 for every point above 100. For example, a boar indexing 112 on a home test would fetch the base price at the time plus $60, or a total of $260. A boar or sow that does not index 100 is below average and should be culled as a sire or dam.

Farmers in Quebec generally find hogs a steady source of income. They are produced in most counties in the agricultural areas of the province. In recent years farmers have found it convenient to produce hogs on contract with companies that supply feed, and may assist in selling hogs for slaughter. Eighty per cent of market hog production is believed to be on contract to feed companies. Purebred breeders are also becoming integrated with agribusiness despite the fact that the Quebec Ministry of Agriculture supports a policy of self-sufficiency in feed grain production for livestock.

Few breeders have been more dedicated, or made more progress in swine breeding than Frère Roussel. He served as a monk in the Villa St. Alphonse Monastery near St. Jerome for over 40 years, and during that time built up a 50-sow herd of Yorkshires. Weighing and measuring litters on home test was a ritual with this monk. Invariably, however, he selected herd sires from station-tested boars, not only because of their records, but because they had demonstrated strength in the legs and could stand up to the competitive growing conditions of station testing.

He sought meatiness, and uniformity in the Yorkshires. In 1969, he established a record when a boar, Bargeddie Chieftian 40 Y, sired eight offspring on test that averaged 5.94 inches of loin eye area and 83.2% yield of trimmed cuts.

It takes years of testing and accurate information to achieve results the brother contends. Genetic improvement in swine is a long-term process and any change in standards or methods of measurement tend to confuse the breeder's objective in certain traits.

In any case, Frère Roussel has succeeded in establishing a high degree of uniformity, meatiness and fast growth in a 50-sow herd through performance testing. In 1975, his herd sire indexed 118 on the basis of 8 progeny, or 18% above the average performance of the breed at the time. Table on next page shows how sire WL1205F compared to breed average.

Having upgraded the performance of the Yorkshires over 40 years of swine breeding, Frère Roussel has decided to retire. No younger monks at Villa St. Alphonse Monastery have demonstrated an interest in swine, so the herd had to be sold. Paul Lambert bought the breeding stock and facilities and plans to combine the operation with his own herd of Landrace. It will be a two-breed system, totalling about 100 purebred sows.

Like other swine breeders in Quebec, Paul Lambert's future is

Martin Pelletier, Ministère de l'agriculture du Québec, and Frère Roussel weigh a litter of pigs on home test at Villa St. Alphonse.

Charles M. Lalonde and Paul Lambert select a young Villa St. Alphonse boar for station testing at Lennoxville, Que.

tied to increased pork production in the province. He looks forward to more producers buying indexed sires and dams.

"It's the only way to sell boars," he says, "buyers pay for performance."

The Federal-Provincial R.O.P. Program measures the progress of swine breeding in all provinces, giving the breeder a broader basis for comparison on a large population. The national system opens the door to new markets as foreign buyers and artificial insemination units shop around for superior sires and dams.

In Quebec, the results of the Lennoxville station-tested boars are circulated across Canada, and to over 500 producers in the province as a means of advertising and promoting sales. Breeders plan to expand their test facilities to take advantage of the opportunity to sell more performance tested stock anywhere in Canada or abroad. ■

	Age av 200 lb (days)	Loin eye area (sq in.)	Av daily gain (lb/day)	Av backfat (in.)	Feed conversion (lb/100 lb gain)	Av index
Breed av	154	4 83	1.90	.71	259	110
WL1205F	152	5.20	1.94	.62	249	118

GRASSES FOR IRRIGATED HAY IN CENTRAL SASKATCHEWAN

R. P. KNOWLES and
L. G. SONMOR

L'article décrit deux essais de productivité et de persistance de certaines graminées en terres irriguées du centre de la Saskatchewan. Il appert que les principales espèces fourragères utilisées en aridoculture, c'est-à-dire la luzerne, le brome et l'agropyre à crête, se prêtent parfaitement bien à l'irrigation. Les différences entre les lignées sont toutefois suffisantes pour justifier certaines recommandations en fonction des variétés.

With the possibility of extensive irrigation in central Saskatchewan as a result of the South Saskatchewan River Development, tests were made on the suitability of various forage crops for irrigation. Alfalfa has long been recognized as a very productive irrigated crop but less is known about the suitability of various grasses. This article describes two tests on the productivity and persistence of grasses for irrigated hay in central Saskatchewan.

The first test, carried out from 1967 to 1971, involved alfalfa grown alone, and four grasses grown alone and in mixtures with alfalfa. No nurse crop was used. These crops were established in large plots 24 ft X 60 ft with six replications at both Saskatoon and Outlook. Large plots were used so that a succession of annual crops could be planted following each forage crop. Three replications at Saskatoon were seeded in 1966 and three in 1967. At Outlook three were planted in 1966 and three in 1968. Plots were plowed down after 2-3 years. Two cuttings were made each year. Yields of hay on a 2-cut basis are given in Table 1.

Grasses grown alone at Outlook yielded as well as grass-alfalfa mixtures and more than alfalfa grown alone (Table 1). The high fertility status of plots there prior to the test appeared responsible for the good yields of grasses grown alone. At Saskatoon, grass-alfalfa mixtures outyielded pure alfalfa and grasses grown without alfalfa. Results seemed to show that bromegrass, crested wheatgrass, and intermediate wheatgrass were satisfactory for irrigation, especially in alfalfa mixtures.

Dr. Knowles is a grass breeder and Mr. Sonmor is irrigation specialist at the Agriculture Canada Research Station, Saskatoon, Sask.

Reed canarygrass gave lower yields and appeared slightly winter damaged.

The second test, carried out from 1971-1976, involved a wider range of grass strains, seeded at Saskatoon in 1971. Plots 6 ft X 20 ft were established using 9-in. row spacings and no nurse crop. Six replications were used, two being seeded to mixtures with Beaver alfalfa, two with Roamer alfalfa, and two with Melrose sainfoin. Such poor stands of sainfoin were obtained that a portion of the test was essentially grass alone, and was heavily fertilized with nitrogen to compensate for the absence of the legume. As the two alfalfas performed equally well, grass mixtures with them were treated together for statistical analysis. Two cuts were made each year, the first being in early July and the second in late August (Table 2).

Crested wheatgrass, on the average, was the top-yielding grass in mixtures with alfalfa. The high yields resulted in part from the high proportion of alfalfa in the mixture. When crested wheatgrass was grown without alfalfa, yields were below those of bromegrass. Only Fairway and Parkway crested wheatgrass varieties maintained good stands to 1976. Nordan, Summit, tetraploid Parkway and S-7171 showed reduced stands after 5 years.

There was little to choose among bromegrass strains on the basis of yields or persistence. The S-7133 strain, which has reduced creeping, showed more alfalfa in the mixture than other varieties, but this did not result in higher yields. Meadow bromegrass differs from smooth bromegrass in having hairy leaves and stems, less creeping habit, and more basal leaf growth. Of the three strains of meadow bromegrass, S-7385 did not survive beyond the first season, while Regar and S-7406 were as hardy or hardier than smooth bromegrass. Meadow bromegrass did not yield as well as smooth bromegrass and it lodged considerably. Chief intermediate

Harvesting second growth of bromegrass-alfalfa mixture, University Farm, Sask., August 24, 1972. Sprinkler irrigation.

TABLE 1 HAY YIELDS OF ALFALFA, GRASSES, AND GRASS-ALFALFA MIXTURES UNDER IRRIGATION AT OUTLOOK AND SASKATOON, SASKATCHEWAN, 1967 - 1971

Crop	Hay yield: tons dry matter/ac			
	Outlook		Saskatoon	
Alfalfa (Beaver) — grown alone	3.70		3.07	
Grasses grown alone				
Bromegrass (Carlton)	5.06		2.60	
Crested wheatgrass (Fairway)	4.62		2.36	
Intermediate wheatgrass (Chief)	4.91		2.63	
Reed canarygrass (Common, S-6982)	4.23		2.26	
Grasses grown with alfalfa				
Bromegrass	4.74		3.62	
Crested wheatgrass	4.98		3.48	
Intermediate wheatgrass	4.25		3.38	
Reed canarygrass	3.99		3.16	
Mean	4.50		2.95	
Fertilizer lb/ac/yr	N	P_2O_5	N	P_2O_5
Alfalfa alone	40	30	40	35
Grasses alone	65	30	85	35
Grass — alfalfa mixture	40	30	50	35
Irrigation, in./yr (2-5 irrigations)	5.0 - 15.5		5.0 - 15.0	

TABLE 2 COMPARISON OF GRASSES IN ALFALFA MIXTURES AND GROWN ALONE, SASKATOON, 1972-1976, APPROXIMATELY 11 IN. SPRINKLER IRRIGATION PER YEAR

Grass and variety	Yield of hay t/ac 1972-1975 av		2nd cut as % of total		% alfalfa in mixture 1st cut	% grass stand 1976	
	Alfalfa mixture	Grass alone	Alfalfa mixture	Grass alone	1972-75 av	mixture	alone
Smooth brome							
Carlton	3.04	3.44	34	27	21	22	65
Magna	3.07	3.71	33	30	18	11	50
Saratoga	3.15	3.29	35	31	18	10	45
Baylor	3.24	3.51	37	28	21	6	12
S-7133	3.01	3.27	35	28	26	29	50
Meadow brome							
Regar	3.06	3.18	34	30	16	12	55
S-7385	2.89	2.74	41	26	67	0	0
S-7406	3.11	3.14	38	28	28	20	62
Crested wheatgrass							
Fairway	3.45	3.15	36	26	33	42	100
Parkway	3.57	3.41	36	28	34	40	95
Nordan	3.44	3.39	40	26	59	9	50
Summit	3.44	3.21	36	23	48	8	60
Tetra-Park	3.44	3.24	36	26	57	16	67
S-7171	3.54	3.15	36	25	47	10	60
Intermediate wheatgrass							
Chief	3.38	3.03	33	19	40	31	75
Greenleaf	3.23	2.91	34	22	32	24	75
Reed canarygrass							
Frontier	2.92	3.38	39	38	22	39	65
S-7358	3.05	3.30	40	36	31	28	62
Slender wheatgrass							
Revenue	3.29	2.97	38	30	55	0	0
Russian wild ryegrass							
Sawki	3.05	2.84	43	34	72	1	17
Fertilizer lb/ac/year							
N	66	125					
P_2O_5	30	37					

Measuring plant heights in crested wheatgrass under irrigation at Outlook, Sask. 1967.

wheatgrass, Greenleaf pubescent wheatgrass and reed canarygrass yielded well and persisted fairly well. However, slender wheatgrass and Russian wild ryegrass were dominated by alfalfa and were eliminated after 5 years.

Slightly over one third of the yearly production of grass-alfalfa mixtures was in the second cut. For grasses grown alone slightly less than one third of yearly production was in the second cut. Alfalfa far excelled grasses in regrowth, thus making greater yield of mixtures in the second cut. Reed canarygrass and Russian wild ryegrass showed best regrowth among the grasses, and intermediate wheatgrass showed the slowest recovery.

An interesting feature of this test was the serious decline in bromegrass stands in 1975 and 1976, especially when grown with alfalfa. Alfalfa stands were well maintained. It was expected that alfalfa would thin out faster than bromegrass, as is the case on dryland. The sensitivity of bromegrass to cutting in alfalfa mixtures has been noted in other areas, particularly Wisconsin, and this appeared the reason for the bromegrass decline.

Lodging was not a serious problem but was apparent in pure stands of Fairway crested wheatgrass, meadow bromegrass, and Saratoga bromegrass. Reed canarygrass and intermediate wheatgrass were very resistant to lodging. Weeds, especially dandelions, were fairly apparent by 1975 where grasses were thinned from winter damage. An interesting invader grass was hard fescue, *(Festuca ovina* var. *duriuscula* (L.) Kock.), which was seeded on roadways on two sides. Shattered seed from this early ripening grass made considerable inroads by 1976, thus showing its adaptation to irrigated conditions.

These tests for hay do not reflect the true value of the same grasses for pasture. The rapid recovery of Russian wild ryegrass after clipping and the good fall growth of meadow bromegrass make these grasses particularly desirable for pasture. In general, these tests indicate that the principal forages for dryland; namely, alfalfa, bromegrass, and crested wheatgrass are fully suitable for irrigation. Sufficient strain differences are present to warrant recommendation on a variety basis. ■

AN INTERNATIONAL WHEAT/WEATHER EXPERIMENT

H. R. DAVIDSON

L'Organisation mondiale de météorologie (OMM) a été créée par les Nations Unies pour étudier les phénomènes climatiques à l'échelle mondiale. La Commission d'agrométéorologie, chargée d'étudier tous les aspects des rapports entre le temps et les cultures, intéresse tout particulièrement les agronomes.

Climate, climatic change and meteorological phenomena have become topics of increasing interest in recent years. The World Meteorological Organization (WMO) was set up as an agency of the United Nations to deal with climate on a world basis. Its scope is very broad but one technical commission, the Commission for Agricultural Meteorology (CAgM), is of particular interest to agriculturists because it investigates all aspects of crop-weather relations.

The Commission created a Working Group on International Experiments for the Acquisition of Crop-Weather Data at its fifth session. In June 1972 the group met in Geneva and formulated plans for an international experiment on wheat/weather relationships. Canada has a history of active participation in the WMO and was present to serve as one of the founding organizers.

It was agreed that wheat should be used in the experiment because it is a staple food crop and is grown in many different climatic regions. The working group outlined their task as follows:

- Develop techniques for taking observations on wheat and its environment to evaluate the effect of weather/climate on its potential production and quality on an international basis.
- Define the observations and procedures necessary in conducting these trials.
- Arrange for the conduct of trials in a number of countries with differing climatic regimes.
- Arrange for the recording of the agrometeorological and biological data, for their collection centrally and transfer to punch cards.
- Review the techniques after the first year's experiments by correspondence, and try to finalize them.
- Submit a report on the progress of the experiments to the president of CAgM before the sixth session of the Commission, scheduled for October 1974.
- If possible, discuss the second year's results at an informal meeting during the sixth session.

The Geneva meeting in 1972 was a significant event in the history of agricultural science. This was the first attempt by any WMO technical commission to launch an international experiment spread over several years. Through the collaboration of agricultural meteorologists, comparable biological and meteorological data were to be collected in different climates and shared by all participants.

The experiment has been under way for 4 years. There are eight countries participating: Argentina, Brazil, Canada, the Federal Republic of Germany, Israel, Italy, Norway and the U.S.S.R. Each country provides one member on the working group. The Canadian member is from Agriculture Canada Research Station at Swift Current and at present is Dr. H. Davidson of the Environment Section. A representative from the Food and Agriculture Organization (FAO) is also included as a member because of the close cooperation between the two organizations and the importance that FAO attaches to the results of the working group.

Dr H. R. Davidson is an agrometeorologist with the Agriculture Canada Research Station, Swift Current, Sask.

The experiment is simple in design but broad in scope. It is a very efficient way of collecting data under a variety of meteorological conditions with a minimum of expense to the individual countries. There are 11 locations where the experiment is performed. Each participating country has one experimental site with the exception of Canada, Italy and the U.S.S.R. which have two because of the great variation in climate in their wheat growing areas. In Canada there is the site in Swift Current and a second one in Ottawa where the experiment is carried out under the direction of the Agrometeorology Section of the Chemistry and Biology Research Institute. A common variety of wheat, a Mexican variety called Sieta Cerros, is grown at the 11 sites. Each site also grows a home variety common to its area. For each variety, there are two planting dates, 15-30 days apart with two rates of fertilizer application at each planting. Records are kept of phenological stages, crop cover, number of tillers, number of mature heads, plant dry weights at two stages, final yields and average grain weight. Tests of baking quality are also done. Detailed meteorological observations of radiation, wind, ambient air temperature and soil temperature at three depths are taken on an hourly basis. Daily records of precipitation and weekly soil moisture readings are also recorded.

At the end of the crop year the data are tabulated and sent to the chairman of the working group, Professor J. Seemann of the Federal Republic of Germany, where they are put on computer magnetic tape. There has been a large volume of information acquired during the last 4 years. For the Mexican variety of wheat alone, considering there are two planting dates and two fertility levels, there are 176 experiments for analysis.

The working group last met in Rome on May 3, 1976 when it was agreed that experimental work should cease at the end of the present crop year and importance be placed on the analysis of data. Simulations of plant growth were emphasized as a technique for analysis because they have the advantage of relating meteorological parameters directly to plant growth. In addition, they can be used to predict yield and to perform preliminary studies on the feasibility of growing wheat at a given location providing the meteorological normals are known for that area. Sub models for soil moisture and phenological stages were also named as important. All participants were requested to try to develop such models and report to the chairman of the working group by mid 1978. The group hopes to meet again in 1978 to discuss the experimental results and analysis and to decide on the final report to be presented to the WMO.

The results of the experiment should prove to be of much scientific value, and of particular importance to Canada, as it is one of the major grain exporting countries. They should prove valuable because the purpose of the experiment is to compare the effects of climatic factors on the growth of wheat in different parts of the world so they can be better understood and predicted.

The spirit of cooperation shown by the members of the working group and their success thus far in performing a task of considerable difficulty can be judged as a major achievement in itself. This speaks well for future international cooperation in the agricultural sciences. ■

The 1974 experimental plots at Swift Current, Saskatchewan. The eight treatments are surrounded with a border of Manitou wheat. The walkway separating the treatments is sown to winter wheat and trimmed with a mower.

BREEDING DESSERT APPLES

W. DAVID LANE and H. SCHMID

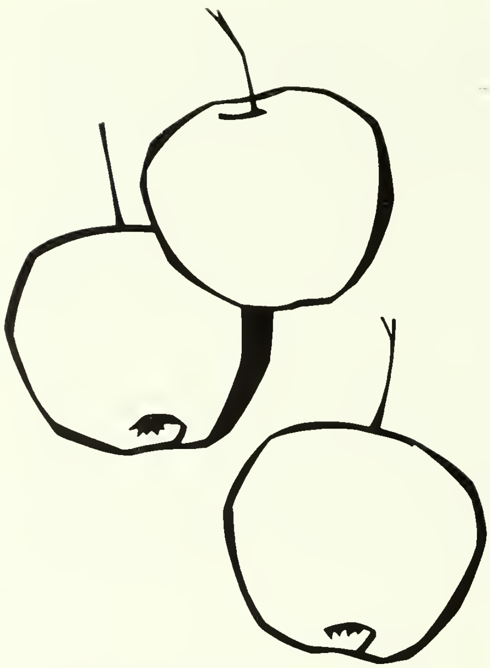
La productivité et la résistance aux maladies sont les deux caractères les plus difficiles à introduire dans une nouvelle variété. Généralement, les variétés les plus productives sont des mutants naturels des variétés communes de type "spur". Deux méthodes ont servi à produire des pommiers de ce type

Imagine the perfect apple — one that is uniform in color and shape, has a crisp breaking texture, is juicy and has a delicious flavor and aroma surrounded by a sweetness balanced with just the right amount of tanginess. At the Summerland Research Station, work is under way to develop just such an apple.

This fruit has always been appreciated for its distinctive taste. Hence, in the development of new varieties of dessert apples, it is imperative that their eating quality, including appearance, be superb. Otherwise, it will be difficult to compete successfully with presently popular varieties. The producer, as well as the consumer, must consider the new introductions to be better than varieties presently available.

Incorporating the necessary fruit quality is a relatively easy step, achieved by combining the best attributes of the 200 or so named apple varieties in our collection at Summerland. Unnamed selections resulting from previous crosses are also used.

The next requirement is to ensure that hardiness is sufficient to avoid serious damage in our commercial apple growing areas. At least three



components of hardiness are evaluated: the susceptibility of the trunk and major branches to damage from extreme cold during midwinter; the susceptibility of roots to cold damage, which usually happens if severe cold occurs before there is sufficient snow cover to insulate the roots; and the tendency of flower buds to begin growing in the early spring if there is a warm spell, thus predisposing themselves to damage by losing dormancy too early.

Several varieties which possess excellent fruit quality are available as sources of hardiness. The best example is McIntosh, found growing as a wild seedling on the McIntosh homestead, Matilda Township, Dundas county, Ontario, in 1797. Under natural conditions the best seedlings survive after a particularly cold winter has taken its toll. Several other means are available to compare selections and varieties for hardiness. One of these is to artificially freeze branches in a cold chamber which is programmed to cool at a predetermined rate. The shoots and blossoms are then forced and rated for damage. Other methods depend on measuring electrolytes leached from cells which are damaged during freezing.

The two most difficult attributes to incorporate into a new variety are productivity and disease resistance. Currently, the most productive varieties are naturally occurring mutants of common varieties known as "spur-types". Most have been found in commercial orchards. They produce fewer branches and grow less vigorously than the parent variety and so are more easily trained to a convenient size and shape. Spur-type trees also usually have stronger apical dominance and more upright branches, they flower precociously and have many more flower-bearing spurs per length of branch than standard varieties. Early fruiting, high production and small tree size combine to make spur-types horticulturally superior to standard varieties. The trouble is that, so far, we have been unable to genetically transmit the high yield from most spur types. However, one atypical spur-type mutant, discovered by retired Summerland Research Station breeder, Dr. K. O. Lapins, has been found to have a single dominant gene controlling spurriness and has been used in many crosses. However, further research using this spur is necessary to improve fruit quality, increase fertility, and reduce uprightness/stiffness in the branches.

Two other approaches have been used to produce spur-type trees. Named varieties with some characteristics of spur-types have been crossed and large seedling popula-

Dr Lane and Mr Schmid are fruit breeders at the Agriculture Canada Research Station, Summerland, B C

Figure 1. Standard variety with many thin branches and few fruit-bearing spurs.

Figure 2. Spur-type variety with strong upright branches and many fruit-bearing spurs.

tions obtained from which those most resembling spur-types were chosen. In the next generation we may be able to incorporate acceptable fruit quality and hardiness.

Ionizing irradiation can be used to induce mutations and we have used this to increase the frequency of mutation to spur-type growth habit. Using this technique, it is possible to improve existing varieties as well as unnamed hybrids from the breeding program. The procedure is relatively simple but requires several years of evaluation to determine the suitability and stability of the mutants. Dormant scions are irradiated at a dose lethal to 30% and then grafted on healthy non-irradiated rootstocks and grown either in the greenhouse or nursery. Spur-types can be identified very early by their leaves, which are closer together, and by their branches, which are thicker than non-spurs of the same length. Five trees of each promising mutant are propagated and detailed measurements of their growth and fruit habit are made in replicated plantings. The best selections remaining after these tests are repeatedly repropagated to ensure that the mutant is pure and not a mixture of normal and mutated cells.

Mutants resulting from irradiation can also be screened for resistance to fungus diseases and insects. This method would appear to offer an alternative to the traditional methods of breeding for resistance to diseases and insects which now takes several generations and many years of careful work.

Incorporation of all the attributes which would result in the perfect apple is certainly not an easy task. However, the breeding of dessert apples continues at Summerland in an effort to accomplish this. ■

WHY HERBICIDES SOMETIMES FAIL

P. N. P. CHOW

Les agriculteurs se plaignent souvent de l'inefficacité des herbicides et des dégâts qu'ils causent aux cultures. Une enquête a fait ressortir la nécessité de respecter soigneusement les doses et modes d'emploi recommandés. D'autres facteurs, tels les effets du milieu sur l'activité des herbicides, la gestion du sol, la densité des mauvaises herbes et les contraintes climatiques sur les plantes, méritent également attention si on veut assurer un désherbage efficace sans endommager les cultures.

Results of a study done at the Brandon Research Station stress the importance of strict adherence to recommended herbicide application rates and techniques for maximum weed control and crop safety

Several complaints concerning poor weed control and crop injury are received from farmers each year. However, the number received last year was high. To gain further information on this problem, we conducted a survey last October from the Brandon Research Station. The author thanks provincial weed specialists, coordinators and municipal weed supervisors for collecting questionnaire information and making the survey possible.

Our questionnaire, which listed eight registered wild oat herbicides, was distributed to farmers who had encountered herbicide problems in 1976. We got back 160 questionnaires indicating that most complaints related to poor control.

Most farmers reported that hot, dry weather was the main cause of herbicide failure (Tables 1 and 2). Some 72% of the farmers indicated that abnormal weather was a major factor contributing to poor weed control with preplanting soil incorporated herbicides. In low-lying areas, particularly along sloughs on clay soil, excessive soil moisture derived from heavy snow did not permit good seedbed preparation. Lumpy soil prevented uniform spray coverage resulting in poor weed performance in 2% of the cases. For fall-applied herbicides, the heavy trash cover made use of the press drill almost impossible and did not permit herbicide incorporation into the moist soil layer. Extremely dry soil and high winds caused chemical losses along with drifting soil before the chemical could be incorporated into the soil.

We found that dry, hot weather was the major factor responsible for 33% of the cases of poor weed control after the application of post-emergence herbicides. Also, a 10-day period of continuous rainfall in early June either washed away the applied herbicides or delayed their application, so that a second flush of weeds germinated. All these factors combined accounted for about 25% of the cases of poor weed control.

Other factors listed in Tables 1 and 2 included shallow harrowing instead of discing, low application rates due to misinformation and lack of clarity in the instructions, malfunctioning sprayers and problems with the formulations.

Crop injury was reported for trifluralin (Treflan) to wheat and flax, triallate (Avadex BW) to wheat, asulam (Asulox F) and EPTC (Eptam) to flax, barban (Carbyne) to wheat and flax, and benzoylprop-ethyl (Endaven) to wheat. Causes of injury were not assessed.

During the early part of the 1976 growing season, drought conditions were experienced until early June, which was followed by continuous rain for more than 10 days. A hot, dry period extended into July. Most farmers recognized that these abnormal conditions were responsible for poor chemical weed control and crop injury.

Preplanting soil incorporated herbicides Triallate and trifluralin are extensively used for wild oat control in cereal and oilseed crops, and EPTC is used in flax and sunflower. These herbicides are highly volatile

Dr Chow is a weed physiologist at the Agriculture Canada Research Station, Brandon, Man

and require soil incorporation after application. Trifluralin is subject to photodecomposition if not incorporated into the soil immediately. Also, incorporation ensures better control by placing the herbicide in closer contact with wild oat seeds.

Warm, dry soil and strong winds favor vaporization and loss of herbicides. The poor control of wild oats obtained with triallate after shallow incorporation is partly caused by herbicide depletion from the drying out of the surface layers of the soil during a dry period.

On the other hand, excessive moisture in soil also accelerates volatilization of herbicides such as trifluralin, resulting in poor weed control. The volatilization of trifluralin increased as soil moisture increased. High moisture content may also block the active sites of trifluralin adsorption on soil particle surfaces. Colloids may become hydrated and adsorptive sites less accessible to the hydrophobic trifluralin molecule. Unadsorbed trifluralin molecules would then diffuse more rapidly into the atmosphere. The volatility of trifluralin also increases with increasing temperature. Degradation of trifluralin is increased in moist soil resulting in decreased weed control.

Poor weed control with EPTC was due to the loss of the herbicide from the hot, moist soil by volatilization. The loss was 23, 49 and 69% after one day on dry, moist and wet soil, respectively. EPTC was lost at a faster rate on sunny days than cloudy days. Increasing the temperature from 0°C to 16°C increased the rate of EPTC vaporization from moist soil. The deeper the EPTC was incorporated into moist soil, the better it was retained.

Postemergence applied herbicides There is limited information on postemergence applied wild oat herbicides. Barban should not be applied later than the 2½ leaf stage (14 days after emergence) of wild oats, since in some years, they reach a resistant stage very early. In some cases, wild oats were not controlled at 32°C with rates up to 1.4 kg/ha.

When barban is applied at rates higher than those recommended, crop injury may occur. At rates of 0.56 and 1.12 kg/ha, some injury occurred to wheat in the form of stunting, thinning and occasionally, reduced yields. Wheat injury was greatest when barban was applied during a period beginning about 15 days after crop emergence and continuing for several weeks. The environment is another major contributing factor to crop injury. Wheat and wild oat susceptibility to barban increased as the temperature decreased from 32 to 10°C. Therefore, barban applications should be either delayed if cold weather is forecast or the lower rates should be used to avoid possible injury.

The toxicity of trifluralin to both wheat and green foxtail appears to decrease with an increase in the organic matter content of the soil.

Flax is very tolerant to diallate and triallate, barley is moderately so, and wheat is the least tolerant. Wheat can be seriously damaged if sown in treated soil. Its injury can be avoided or reduced if planted 1.3 cm or more below a layer of treated soil. Damage to wheat is most severe on heavy clay soil which is low in organic matter.

This survey underlined the need for strict adherence to recommended herbicide application rates and techniques. Close attention should be paid to environmental influences on herbicide activity, soil management, weed density and weather stress on plants to assure maximum weed control and crop safety.

After application, herbicides in plants or in the soil are complexly influenced by the environment. More research is required to assess this interaction. Research may develop techniques to overcome or reduce these environment-herbicide stresses and also explain why the performance of some herbicides failed under conditions of stress. ■

TABLE 1 CAUSES OF POOR WEED CONTROL AND CROP DAMAGE WITH PRE-PLANTING SOIL INCORPORATED HERBICIDES.

Poor Weed Control						Crop Injury
Environmental					Other	
Dry Hot	Too Wet	Strong Wind	Too Much Trash	Lumpy Seedbed		
%						
72	2	2	4	2	8	9

TABLE 2 CAUSES OF POOR WEED CONTROL AND CROP DAMAGE WITH POST-EMERGENCE APPLIED HERBICIDES.

Poor Weed Control							Crop Injury
Environmental						Other	
Dry Hot	Too Wet	App. Late	2nd Flush Wild Oats	Heavy Infest	Other Weeds		
%							
33	4	7	9	2	2	22	20

BIOLOGICAL CONTROL OF FUSARIUM

W. R. JARVIS

Une nouvelle maladie cryptogamique transmise par le sol s'est déclarée dans les cultures de tomates de serre du sud-ouest de l'Ontario et d'autres régions. Les phytopathologistes de la Station fédérale de recherches de Harrow préconisent une méthode de lutte biologique pour l'enrayer.

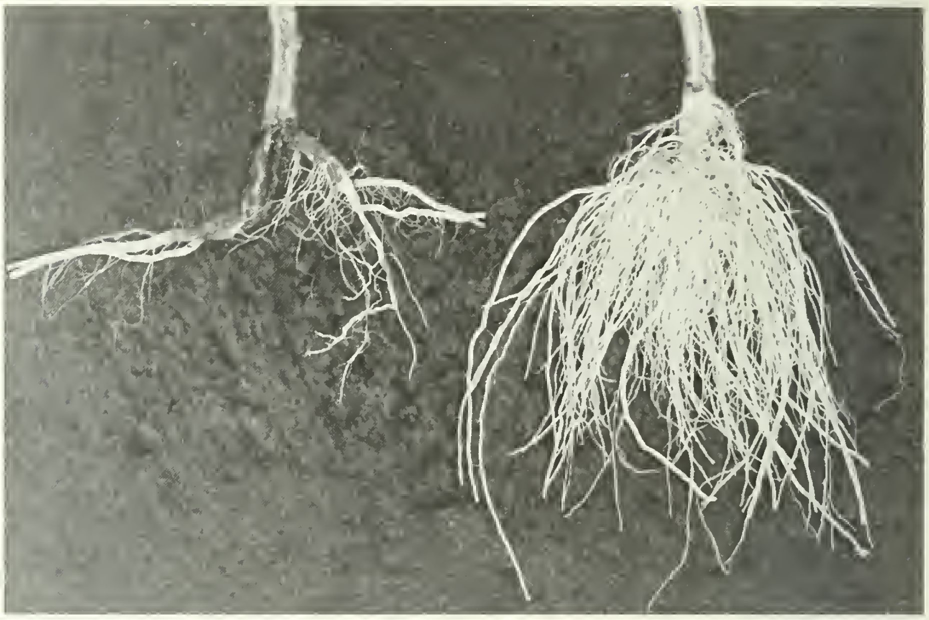


Figure 1. Fusarium foot and root rot of tomato. Left, diseased; Right, healthy.

In southwestern Ontario, particularly the Leamington area, there are about 100 ha of tomato greenhouses. In the spring of 1974, many of the crops were ravaged by a new disease caused by *Fusarium oxysporum*. The fungus appeared simultaneously in greenhouses in British Columbia and Ohio, and in winter field crops in Florida.

There is a tomato wilt disease caused by a closely related fungus, *Fusarium oxysporum* f. sp. *lycopersici*, which is quite well known. This fungus causes no external rotting, but the vascular system becomes blocked and the plant wilts. The new disease, however, has different symptoms. It is a soil-borne fungus which rots off the tap root and the stem base wherever adventitious roots break through it. Similarly, it attacks the main roots wherever secondary roots emerge so the root system is considerably reduced (Figure 1).

Although seedlings can be easily infected, the disease is not usually obvious until the plant is producing its first ripe fruit. Then it collapses, at first temporarily in the heat of the day or until some of the fruit load is removed. Sometimes, if the fruit is picked very frequently, the weather becomes cooler, or the base of the plant is mounded up with soil to encourage adventitious root production, the plant may survive to produce a crop of somewhat lacklustre fruit. More often, however, the plant will die quickly and sometimes up to half the plants in a greenhouse will die.

There is a second important difference between the two diseases. Whereas *Fusarium oxysporum* f. sp. *lycopersici* can be controlled by a combination of soil sterilization and resistant cultivars, the new *Fusarium oxysporum* has eluded all attempts at control by fungicides, resistant cultivars and soil sterilization. Some 20 fungicides proved either ineffective, no matter how they were applied, or else moderately effective at the expense of uneven plant stands and phytotoxicity. No commercial tomato cultivar, either in the greenhouse or field, is resistant to the disease and only a few resistant *Lycopersicon* species and hybrids that are distant relatives of the commercial tomato have been found.

In all other soil-borne diseases of greenhouse crops, the standard recommendation is for sound greenhouse hygiene and complete soil sterilization. In this case, however, it was often found that the best of greenhouse managers had the worst outbreaks of the disease, while those who took less trouble with hygiene between spring and fall crops escaped with little or no disease.

Using experimental groundbeds, we found that plants transplanted in a newly-steamed groundbed developed a mean disease rating of 3.64 on a 1-5 scale, those transplanted in a Vorlex-fumigated one had a rating of 2.40, and those in an unsterilized one that had just borne a tomato crop had a rating of only 1.86.

These observations and results

Dr. Jarvis is Head, Plant Pathology Section, Agriculture Canada Research Station, Harrow, Ont.

suggested two main hypotheses. One was that the fungus could survive somewhere in or near the greenhouse and could reinvade newly sterilized groundbed and potting soils very quickly and the other was that some form of biological control operated in the indifferently cleansed greenhouses.

We soon found that the fungus could indeed survive as highly resistant chlamydospores below the level of effective steam sterilization (about 50 cm) in groundbeds and on headerhouse floors, (sometimes dirt floors) and on the ground outside greenhouse doorways where machinery had passed and trash piles had been deposited. Work in Ohio showed that the population of the fungus could increase a millionfold within a week in newly sterilized groundbeds, apparently arriving there as airborne microconidia. These two findings readily explained the rapid reappearance and devastating effect of the fungus in new crops despite excellent hygiene operations within the greenhouses.

Spurred by the knowledge that we had no conventional means of controlling the disease, we looked into the possibilities of controlling the fungus by exploiting its natural competitors, antagonists and parasites present in relatively unsanitary conditions of greenhouses receiving no special treatment between spring and fall crops.

First, we saw that at each stage of plant propagation, that is, the seedling tray, the peat-vermiculite planting block or pot, and the groundbed stages, a sterile planting medium permitted uninhibited access of *Fusarium oxysporum* to the plant when it was introduced into the medium in any form whatsoever. By not sterilizing these media, we were able to almost completely protect the plant from an added inoculum. We could also protect plants almost entirely from infection, provided we introduced nonsterile peat moss or field soil into any of the sterilized propagation media before the pathogen inoculum. Some of the results are summarized in Table 1.

While our field soil, taken from a remote fallow plot, was highly effective in controlling the fungus, we realize it would be very unsound

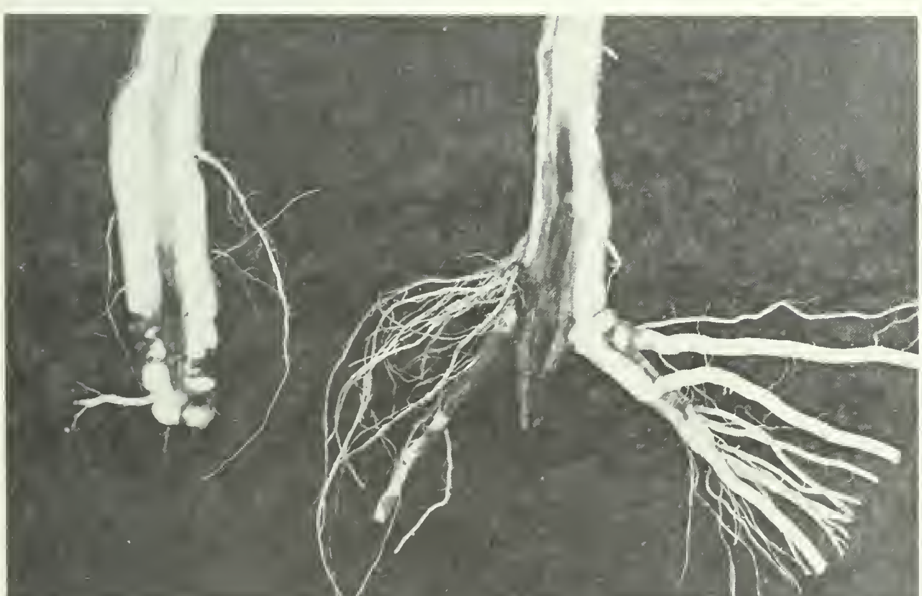


Figure 2 The stem bases are split open to show rotting where the fungus has entered the stem via adventitious roots (left) and a chocolate brown discoloration extends up inside the stem Both tap roots have been rotted off Note (right) infections on the main roots where secondary roots emerge

Figure 3 The stem base split open to show how roots emerge from deep within the stem and cause wounds invaded by the fungus Note the discoloration extending up the stem It differs from the wilt caused by *Fusarium oxysporum* f sp *lycopersici* in that the vascular system in the wilt disease is discolored throughout the plant; here, discoloration is restricted to about 10 cm

TABLE 1 INCIDENCE OF FOOT AND ROOT ROTS, CAUSED BY FUSARIUM OXYSPORUM IN SEEDLINGS AND TRANSPLANTS OF TOMATO, CV. MR. 13, IN STERILIZED AND UNSTERILIZED PEAT-VERMICULITE AND WITH RAW FIELD SOIL AMENDMENT. TRIALS I AND II.

Treatment of peat-vermiculite mix	I Percent seedlings with		II Percent transplants	
	Stem rot	Root rot	Stem rot	Root rot
Steam-sterilized + *F. Oxysporum* inoculum	62.7	83.9	80.0	93.3
Steamed + field soil + inoculum	4.7	7.4	16.6	33.3
Not steamed + inoculum	18.3	21.7	0	0

advice to recommend that growers reinfest newly-sterilized groundbeds with a sprinkling of soil taken from a nearby field. Not only is the risk of reintroducing *Fusarium oxysporum* high in an area such as Leamington, where greenhouses are so numerous and are interspersed with tomato fields, but there is also the risk of introducing tomato mosaic virus, nematodes, bacterial canker and various other fungal diseases such as damping-off, Verticillium wilt and even *Fusarium oxysporum* f. sp. *lycopersici* wilt. Far less chance of such introductions would arise from the use of unsterile peat moss for making seedling and potting mixes and for amending newly sterilized groundbeds.

All commercial seedling and potting mixes in southwestern Ontario are steam-sterilized. Their amendment by the addition of peat moss from newly opened bales should greatly reduce the incidence of disease at the susceptible early stages of plant propagation. Also, the incorporation of fresh peat moss into groundbeds as soon as possible after steaming or fumigating should greatly reduce the risk of groundbed reinfestation. Thus, it seems we shall have a cheap, simple and effective biological control of this disease and time will tell whether our expectations will be realized in commercial conditions. Meanwhile, work is proceeding to identify the biological control agents present in raw peat moss and field soil, and investigation of the possibilities for killing pathogens in the growing media through pasteurization. With luck, thermophilic and biologically-controlling organisms will survive the pasteurization process. ■

ECHOES FROM THE FIELD AND LAB

ECHOS DES LABOS ET D'AILLEURS

THE GREAT GRAIN TURNOVER Turning grain on cold winter days to kill insects is a common practice at country and terminal elevators. Cereal crop researcher Lawrie Smith at Agriculture Canada's Winnipeg, Man., Research Station says farmers could adopt the same practice on the farm to allow the intense prairie cold to work for them. Even on extremely cold days the center of a storage bin stays warm enough for some insects to survive unless the grain is turned or moved, Dr. Smith says.

THE ADA The automatic digital analyzer, or ADA as it's called by the Canadian Grain Commission in Winnipeg, is a sophisticated machine used for measuring protein content in wheat. The ADA has worked well enough so far that the Grain Commission is beginning to look at it as the protein tester of the future. The Commission has been using the ADA since June, 1975, and it can test up to 2,500 grain samples per day at one-third the cost of the older chemical Kjeldahl method by which only about 800 samples per day can be tested.

CASHING IN ON A SURPLUS Following a tour of Switzerland, Agriculture Canada potato breeder Andy Russell of the Morden, Man., Research Station has come up with a way of making good use of surplus potatoes.

He says surplus potatoes could be dehydrated for livestock feed by making slight modifications to existing alfalfa dehydration plants and using them to process potatoes in the fall and winter months. In Switzerland, drying plants handle a variety of farm products at various times of the year.

FEEDING THE HUNGRY More than 90 percent of the Canadian wheat shipped to developing nations finds its way to hungry people despite transportation and storage problems.

Dr. Fred Watters, head of cereal crop protection at Agriculture Canada's Winnipeg, Man., Research Station and a consultant to the Food and Agriculture Organization of the United Nations, found out first-hand how Canada's wheat is handled when he visited Yemen, Nepal, Sudan and Chad in 1975. He says he was heartened to see that such a high proportion of grain food aid was reaching its destination.

LIVESTOCK GUARD DOGS There is a type of livestock guard dog, called a komondor, which has been bred almost exclusively to protect livestock against predators. Its ancestry goes back 6,000 years, when the dogs were apparently used in the Middle East to guard livestock. According to Tom Seaborn, who breeds komondors, and who is Alberta Agriculture's district agriculturist at Rocky Mountain House, these dogs are intelligent and easily trained. He says as guard dogs for livestock, they are unsurpassed.

According to Mr. Seaborn, the United States Department of the Interior started using komondors on an experimental basis for predator control work three years ago. They have apparently proved so successful at controlling predators in those parts of the United States where they have been used that the American National Cattlemen's Association has set up a komondor predator control committee in conjunction with their helicopter and cyanide control committees.

ORGANIC MATTER SUPPLY IN SOIL There is no single answer to what constitutes a good supply of organic matter in the soil. The level of organic matter in the soil always changes to be in equilibrium with its environment. Dr. J. F. Dormaar, soil chemist at the Lethbridge Research Station, says they are fortunate there that many years ago scientists established rotations with a variety of cultural practices. He says some of these rotations may not be valid today, but they still allow them to study how the organic matter in the soil changes.

The soil of a number of these long-term field experiments is being examined in an attempt to measure in terms of crop yields the effect of cultural treatments on organic matter levels. Such cultural treatments include different types of rotations, stubble burning, seeding of cultivated grasses and grazing.

Dr. Dormaar says there is no arbitrary organic matter level that must be maintained, what is needed is adequate organic matter but adequate is a variable quantity.

WHY NOT PORK? Agriculture Canada's Food Systems Branch believes pork should be more popular with the hotel, restaurant and institutional trade in Canada. Only two pounds of pork are eaten for every 10 pounds of beef consumed in the hotel, restaurant and institutional trade, although on an overall per capita basis Canadians eat five to six pounds of pork for every 10 pounds of beef.

The answer to this problem is believed to be promotion. People must be convinced that pork is as delicious and nutritious as other meats. Agriculture Canada's Food Advisory Services has listed a few plus points for pork: it supplies high quality protein essential to growth and good health; it is an excellent source of thiamine and niasin (B-vitamins); it is a good source of phosphorus and iron — pork liver is an excellent source of these minerals as well as Vitamin A, riboflavin and niasin; the lean portions of cooked pork contain about the same amount of calories as the lean of other meats.

STORING HIGH MOISTURE WHEAT Scientists at the Agriculture Canada Research Station at Winnipeg have been investigating the use of hermetically sealed, air-tight storage for high moisture wheat. Initial tests revealed some limitations that might be overcome by lowering the storage temperature.

Mr. Ben Berck, a specialist in fumigant chemistry at the Research Station, reports that later tests confirm the earlier indications. Seeds of hard, red, spring and durum wheats, and of flax and rapeseed, with a moisture content ranging from 8.5% to 22.5%, were stored for up to 7 months at temperatures from 4°C to 7.5°C. At the end of the storage period, the seeds had greater than 95% germination and no resultant deterioration in baking, milling, or processing qualities.

Hermetic storage at low temperatures has useful potential for storing high moisture cereals until they can be dried; this method controls molds and insects without introducing chemicals that leave residues.

BETTER BLUEBERRIES The 1975 blueberry crop was 9.9 million pounds and returned 2.7 million dollars to growers. Agriculture Canada is working closely with the Blueberry Growers Association of Nova Scotia to provide technical support to this promising crop.

Dr. I. V. Hall at the Research Station at Kentville is working on developing new varieties of lowbush blueberries for commercial plantings. Beginning in 1961, he and Dr. L. E. Aalders searched wild blueberry fields for outstanding clones. Underground stem pieces were brought back to Kentville where they were grown, multiplied, and tested further.

One new variety, Augusta, developed from a blueberry from Maine has already been named. Three more varieties from native New Brunswick stock are expected to be released soon: one will be ready shortly and the other two after the 1976 trials.

DETECTING LITTLE CHERRY A fast and simple method has been developed at the Research Station, Vancouver, to detect little cherry disease, a serious threat to cherry trees in the Okanagan Valley. Early detection is important because the disease has no known treatment; affected trees must be removed to control its spread.

The new method of detection was developed by Dr. Linda Verbeek, a visiting scientist from the British Columbia Department of Agriculture (BCDA). She worked in cooperation with Harry O'Reilly, head of BCDA's plant pathology branch. The technique involves microscopic examination of tiny slices of tissue.

It should be possible to test up to 70 trees a week using the new method. Moreover, the technique can be used throughout the growing season because parts of the cherry leaf can also be used as specimens. The previous method of visual diagnosis could be used only during the 10-day fruit ripening period in July.

Some refinement is needed before the new technique can be depended upon entirely, but it does offer B.C. cherry growers some encouragement against little cherry disease.

DRYING FRUIT Drying as a food preservation method is receiving increased attention by energy-conscious consumers. Drying fruits requires little energy and storage space. Inexpensive containers can be used.

Food consultant Dorothy Britton at Agriculture Canada's Summerland, B.C., Research Station says dried fruits are a lightweight, high-energy food – more nutritious than most snack foods. She has prepared a leaflet, Home Drying of B.C. Fruits, which can be obtained by sending a stamped, self-addressed envelope to the Summerland Research Station food processing section.

INFORMATION
Edifice Sir John Carling Building
930 Carling Avenue
Ottawa, Ontario
K1A 0C7

Canada Post Postage paid
Postes Canada Port payé
Third class
Troisième classe
K1A 0C5
Ottawa

IF UNDELIVERED, RETURN TO SENDER   EN CAS DE NON-LIVRAISON, RETOURNER À L'EXPÉDITEUR

Love Printing Service Limited
Contract No. 03KX 01A08-5-38262