



**SUMMER 74
ÉTÉ 74**

Commercial vineyards are healthier due to CDA's plant protection programs. See story page 3.

Les vignolles commerciaux sont maintenant plus sains, grâce aux programmes de protection des végétaux d'Agriculture Canada. Voir texte en page 3.

CANADA AGRICULTURE



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VOLUME 19 SUMMER 1974 NO. 3
VOLUME 19 ÉTÉ 1974 N° 3

JOURNAL OF THE CANADA DEPARTMENT OF AGRICULTURE—OTTAWA REVUE DU MINISTÈRE DE L'AGRICULTURE DU CANADA—OTTAWA

MINISTER, HON. EUGENE WHELAN, MINISTRE

DEPUTY MINISTER, S. B. WILLIAMS, SOUS-MINISTRE

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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.

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KEEPING HORTICULTURE HEALTHY

D. W. MACDONALD

La Station de quarantaine de Sydney (C.-B.), administrée conjointement par la Division de la protection des végétaux et la Direction de la recherche, décèle les infestations dans les produits de pépinière et de sélection destinés à l'horticulture canadienne. La Station fait un triage de tout le matériel de multiplication des arbres fruitiers et de la vigne importé au Canada, à moins qu'il ne provienne d'un plan de certification reconnu. L'indexage des divers virus est une opération complexe et critique.

In 1939, a B.C. fruit grower bought some Granny Smith apple trees from a New Zealand nurseryman. The trees showed no symptoms of virus infection, and they grew well under Okanagan growing conditions. In 1958, when scions were required for virus host studies at the Summerland Research Station, wood from the imported trees was selected, and budded on McIntosh.

Two years later, the McIntosh fruits showed disease symptoms that had not previously been observed in western North America. A new disease had inadvertently been introduced into the country. While it remained hidden in Granny Smith, it

seriously degraded McIntosh by inducing misshapen, russeted fruit. The original Granny Smith trees and all others propagated from them eventually had to be destroyed.

This incident illustrates the virus problem in horticultural plantings. Orchards and vineyards in Canada already contain numerous viruses, and introduction of others run the risk of debilitating tree vigor and reducing the production of fruit.

Some viruses, of course, are more serious than others. Little cherry, introduced through Japanese flowering cherry trees some years ago, destroyed the cherry crop in B.C.'s Kootenay Valley by 1950. It has now occurred in the Okanagan Valley, causing real consternation among cherry growers in that area. Plum pox has ravaged stone fruit orchards in continental Europe for many years. The virus could mean the end of the best varieties of plum, peach and apricot if it ever gained entry into Canada.

The horticultural industry needs protection against contaminated nursery and breeding stock. It also needs technical assistance to clean up viruses already established in orchards and vineyards, particularly new varieties or introductions.

Viruses are responsible for many symptoms including modification of tree habit; tree decline; dwarfing; delayed emergence from dormancy; stock-scion incompatibility; mottling; chlorotic flecking; puckering and necrosis of leaves; and russetting, pitting, blotching and deformity of fruits.

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



Don Bertoia views growth chamber where virus infection is removed from valuable horticultural varieties by heat therapy.



Virus-tested clones are grown in isolation in screenhouse repository.

A virus may not show visible symptoms in one host, and may demonstrate different symptoms in other hosts. This makes detection and identification difficult, especially in the latent form, and it may be necessary to observe its reaction on one or more indicator plants for positive identification.

In the 1950's, Dr. Maurice Welsh of the Summerland Research Station recognized the danger of viruses becoming widespread through distribution of contaminated nursery stock and he initiated measures of detection and indexing with a view to certifying their absence from certain stocks. The wisdom of Dr. Welsh's work was soon apparent when in 1966 the United States announced an embargo on all tree fruit nursery stock entering that country. Fortunately, Dr. Welsh and officials of CDA's Plant Protection Division were able to convince authorities in Washington that Canada had the expertise and knowledge to guarantee stocks free of certain viruses.

Generally, viruses do not spread rapidly in an orchard. They are not usually transmitted by the wind, through the soil, by insects or even by normal contact. The best defence against viruses, therefore, is to plant virus-free stock. There is reasonable expectation that trees free of virus at planting time will escape infection for a number of years, particularly if precautions are taken to avoid introduction. There are exceptions, of course, particularly among stone fruits. Certain viruses, notably plum pox, are difficult to

control because they are spread by common insects, and some cherry viruses are pollen transmitted.

The Canadian horticultural industry has protection under the Plant Quarantine Act, which supercedes the Destructive Insects and Pests Act on July 1, 1974. All plant importations are examined at their point of entry by officials of the Plant Protection Division. If certification by the country of origin is acceptable in this country, shipments are released immediately to the purchaser or importer.

Visual inspection is not always sufficient, however. Imports are normally directed to the Post-Entry Quarantine Station at Sidney, B.C. (formerly Saanichton), on Vancouver Island. The station, established in 1965, is operated jointly by Agriculture Canada's Plant Protection Division and Research Branch on 20 acres of land at the Sidney Research Station, where screen-houses and laboratory space for research, testing and indexing work are available.

The professional staff engaged at the Quarantine Station include Don Bertoia, the officer-in-charge, and Alan Oliver, who recently joined the staff following special training in virus indexing. A number of skilled technicians and plantsmen assist in the operation. All work is under the immediate supervision of the Director of the Sidney Research Station, H. Andison.

The Post-Entry Quarantine Station has the task of screening all tree fruit and grape material from

outside Canada unless it comes from a recognized certification scheme. As of January 1974, 1,394 samples of foreign and domestic origin had been tested for viruses. The station also serves as a repository for imported materials that indexing has shown to be free of virus infection. Approximately 270 tree fruit and grape plants are presently being maintained in the repository as foundation for propagation stock. An advisory committee of six scientists from across the country decides whether release of tested fruit tree and grape stock will be permitted. The committee is composed of:

Mr. H. Andison, (Chairman),
Director,
CDA Research Station,
Sidney, B.C.

Dr. W. P. Campbell, Chief,
Plant Inspection and Quarantine,
CDA Plant Protection Division,
Ottawa.

Dr. C. J. Bishop,
Research Coordinator (Horticulture),
CDA Research Branch,
Ottawa.

Dr. H. F. Dias,
Grape Virologist,
CDA Research Station,
Vineland, Ontario.

Mr. Don Bertoia,
Officer-in-Charge,
Post-Entry Quarantine Station,
Plant Protection Division,
Sidney, B.C.

Dr. M. F. Welsh and Dr. J. Hansen,
CDA Research Station,
Summerland, B.C.

When clones arrive at the Station, they are fumigated with methyl bromide and each one on test is assigned a quarantine number. It is immediately perpetuated on three appropriate virus-free rootstocks and maintained in the screenhouses as mother plants during the duration of the test. Grape cuttings are rooted and maintained in the screenhouses as well.

Indexing procedures at Sidney are critical, and are very involved and complex. For example, each tree fruit clone is indexed with seven indicators, requiring 21 rootstocks and 84 budding operations. It may take several years to detect a virus using woody type indicators. It takes as long as is required for the variety to bear fruit—a minimum of 2 or 3 years in the case of apples, and often considerably longer.

Annual herbaceous plants are now being used as indicators to augment woody indicators, and certain viruses can be screened out in 6 to 8 weeks. For example, all foreign stone fruit clones are indexed on cucumber to eliminate those clones infected with Prune Dwarf and Ring Spot viruses. It is expected that herbaceous material will also be used extensively



Freshly budded fruit tree rootstocks take hold in shadehouse.

Grape indexing plot at the Post-Entry Quarantine Station, Sidney, B.C.





Screenhouses hold mother plants in isolation.

Rootstocks required in virus-indexing program are propagated in stoolbeds.



in the future to detect specific viruses in grapes.

Herbaceous indexing of pome fruits has not been fully implemented because of the low chance of success. Work to improve the method is continuing since the potential time saving is great.

Foreign certification schemes are verified by taking samples and using a reduced indicator range to detect significant viruses such as Proliferation, Rubbery Wood, Mosaic, Flat Limb, Little Cherry, Stecklingberg and Plum Pox viruses.

Viruses can sometimes be eradicated altogether from woody plants through heat therapy. The main work on heat therapy at Sidney has been to free apple and pear clones of viruses. This is done by budding the infected clones onto an apple or pear seedling, which is placed in cold storage, preconditioned, then grown in a chamber at 100°F for 3 to 4 weeks. Virus-free shoot tips are then taken from the new growth and wedge-grafted onto an approved virus-free rootstock in the greenhouse. Over 30 tree fruit plants have been heat treated in this manner. These plants are perpetuated and reindexed twice before declaring them virus-free.

Stone fruits and grape clones are more difficult to free of viruses and methods are being developed in this area. A heat therapy program for grapes is being worked out at the present time.

A list of virus tested varieties at the Post Entry Quarantine Station is now available for distribution to certified budwood schemes, research stations and provincial establishments. It will be the responsibility of these agencies to propagate and multiply scion material for distribution to industry or private individuals.

Several non-fruit crops also receive attention at the Station.

Greenhouse chrysanthemums contribute substantially to the Canadian economy. Propagated vegetatively, they are beset with a fungus, a White Rust disease, which can be serious in a wide range of host plants. Fortunately, the disease is not known to occur in North America and all imported chrysanthemum species from countries other than the United States must go to Sidney for growing tests for this disease.

Not long ago a west coast lumber company became interested in importing species of aquatic willow from Europe to control run-off along rivers and streams. European willows are known to have a bacteria disease called 'Water Mark Disease' not known to occur in Canada. It had to be checked out before allowing imports. Aquatic willows, therefore, are undergoing disease detection and identification treatment at Sidney, before being released for planting along watersheds in Canada, hopefully in the fall of 1974.

It all adds up to an efficient system of control that is helping the Canadian horticultural industry to combat importation of new diseases and provide disease-free material for commercial production. ■

NOVA SCOTIA GROWERS AIM FOR VIRUS-FREE APPLE TREES

R. G. ROSS

Les chercheurs de la Station de recherches du ministère fédéral de l'Agriculture de Kentville, en Nouvelle-Écosse, collaborent avec l'Association des producteurs de fruits de la même province en vue de multiplier du matériel de plantation exempt de virus pour les vergers de pommiers. A mesure que des variétés et des porte-greffes exempts de virus deviennent disponibles, on les plante dans le verger-mère afin de constituer un matériel de plantation sain pour les producteurs de fruits de la province. On utilise sept indicateurs de divers virus pour indexer le verger-mère en vue d'assurer la production d'arbres exempts de virus.

The Agriculture Canada Research Station at Kentville is cooperating with the Nova Scotia Fruit Growers' Association in providing healthy apple trees for new orchards. Until recently, most commercial apple varieties had been infected with five or more apple viruses. Since mature infected trees cannot be cured, the control of apple viruses might seem like a hopeless task. However, we are concerned with improving the health of trees in future plantations rather than controlling viruses in existing orchards.

LATENT VIRUSES

On commercial varieties of apples some viruses produce obvious diseases such as distorted fruit, stems or leaves while other viruses may be present in the trees and not cause any recognizable symptoms. These are called latent or masked viruses and apple trees carrying them may be less productive than healthy trees. Viruses may also cause an incompatibility between the roots and top of a tree. Each apple tree consists of two different varieties or species, the rootstock and the scion, and the two must be grafted together to produce a commercial apple tree. Most of the virus research is conducted at the Sidney Research Station.

To index a tree for the presence of latent viruses a range of indicators is used. These are varieties or

species of apples in which the viruses show symptoms even though they may be masked or latent in a commercial variety. For instance, the virus causing the disease, rubbery wood, is latent or masked in the variety McIntosh, but in the variety Lord Lambourne limbs are very flexible or rubbery. These indicators are grown in the same tree as the variety being indexed and it may take several years to ensure that a variety is free of viruses.

VIRUS-FREE STOCK

The Nova Scotia Fruit Growers' Association, in 1966, purchased 7 acres of land in the Bowen Dyke near Canard, Kings County, to be used as a mother orchard for the propagation of virus-free planting stock. This area was selected because of its isolation from other apple orchards from which viruses might spread. As virus-free varieties and rootstocks become available they are planted in the mother orchard and become a source of healthy planting stock for the fruit growers of Nova Scotia.

The Research Station at Kentville ensures that propagating stock in the mother orchard remains virus-free. Each year budwood from the mother orchard trees is indexed for freedom from viruses. We use the double budding technique to index for viruses. The bud of the indicator variety is budded into an apple seedling about 6 inches from the ground. Then a bud of the variety to be indexed is inserted about 2 inches below the indicator bud. As soon as the lower bud shows evidence of growth, it is rubbed out and the indicator is allowed to grow. The virus, if present, passes through the seedling into the indicator where it produces its symptoms. Foliage and wood symptoms show up in the first or second year, but fruit symptoms will not show up until fruiting. We are using seven different indicators for various viruses to index the mother orchard and ensure that the trees remain virus free.

When a new apple orchard is planted, it is expected to last 20 or 30 years so it is essential that the trees be as healthy as possible. Once a tree is planted it is impossible to free it of viruses which remain for the life of the tree. The Nova Scotia Fruit Growers' Association and the CDA Research Station at Kentville are working together to ensure that our future orchards are as productive as possible. ■

Dr. Ross is Head, Plant Pathology section, CDA Research Station, Kentville, Nova Scotia.



BEEF CATTLE SELECTION AND BREED DEVELOPMENT

J. E. LAWSON

La Station fédérale de recherches de Lethbridge (Alb.) collabore avec le ranch Ross d'Elkwater dans une étude des avantages globaux de la sélection et du croisement comme moyens de maximiser les rendements. Leurs recherches ont montré que le croisement et la sélection des bovins de boucherie basés sur le contrôle des aptitudes peuvent permettre d'atteindre et de maintenir des rendements plus élevés chez une race nouvelle que la sélection en race pure.

Selection of beef cattle based on performance testing has been practised for years in some registered herds and to some extent in commercial herds. However, there is a shortage of high-performing straightbreds and many cattlemen have begun using artificial insemination or crossbreeding, or both, to improve performance. If the parental breeds are chosen judiciously, the resulting crossbred populations can achieve (through heterosis) a higher overall performance in their first generation than can be obtained by selection in straightbreds through several generations. It is important to maintain this superior performance.

A COOPERATIVE VENTURE

The logical step is to combine the effects of crossbreeding and selection. In 1963, the CDA Research Branch, in cooperation with Ross Ranches Limited,

Mr. Lawson is an animal geneticist, Animal Science section, CDA Research Station, Lethbridge, Alberta.

initiated a project to examine this concept. The project, located at the Flying R Ranch, Elkwater, Alberta, was the brainchild of the late George Ross, Jr., and Dr. H. F. Peters, at that time superintendent of the CDA Experimental Farm, Manyberries, and now with the Animal Research Institute, Ottawa. The Rosses agreed to provide the cattle and the land, and to supply all the feed and management necessary for a routine ranch operation. Research information was to be gathered by the research personnel.

PROCEDURES

Our research objective was to determine the influence of the genetic composition of the foundation populations of beef cattle on the effectiveness of selection. Specifically, we are interested in (a) the relative effectiveness of selection for yearling weight, and (b) the direction and magnitude of response within all other traits, in straightbred and crossbred populations. The Rosses are interested in improving growth rate, efficiency of feed utilization and lean meat yield of their cattle. They hope to develop a red breed with a high percentage of polled animals. Emphasis, however, has been placed on selection for high yearling weight.

The plan was to compare the Ross line, established for breed development from a crossbred foundation, with a line established from a straightbred foundation. To produce the crossbred line four Holstein and four Brown Swiss bulls were mated with 200 commercial Hereford range cows in 1963 and 1964. Selected progeny were intermated. Red Angus X Hereford cattle also were incorporated into the new breed. Seven of 17 bulls used in the crossbred line in 1969,

and eight of 16 bulls in 1970 were F₁ Red Angus X Hereford. Thirty F₁ Red Angus X Hereford heifers were added to the herd in 1970. There will be no further introductions of genetic material. Male and female progeny are selected on the basis of their performance and are then intermated.

Hereford cows from the original Ross Range herd (the same herd that produced the crossbred line) were mated to performance tested sires from three sources to produce the straightbred line. In the early days of the Ross range herd, about 10 percent of the bulls used were Shorthorn. However, cows with Shorthorn markings were excluded from the foundation herd and calves with Shorthorn markings are being excluded from the project, so that the Shorthorn influence will be negligible. Replacement progeny for the straightbred line are selected on the same basis as the crossbreds. Both the straightbred and crossbred herds will be increased to 300 head if grazing conditions permit. Two hundred and fifteen cows of each line were in the breeding fields in 1973.

The original Hereford herd, on which both the crossbred and straightbred populations were based, had undergone natural selection for several generations. Cows were not assisted at calving and were seldom supplied with supplementary feed during the winter. They provided a good base for the foundation herds because they were adapted to the shortgrass prairie region. However, when the Herefords were crossed with Holsteins, Brown Swiss, and Red Angus, there was an immediate and dramatic improvement in performance.

The crossbred line, originally dubbed "The Breed" by George Ross and popularly known as "The Ross Breed", will now be known as the "Ross Regenerator." The definition of regenerate namely, "to restore to a better, higher, or more worthy state (by redemption from error or decay)", aptly describes the thoughts and motives of the founders in developing a new population.

Generations are turning over rapidly as two-thirds of the bulls used each year are selected yearlings. The other one-third are the highest performing of the bulls used the previous year. Starting in 1973, yearling heifers also were bred. In most years, over 90 percent of the cows of both lines are diagnosed pregnant. Open cows and those with any form of disability that might affect reproduction are culled.

PROGRESS

"Ross Regenerator" calves have been about 14 percent heavier at birth, but have a higher survival rate to weaning than the straightbred calves. Death losses in the feedlot tend to be higher for the Herefords. In the year of greatest loss (1972-73), 29 of 174 calves died (most with respiratory problems); only four of the 29 were crossbreds.

In the past five years, progeny from the crossbred herd have exceeded the Herefords in 205-day

adjusted weaning weight by 13 to 33 percent. In yearling weight, the crossbreds showed a 16 to 22 percent improvement in bull calves on a good growing ration, and from 20 to 37 percent in heifers on a minimum wintering ration. In 1972, when the winter ration was improved for heifers, there was only a 10 percent advantage in favor of the crossbreds. With greater variation in genetic material available, it is probable that the crossbred herd will achieve and maintain a much higher level of performance as a result of the selection program than the Herefords.

This project utilizes the combined benefits of crossbreeding and selection to maximize performance. The technique is a logical approach to the development of new breeds. The greatest value of this technique, however, will be in the formation of populations adapted to specific areas with high performance in traits specified by the producer and with enough flexibility to adapt quickly to environment and market conditions. ■



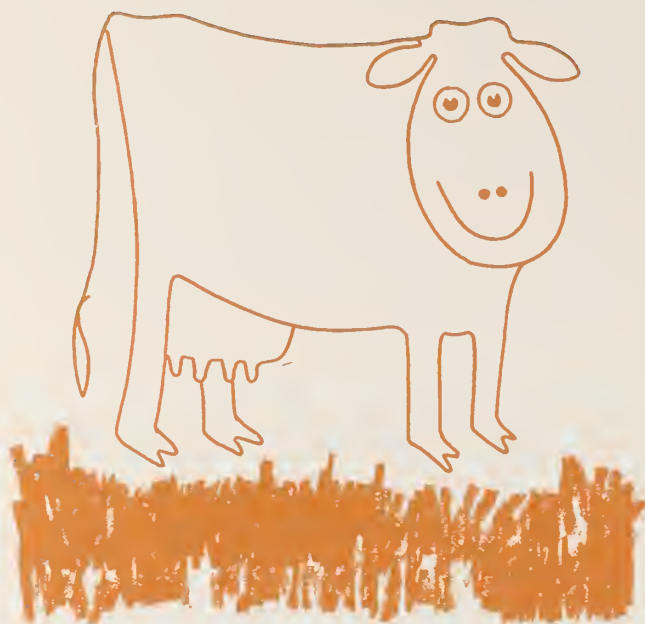
(Top) Holstein x Hereford first cross bull.

(Bottom) Brown Swiss x Hereford first cross bull.

T.D.N. VERSUS NET ENERGY

UNT OU ÉNERGIE NETTE

R. BOUCHARD



R. BOUCHARD

In North America, total digestible nutrients (TDN) is the most common system used to estimate the energy value of rations for ruminants. (A metabolizable energy (ME) system is used to measure value of feeds for non-ruminants, i.e. swine, poultry). Within the last 30 years, however, there have been serious doubts about the accuracy of the TDN method. Efforts have been made to replace it with a system based on the effective energy value of feeds for milk production or net energy for milk production.

At the present time, the TDN system is the only one available for evaluating energy. Although the net energy for milk production system is more precise, it cannot be used to advantage because of the lack of available data on dairy feeds. The conversion of TDN values into net energy values by means of a regression equation is advisable for those who wish to learn

Dr. Bouchard is an animal science nutritionist at the CDA Research Station, Lennoxville, Quebec.

C'est par les unités nutritives totales (UNT) qu'en Amérique du nord on exprime le plus souvent la valeur énergétique des rations pour vaches laitières, ou plus généralement, des rations pour ruminants. Depuis une trentaine d'années, ce système a été sérieusement mis en doute et des efforts ont été faits pour le remplacer par un système de mesure de l'énergie basé sur la valeur énergétique de l'aliment réellement disponible pour la production du lait. Ce dernier système est le système de l'énergie nette (EN).

Actuellement, seul le système UNT sert à évaluer l'énergie. Même si la notion "EN" est plus précise, les données disponibles sur les rations des vaches laitières sont insuffisantes pour l'utiliser avantageusement. La conversion des UNT en valeurs EN par une équation de régression peut se faire pour quiconque veut utiliser EN mais n'apporte aucun renseignements sur la valeur réelle de l'aliment comme source d'énergie pour la production du lait.

Les buts principaux lors de l'estimation de la valeur énergétique sont donc d'abord de satisfaire aux exigences nutritives d'un animal dont on connaît le poids, l'état physiologique et la nature de la production; ensuite, d'être capable de déterminer et de choisir parmi les différents aliments ceux qui satisferont ces besoins alimentaires précis. Le système UNT comme d'ailleurs les mesures de l'énergie digestible, ne tiennent compte que de l'énergie perdue dans les excréments solides pour différents aliments. En plus des pertes d'énergie dans les fèces, il y a une quantité variable et mesurable d'énergie perdue sous forme de méthane, sous forme de chaleur due à la fermentation et au métabolisme des aliments et sous forme de composés carbonés incomplètement oxydés dans l'urine. Le système UNT, s'appuyant sur l'énergie digestible, considère ces pertes comme constantes et comme étant de l'énergie disponible pour l'animal.

SYSTÈME DE L'ÉNERGIE NETTE

Comme pour les minéraux, les protéines, les graisses et les hydrates de carbone, l'énergie ingérée n'est pas utilisée à 100% pour la production. Un autre élément commun aux graisses, aux protéines et aux hydrates de carbone, est le fait que chacun produit de l'énergie. Le but premier de tout aliment est de produire de l'énergie pour soutenir les fonctions d'entretien du corps de l'animal et ses fonctions de production comme muscles, lait et travail. Puisque tous les

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to use the system, but it provides no additional information about the effective value of the feed as a source of energy for milk production.

The principal objectives of estimating energy value are first to satisfy the nutritional requirements of animals of known weight, physiological condition and type of production; and second, to properly distinguish and select feeds which will adequately meet specific requirements. In the TDN method, and other measurements of digestible energy, the only energy losses deducted for each type of feed are those contained in the feces. In addition to energy losses in the feces, a variable but measurable quantity of energy is lost in methane, heat generated by fermentation and metabolism, and incompletely oxidized carbon compounds in the urine. The TDN system, based on digestible energy, considers such losses constant and the energy available to the animal.

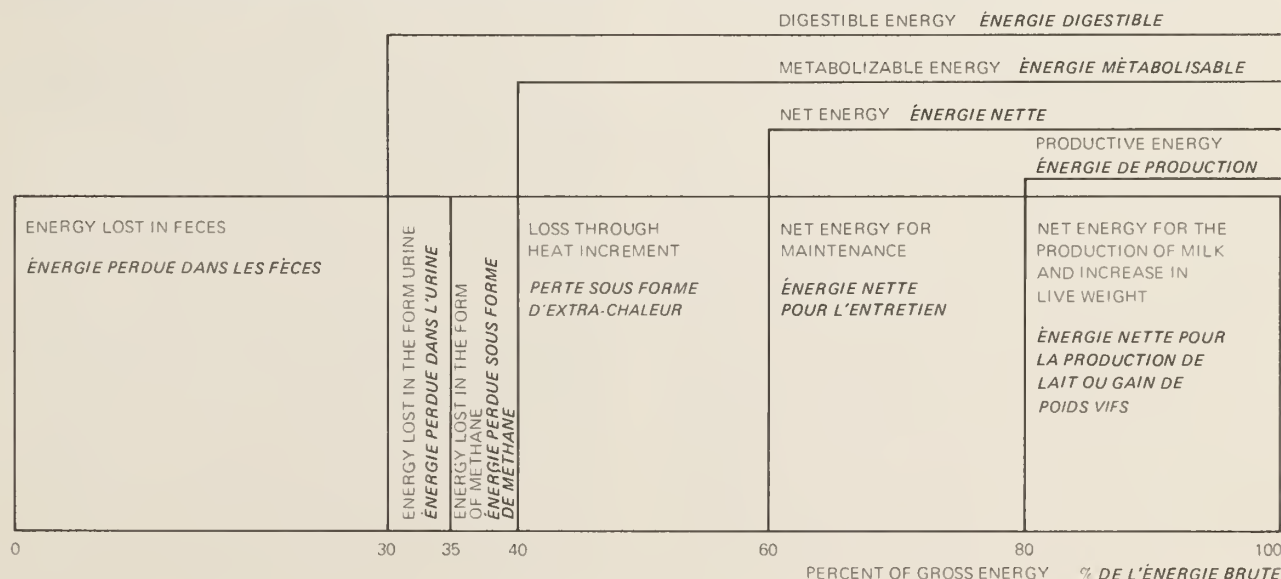
Approximate percentage of gross energy contained in feeds which is lost in the feces, the urine, in the form of methane, and through over-heat, and percentage available for maintenance and production.

nutriments organiques peuvent remplir cette fonction, la valeur énergétique sert de base commune pour exprimer la valeur productive d'un aliment.

L'énergie brute d'un aliment servi à la vache laitière, remplit différentes fonctions (voir illustration). D'abord, une partie de l'énergie ingérée sous forme d'aliment contenant protéines, fibres brutes, sucres et graisses ne quitte jamais le tube digestif et est excrétée dans les fèces. La partie de l'énergie qui reste dans l'animal forme l'énergie digestible apparente. Il y a aussi des pertes d'énergie dans l'urine sous forme de composés carbonés incomplètement oxydés comme l'urée et ensuite sous forme de gaz de fermentation comme le méthane. Après que les pertes d'énergie dans l'urine et celles des gaz combustibles volatilisés dans l'air sont soustraites de l'énergie digestible, on obtient l'énergie réellement métabolisable.

En plus de ces pertes, soustraites de l'énergie brute pour obtenir l'énergie métabolisable, on doit tenir compte des pertes d'énergie sous forme de chaleur dégagée par l'animal avant d'en arriver à la partie de l'énergie qui est réellement utilisée par le corps du ruminant pour l'entretien et la production. Dans chaque cellule d'un organisme vivant, se produisent continuellement des réactions chimiques. Ces réactions produisent de la chaleur dont une partie s'échappe continuellement de l'animal. Cette perte proportionnelle à la quantité d'aliments consommés s'appelle extra-chaleur. La chaleur de fermentation dans le tube digestif due aux micro-organismes et la chaleur dégagée par le métabolisme des nutriments sont aussi des pertes. Chez les ruminants ce sont les pertes par fermentation qui sont les plus importantes. La subtraction de l'énergie métabolisable, des pertes d'énergie dues à l'extra-chaleur donne l'énergie pou-

Pourcentages approximatifs de l'énergie brute contenue dans un aliment et perdue dans les fèces, l'urine, en méthane, en extra-chaleur et énergie disponible pour l'entretien et la production.





NET ENERGY SYSTEM

The energy ingested in the form of minerals, proteins, fats and carbohydrates is not wholly available for productive purposes. Another factor common to fats, proteins and hydrocarbons is that they all produce energy. The basic requirement of any feed is to produce energy for the maintenance of the animal's body functions and for productive purposes. Since all organic nutrients serve this purpose, their energy value provides a common basis for expressing the productive value of feeds.

The illustration shows that the gross energy available in dairy feed is used in various ways. First, some of the energy ingested in a feed consisting of proteins, fibre, sugars and fat, remains in the digestive tract and is eventually excreted in the feces. That portion of the energy which remains in the animal is the apparent digestible energy. Energy losses also occur in the form of incompletely oxidized carbon compounds, such as urea, passed in the urine and in the form of fermentation gases, such as methane passed during eructation. After losses through excretions in the urine and through combustible gases vented into the atmosphere have been deducted from the digestible energy, the remainder is the effectively metabolizable energy.

Once these losses have been deducted from the gross energy to obtain the metabolizable energy, losses in the form of heat given off by the animal must be subtracted to arrive at the energy which is actually used by the ruminant for maintenance and productive purposes. In the process of living, chemical reactions continually take place in the cells. These reactions produce heat, some of which is constantly being lost from the animal. This heat loss, which increases with the quantity of feed consumed, is known as heat increment. Other heat is lost due to fermentation resulting from the activity of microorganisms in the digestive tract and from feed metabolism. In ruminants, the principal heat losses are those due to

vant être utilisée pour le maintien des fonctions essentielles du corps de l'animal et ses fonctions de production.

UNITÉS NUTRITIVES TOTALES

La détermination des unités nutritives totales d'un fourrage, d'un ensilage ou d'une céréale est basée sur l'analyse approximative de leur contenu en protéines ($N \times 6.25$), fibres brutes, extractifs non azotés (hydrate de carbone) et extractifs éthers (graisses). Sans aller dans d'autres détails de l'analyse des aliments par cette méthode, disons pour le moment que cette technique inclut des erreurs importantes dans la mesure des fibres brutes, extractifs éthers et extractifs non azotés. Une fois, la composition de l'aliment connue, chacune des composantes est multipliée par le facteur de digestibilité apparente déterminé par essais de digestibilité pour l'aliment concerné utilisant chaque espèce animale étudiée. La valeur obtenue pour les graisses est multipliée par 2.25 tel que déterminé par Atwater à fin du siècle dernier (tableau 1) en utilisant l'humain et d'autres non-ruminants tel le chien. La valeur physiologique (physiological fuel value) des sucres est de 45 kcal/g, celle des graisses est de 9 kcal/g et celle des protéines est de 4 kcal après avoir corrigé pour l'énergie perdue dans l'urine venant de la matière organique non oxydée. Ces facteurs ont été corrigés auparavant pour leurs digestibilités qui étaient de 91, 96 et 96% respectivement pour les protéines, les graisses et les sucres. La formule suivante est utilisée pour calculer la quantité d'unités nutritives totale d'un aliment pour ruminant: $UNT (lb/100 lb) = \text{protéines digestibles (lb)} + \text{extractifs non azotés digestibles (lb)} + \text{fibres brutes digestibles (lb)} + (2.25) \text{ graisses digestibles (lb)}$. Ce système estime l'énergie digestible de l'aliment et apprécie grossièrement l'énergie perdue dans l'urine, cependant, néglige les pertes d'énergie dues à la production de méthane et les pertes de chaleur reliées à la fermentation et à la digestion de l'aliment.

Les données du tableau 2 indiquent que l'énergie contenue dans la paille d'avoine est égale à 91.2% de l'énergie disponible dans du foin de luzerne coupé au stade de la floraison. Quiconque connaît l'alimentation de la vache laitière sait que la valeur relative de la paille d'avoine et du foin de luzerne est de loin celle indiquée par le système des unités nutritives totales. Si la comparaison est faite entre le foin de mil et le foin de luzerne coupé au même stade de croissance, il est évident que le système des unités nutritives totales donne plus de valeur au mil qu'à la luzerne alors que l'on sait que le foin de luzerne permet d'obtenir une plus haute production laitière que le foin de mil. L'étude du système des unités nutritives totales pourrait être facilitée par la comparaison avec les autres systèmes existants comme celui de l'énergie digestible, l'énergie métabolisable et l'énergie nette.

L'énergie nette d'entretien est fonction du poids de l'animal et, pour la vache laitière, est définie comme

fermentation. Correction of the metabolizable energy for losses due to heat increment leaves the net energy which is the energy available for the maintenance of the animal's vital body functions and for productive purposes.

The net energy required for maintenance depends on the weight of the animal and is defined in the case of dairy cattle as the energy required to maintain the energy equilibrium of a productive nongestating dairy cow consuming an optimum level of protein in its ration. The formula for determining maintenance energy requirements is 73 kcal of net energy for the production of milk multiplied by liveweight in kilograms to the power of 0.75

Once the energy required for maintenance has been deducted from the total net energy, the remainder is available for milk production and for building the reserves which increase the animal's liveweight. This portion of the net energy represents approximately 20 percent of the gross energy consumed.

COMPARISON OF SYSTEMS

The purpose of the net energy system is to determine how much of the feed capacity is effectively used for milk production and increasing liveweight. The TDN system assesses the energy value of the feed without reference to its productive capacities and qualities. The proportion of energy lost in the form of methane and overheating is usually from 25 to 40 per cent of the gross energy. The examples given in Table 2 using the TDN system show approximately similar values for oat straw and alfalfa hay because the TDN system does not allow for the energy lost in the form of overheating, which is considerable in the case of oat straw as compared with alfalfa hay.

To determine the net energy available for milk production in hundreds of forages and cereals requires a tremendous amount of work. It is chiefly

l'énergie nécessaire pour l'entretien d'une vache en lactation non gestante en équilibre énergétique et consommant un niveau optimal de protéines dans la ration. La formule décrivant les exigences énergétiques d'entretien est de 73 kcal d'énergie nette pour la production du lait, multiplié par le nombre de kg de poids vif à la puissance 0.75.

Une fois que l'énergie nécessaire pour l'entretien est soustraite de l'énergie nette totale, le reste de l'énergie disponible servira à la production du lait et à l'entreposage de réserves qui résulteront en un gain de poids vif. Cette partie de l'énergie nette représente environ 20% de l'énergie brute consommée.

COMPARAISON DES SYSTÈMES

Le but du système d'EN est de déterminer la capacité réelle d'un aliment utilisé pour la production du lait et le gain de poids vif. La différence avec le système UNT estime la valeur énergétique de l'aliment sans tenir compte de ses capacités et qualités de production. La partie de l'énergie perdue en méthane et extra-chaleur représente généralement de 25 à 40% de l'énergie brute. Les exemples du tableau 2 exprimés en unités nutritives totales, donnent approximativement la même valeur pour la paille d'avoine et le foin de luzerne, parce que le système des unités nutritives totales néglige l'énergie perdue comme extra-chaleur qui est grande dans le cas de la paille d'avoine comparativement à celle du foin de luzerne.

La détermination de l'EN pour la production de lait pour des centaines de fourrages et de grains est un travail immense. C'est pour cette raison que les valeurs de quelques aliments seulement sont connues. Les données actuelles ne peuvent suffire qu'à extrapoler des unités totales les valeurs de l'énergie disponible. Les données de l'UNT s'accumulent depuis près de 70 ans de telle sorte que l'on possède une gamme complète de renseignements à partir de

TABLE 1 BASIS FOR CALCULATING THE PHYSIOLOGICAL VALUE FOR HUMANS OF ONE GRAM OF FOOD¹

	Gross energy (k/cal)	Digestibility (%)	Digestible energy (Kcal)	Losses in urine (Kcal)	Physiological value Kcal/g	Value compared to hydrocarbons
Protein	5.65	91	5.14	(1.25) (.91)	4	1
Fat	9.40	96	9.02	—	9	2.25
Hydrocarbons	4.15	96	3.98	—	4	1

¹Values resulting from these calculations are used for calculating TDN values for ruminants

TABLE 2 APPROXIMATE COMPOSITION AND TDN VALUES OF VARIOUS FEEDS (VALUES FOR DAIRY CATTLE BASED ON DRY MATERIALS)

	Oat straw	Mature alfalfa	Early bloom alfalfa	Early bloom timothy	Wheat straw
Protein (%)	4.4	13.6	18.4	8.7	3.6
Crude fibre (%)	41.0	37.5	29.8	33.2	41.5
Carbohydrates (%)	44.3	39.4	40.2	49.3	45.1
Fat (%)	2.1	1.7	2.2	2.6	1.7
Ash (%)	8.2	7.8	9.4	6.2	8.1
TDN lb/100 lb	52	55	57	59	48

TABLEAU 1 BASE POUR LE CALCUL DE LA VALEUR PHYSIOLOGIQUE D'UN GRAMME D'ALIMENT POUR UN ÊTRE HUMAIN¹

	Énergie brute (k/cal)	Digestibilité (%)	Énergie digestible (Kcal)	Perdue dans l'urine (Kcal)	Valeur physiologique Kcal/g	Valeur relative aux hydrates de carbone
Protéines	5.65	91	5.14	(1.25)(.91)	4	1
Graisses	9.40	96	9.02	—	9	2.25
Hydrates de carbone	4.15	96	3.98	—	4	1

¹Valeurs résultant de ces calculs sont utilisées pour calculer les UNT pour les ruminants

TABLEAU 2 COMPOSITIONS APPROXIMATIVES ET UNITÉS NUTRITIVES TOTALES CONTENUES DANS DIFFÉRENTS ALIMENTS (VALEUR POUR VACHES LAITIÈRES SUR BASE DE MATIÈRE SÈCHE)

	Paille d'avoine	Luzerne mature	Luzerne début floraison	Mil début floraison	Paille blé
Protéines (%)	4.4	13.6	18.4	8.7	3.6
Fibres brutes (%)	41.0	37.5	29.8	33.2	41.5
Hydrates de carbone (%)	44.3	39.4	40.2	49.3	45.1
Graisses (%)	2.1	1.7	2.2	2.6	1.7
Cendres (%)	8.2	7.8	9.4	6.2	8.1
UNT lb/100 lb	52	55	57	59	48

for this reason that we have values for only a few dairy feeds. The available information is just sufficient to make it possible to calculate net energy values from the TDN or available energy systems. TDN data have been accumulating for the past 70 years and we have a complete set of figures provided by rough analyses of every type of feed for ruminants.

Scientists, using calorimeters to obtain accurate measurements of the heat given off by animals, the consumption of oxygen, the production of carbon dioxide and methane and the energy lost in the urine and feces, have established relationships between the TDN and net energy systems. The net energy for milk production expressed in Mcal per kg of dry matter is equal to 0.0266 multiplied by the TDN expressed as a percentage less 0.12.

Until such time as observations with a calorimeter provide us with a complete series of net energy values for milk production, we must make allowances for the weak points of both systems.

The weak points of the TDN system are as follows:

- Values are obtained by use of an empirical formula based on chemical findings which make no allowance for the metabolism of the animal.
- Results are expressed as a percentage or other proportion of the weight, whereas energy should be expressed in calories.
- The TDN system allows for digestive and some urinary losses only; it neglects methane and heat losses. In ruminants, the latter losses are frequently equal to digestive losses;
- The TDN system overvalues forage as compared with grain or concentrates, because it neglects heat losses due to fermentation in the rumen and to feed metabolism.
- The system measures what feed contains, rather than what it produces.

In spite of these weaknesses, the TDN system is commonly used and has provided standards for feed formulas for the past 50 years. Although its weaknesses have always been recognized, it was not possible to substitute the net energy system. The difficulty is in obtaining net energy data for every forage, silage and cereal used in dairy feed. Determining these figures is a slow process and, as yet, the information available is sufficient only to provide formulae for converting TDN values into net energy values.

While the net energy for the milk production system seems to offer many advantages over the present TDN system, there are also uncertainties and limitations. It has not yet been possible to determine the net energy for milk production contained in a large number of diets. In addition, the table values are largely derived from TDN data for the various feeds. This does not impair the value of the system, but it means that individual feed values must be corrected as more precise information becomes available. ■

l'analyse approximative de chaque aliment destiné à l'alimentation des ruminants.

Des chercheurs, ont mesuré exactement la chaleur dégagée par l'animal, la consommation d'oxygène et la production de dioxyde de carbone, de méthane ainsi que les pertes d'énergie dans l'urine et dans les fèces, et ont établi des relations entre le système des UNT et le système de l'EN. L'énergie nette pour la production du lait exprimée en Mcal par kg de matière sèche d'un aliment est égale à 0.0266 multiplié par les unités nutritives totales exprimées en pourcentage moins 0.12.

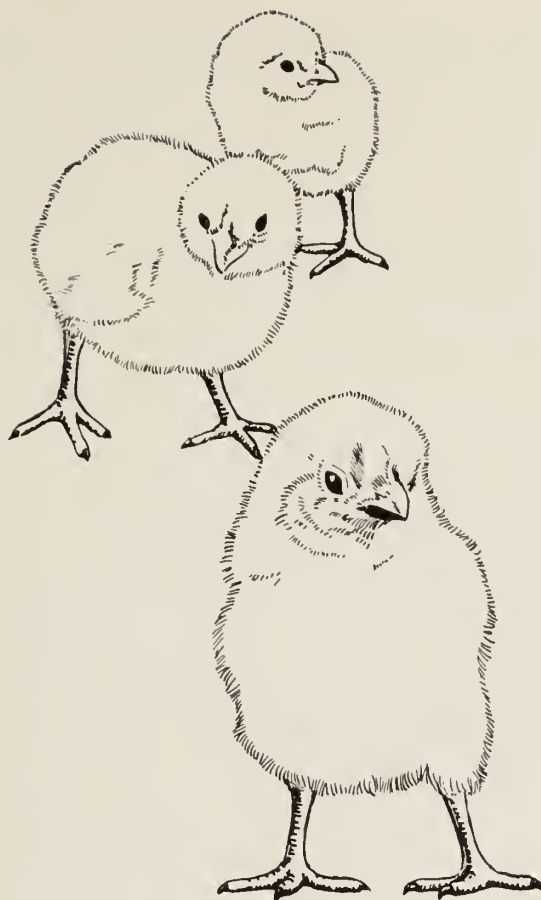
En attendant de posséder une gamme complète de valeurs d'EN pour la production du lait obtenu à partir d'observations au moyen du calorimètre, il sera nécessaire de considérer les points faibles de chaque système.

Pour le système d'unités nutritives totales, sont:

- les valeurs sont obtenues à partir d'une formule empirique basée sur des déterminations chimiques qui ne sont pas reliées au métabolisme réel de l'animal;
- les résultats sont exprimés en pourcentage alors que l'énergie doit être exprimée en calories;
- le système d'UNT ne prend en considération que les pertes par digestion et une partie de pertes par urination négligeant l'énergie perdue sous forme de méthane et sous forme de chaleur. L'importance de ces dernières pertes égale souvent les pertes par digestion chez le ruminant;
- les UNT surévaluent les fourrages par rapport aux grains ou concentrés parce qu'ils négligent les pertes de chaleur dues à la fermentation dans le rumen et aux métabolismes des aliments;
- les UNT mesurent ce que les aliments contiennent plutôt que ce qu'ils pourraient produire.

Malgré ces faiblesses, les UNT sont généralement utilisés et servent depuis près de 50 ans de standard dans la formulation des aliments. Bien que ces faiblesses aient été reconnues dès le début il n'a pu être remplacé par le système d'EN. Le problème réside dans l'obtention de données sur les valeurs d'EN de chaque fourrage, ensilage ou grain ensilé dans l'alimentation de la vache laitière. Il faut beaucoup de temps pour obtenir ces données et celles que nous possédons n'ont suffi qu'à établir des formules de conversion d'un système à l'autre.

Pour la production du lait, même si le système de l'EN semble avoir des avantages considérables sur le système des UNT présentement utilisé, il n'est pas sans question ni sans limites. La mesure directe de l'énergie nette pour la production du lait n'a pas encore été faite pour un grand nombre de rations. De plus les valeurs des tables sont largement calculées à partir du système UNT disponible pour chaque aliment. Ceci ne change pas l'utilité du système mais signifie que les valeurs individuelles pour chaque aliment seront probablement améliorées afin de les rendre plus précises. ■



MEETING THE CHALLENGE OF MAREK'S DISEASE... COOPERATIVELY

Les chercheurs de l'Institut de recherches vétérinaires et de l'Institut de recherches zootechniques d'Agriculture Canada ont mis en commun leurs connaissances pour combattre la maladie de Marek chez les poulets. Ils ont travaillé de concert avec l'industrie biologique canadienne pour fournir le vaccin HVT à l'industrie avicole canadienne. Les Stations fédérales de recherches et les exploitations commerciales de volailles ont effectué de vastes essais d'un bout à l'autre du Canada pour éprouver le vaccin. Les chercheurs essaient présentement de mettre au point des méthodes plus rapides et plus sensibles permettant de déterminer la résistance génétique ainsi que celle due à la vaccination.

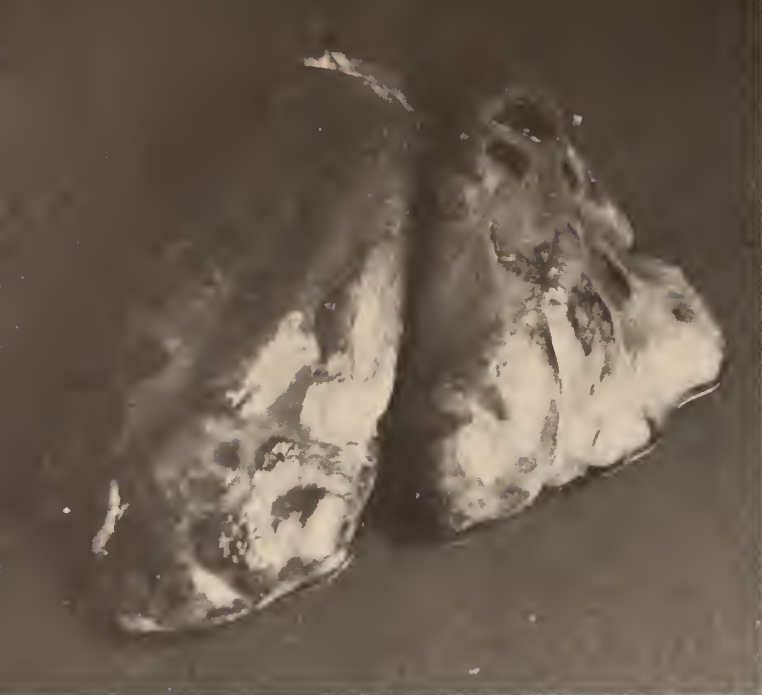
The development of vaccines for Marek's disease (MD) in chickens is one of the remarkable accomplishments of veterinary science because it represents the first successful vaccine against a virus causing tumors in any species. Less than 3 years ago, Marek's disease of chickens was the number one disease problem in the poultry industry. Government scientists and the Canadian veterinary biologics industry combined their expertise to control what was the scourge of the industry. The cooperative efforts of virologists, geneticists, and veterinarians quickly provided the poultry industry with a vaccine to prevent Marek's disease in chickens.

This disease was first recognized in 1907. However, it was during the 1950's and 1960's, when the poultry industry adopted more intensive management practices, that problems of "acute" Marek's disease occurred. Mortality losses in many flocks were 10 to 30 percent, with the greatest losses occurring in pullet replacements before producers had realized any monetary return. Condemnation of carcasses by veterinary inspectors of the Meat Inspection Division sometimes reached 30 percent for skin leukosis. Both good flock management and medication had failed in controlling Marek's disease and genetic resistance was not being incorporated fast enough in commercial chickens to control the disease.

ATTENUATED VACCINE

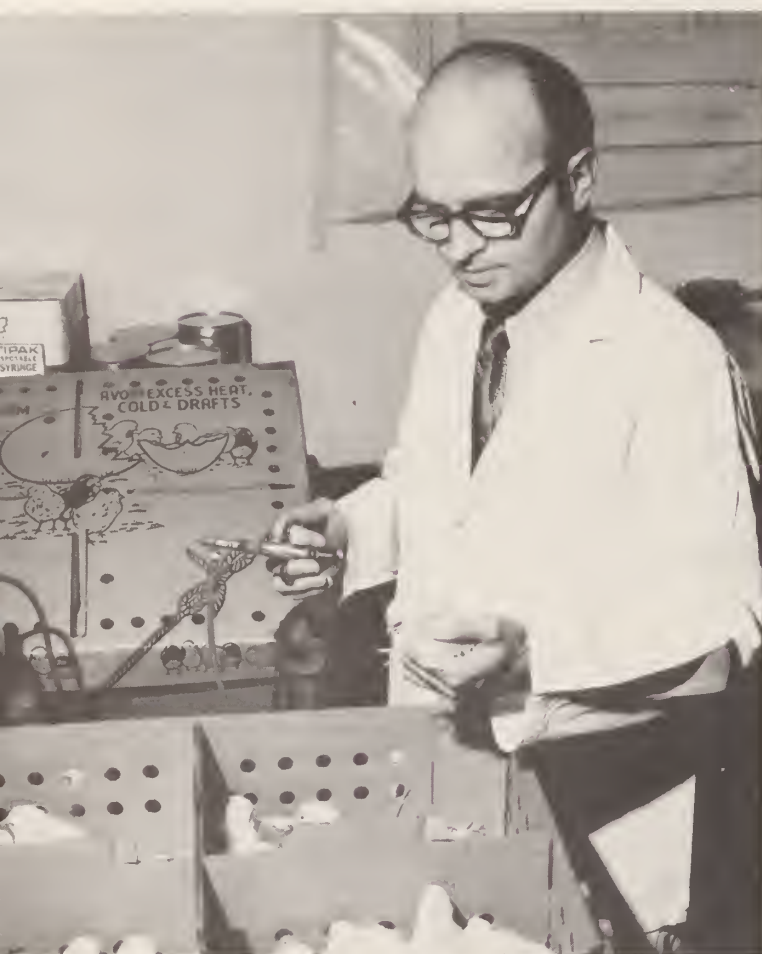
Early in 1969, Agriculture Canada scientists learned that an experimental vaccine had been produced in England. Dr. J. L. Spencer, a scientist from the Animal Diseases Research Institute (A.D.R.I.), recognized the importance of this achievement and immediately commenced research on a comparable vaccine.

Lois James is an editor-writer, Periodical Services Unit, Information Division, CDA, Ottawa.



The liver of a Marek's disease-infected chicken is greatly enlarged and contains many tumor nodules.

One-day-old chicks are inoculated with herpesvirus vaccine by Dr. J. L. Spencer.



He attenuated the Marek's disease virus that had been isolated by Dr. A. Robertson of the same institute, by passing it through chicken kidney tissue cultures. In cooperation with Drs. A. A. Grunder and J. S. Gavora, scientists at the Animal Research Institute (A.R.I.), they demonstrated that the attenuated virus protected vaccinated stock against Marek's disease.

The cooperation between virologists and pathologists from A.D.R.I. and geneticists from A.R.I. still continues. While virological and genetic research on Marek's disease is conducted at many centers throughout the world, seldom is research in these two disciplines as closely integrated as within Agriculture Canada.

One aspect of their research was to define factors that influence the effectiveness of the vaccine. They discovered that the incidence of Marek's disease could be reduced in all stocks or strains of chickens by vaccination. However, the lowest incidence of Marek's disease was in vaccinated chickens with the highest degree of genetic resistance. Another factor identified was the influence of maternal antibody or passive immunity (antibody transferred from hen to chicks via the yolk of the eggs). They discovered that when one-day-old chicks were vaccinated, the maternal antibody reduced the effectiveness of the attenuated vaccine. Their research also confirmed that each chick had to be vaccinated because vaccine virus did not spread from chick to chick. Also, they found that the most effective and efficient place to vaccinate was under the skin in back of the neck.

VACCINE FROM HERPES VIRUS OF TURKEYS

In 1970, United States Department of Agriculture researchers discovered that a herpes virus isolated from turkeys (HVT) could be used as a vaccine virus to prevent Marek's disease. Although HVT is of the same virus group as the Marek's disease virus, it produced no lesions in either chickens or turkeys. Because the HVT vaccine appeared to have advantages over the attenuated vaccine, Agriculture Canada obtained a culture of this vaccine virus in 1970 from the Regional Poultry Laboratory, East Lansing, Michigan. Based on their experience with the attenuated vaccine, the Canadian scientists were able to quickly apply culture techniques and carry out laboratory evaluation of HVT as a vaccine.

Information on cultivating vaccine virus and research results were made available to two Canadian biologics manufacturing companies. The Connaught Laboratories Limited and the Institute of Microbiology cooperated with Agriculture Canada by producing the HVT vaccine for field tests. This vaccine's unique properties, which were different from any previously produced vaccines, presented new production and marketing problems. The vaccine virus is highly cell associated and thus the vaccine had to be marketed as a suspension of live cells. These live infected cells

were stored and shipped across Canada in liquid nitrogen (-196°C). If the cells died through improper handling the vaccine was inactive. Methods are now available for extracting live virus from the cells to produce a freeze-dried product, and this is now in use.

In only 2½ months, the Canadian veterinary biologics industry produced this unusual vaccine on a commercial scale, formulated production and testing methods, developed storage and distribution methods, and taught hatchery people the new vaccination technique. This was an unprecedented achievement.

Because of the unusual nature of Marek's disease and the peculiarities of the virus used in the vaccine, extensive field trials were set up at CDA Research Stations and commercial poultry operations across Canada. Commercial stocks of chickens used in Canada were represented in these trials. Drs. P. H. Langer and J. E. Lancaster of the Health of Animals Branch directed the field tests to ensure purity, safety and potency of the HVT vaccine. Effects of the HVT vaccine were measured in terms of mortality, carcass damage, serological response, egg production, egg size and quality, and weight gains. Results of the field tests confirmed laboratory findings and the vaccine was licenced for sale. Canada was one of the first countries to have a licensed vaccine on the market.

Dr. Spencer attributes in part the success of laboratory research on Marek's disease vaccines to the dedicated efforts of technicians and poultry caretakers as well as the research facilities available at the A.D.R.I. and A.R.I. Their success depended on the tissue culture laboratory for cultivating the virus, the Marek's disease-free flock of chickens and the controlled environment houses for testing the vaccines at the A.D.R.I. In addition, the A.R.I. provided large numbers of chickens of many strains differing in genetic resistance to the disease.

The development of the vaccine, its volume production and the large field trials in both egg producing flocks and broilers demonstrates the best type of cooperative effort between government and industry.

IMPACT ON POULTRY INDUSTRY

The immediate and widespread use of the poultry vaccine has had a dramatic economic impact on the poultry industry in Canada. A marked decrease in mortality has resulted in more pullets placed in laying houses, more hens surviving through the laying year and more eggs produced. This vaccine proved so successful that there were problems of over-production of eggs for the first year the vaccine was in use.

In a field trial conducted by Drs. J. E. Lancaster and W. K. Barr from Agriculture Canada and B. R. Bartlett from the New Brunswick Department of Agriculture, the vaccine proved to be effective for all strains. Mortality was 1.1 percent for vaccinated

birds and 8.6 percent for non-vaccinated birds. There were 42.5 more eggs per bird housed from the vaccinated birds than from the non-vaccinated birds, with a greater return of \$1.03 per vaccinated bird housed.

While the HVT vaccine program has been highly successful in controlling Marek's disease, no vaccine provides 100 percent protection. However, maximum advantage can be obtained by carefully following the vaccine manufacturer's specifications. A remarkable property of the Marek's disease vaccine is that one dose administered at one day of age confers life long immunity. With most other poultry vaccines, it is necessary to give booster doses of the vaccine after the initial dosage.

CURRENT RESEARCH

Dr. Spencer and Dr. Gavora are now attempting to develop more rapid and sensitive methods of determining genetic resistance and resistance conferred by vaccination. Their research is also aimed at better understanding the mechanism of immunity induced by vaccination, and the inheritance of resistance to Marek's disease. Most vaccines protect by stimulating production of antibodies, but their research has indicated that there is more to the resistance induced by Marek's vaccines than antibody production. Knowledge that they hope to gain from these studies may be important in future improvements in the vaccine and may be applicable to other vaccines. ■

Dr. A. Grunder, left, and Dr. J. Gavora review genetic data on chickens assembled by computer analysis.



ECHOES

FROM THE FIELD AND LAB



ALBERTA WEED SURVEY The Lacombe Research Station in cooperation with the Alberta Department of Agriculture conducted a weed survey in 1973 to determine the kinds and numbers of weeds occurring in fields which were seeded to annual crops. In addition, a number of the sites located in central Alberta were harvested to determine the effects of weeds on yield and the effects of spraying. A total of 306 fields were surveyed in Alberta with all soil climatic areas represented.

Forty-one different weeds were reported although many were of minor importance. Stinkweed and wild oats were of about equal prevalence and were found on two-thirds of the farms surveyed. The Lacombe Research Station has developed a formula for estimating crop losses for various densities of wild oats in wheat, barley and rape. Using this information, the average yield reduction for 39 wild oats/y² is estimated to be 23 percent in wheat, 16 percent in barley, and 17 percent in rape. These losses are only those caused by reduction of yield in the field. Losses due to increased harvesting costs, cleaning costs, dockage, and grade reduction were in addition to this.

BLUEBERRY PLANTS FROM CUTTING OR SEED There is still considerable land abandoned from agriculture in the Maritime Provinces which is suitable for growing lowbush blueberries, observes Dr. I.V. Hall, research scientist, CDA Research Station, Kentville, Nova Scotia. Well drained soils with a high percentage of sand or gravel are best suited for blueberries. If the fields of these soil types do not have a population of wild

blueberry plants on them, they can be set out to a stand of better than average producing wild populations.

Such fields can be cultivated and set out with superior clones grown from cuttings or seed. Dr. Hall suggests that the great advantage of propagating from softwood cuttings is that every individual plant will have the same good characters as the mother plant, including number and size of berries. Cuttings can be taken from the field about the first week of July when new growth has ceased. Furthermore, the end of the cutting is active enough to develop roots and the shoot is sufficiently rigid to withstand cutting. Cuttings are kept under intermittent mist for approximately 6 weeks to develop roots. Using this system, Dr. Hall has found that an average of 80 percent of the cuttings will root. Work at the Kentville Research Station shows that a mixture of peat and sand is as good a rooting medium for lowbush blueberries as several synthetic products.

Initially, at least, a larger number of plants can be started per unit area by growing plants from fresh seed. He notes that blueberry seed will germinate readily, if the seeds are extracted from well-ripened berries and planted immediately under the right conditions.

If the demand for lowbush blueberries continues as strong as in the last two years, Dr. Hall believes that growers will plant stands of superior clones. These will be more intensively managed than many existing fields. The use of irrigation water to assist growth in dry weather and to prevent frost injury on cold spring nights is just one possibility. Weed control will be more economic, and hence the applications of very light quantities of nitrogen fertilizer may also more than pay off.

'POP' IN LIVESTOCK FEED Canadian livestock may soon have 'POP', Pasteurized Organic Protein extracted from animal wastes, added to their feed. Agriculture Canada will spend \$34,000 to buy machinery and drying equipment designed to segregate and dry animal waste to develop a protein concentrate for livestock feed.

The Engineering Research Service, Research Branch, Agriculture Canada is undertaking this program in cooperation with the Nova Scotia Agricultural College and the Nova Scotia Department of Agriculture. The work will be done in Truro, N.S., using equipment purchased from Switzerland. European equipment was selected because the weather the machinery will operate in closely resembles European weather conditions. The equipment will also be used to dehydrate grass and legume crops for livestock feed and to dehydrate by-products of the apple and potato industries.

Poultry waste will be the first type tested because it is highly concentrated and handling

is easy as the birds are restricted to a small area. The final product could be used as a 30 percent protein supplement in animal feed, with the dried refuse used as a fertilizer for greenhouse and field crops.

Researchers hope to explore the possibility of using apple and potato waste to see if the process will produce desired results. If research is successful, the Atlantic region could benefit because of the large apple and potato industries located in the region.

ÉVALUATION DES PLANTES ORNEMENTALES DE SERRE Pendant dix années consécutives, la Station de recherche de Sidney en Colombie-Britannique a fait des essais de 460 espèces et variétés de plantes en pot afin de déterminer leur valeur comme plantes ornementales cultivées en serre.

Illustrée de photographies en couleurs, la publication 1457 que viennent de réviser MM. J.H. Crossley et S. Arrowsmith, fournit aux horticulteurs professionnels ou amateurs des renseignements fort utiles.

On peut se procurer *Évaluation des plantes ornementales de serre* publication 1457, en s'adressant à la Division de l'information, Agriculture Canada, Ottawa, K1A 0C7.

NEW LAMB CARCASS GRADING REGULATIONS A new Lamb Carcass Grading System has been implemented after extensive consultation and discussion with the sheep industry. Under the new grading system a cutability factor will be introduced which will divide the Canada A grade lamb carcasses into four fat levels with A1 having the lowest amount of external fat and A4 the most. The restrictive weight ranges which were part of the old regulations have been eliminated. This will permit producers to raise heavier, meatier lambs without risking a penalty.

Lamb carcasses will be graded and branded with a color-coded ribbon brand which will identify each carcass according to quality. The grades are A, B, C, D and E. The A grade (color-coded red) is subdivided to identify four levels of fat content. The B (blue) and C (brown) grades, which are not subdivided, principally designate grades that have less fat cover than is normally considered desirable. The D (black) grade indicates mutton (as opposed to spring lamb) and designates mature animals. It is subdivided into four levels indicating quality. The E (black) grade is for mature males.

Approximately 17 percent of farm sales were made on a rail grade basis under the old grading system. The introduction of the new grading system, together with the construction of specialized lamb-slaughtering packing plants, will probably raise this percentage.

Under the new lamb carcass grading system, the buyer should benefit because he will be able to identify the quality and fat level

ECHOS

DES LABOS ET D'AILLEURS

of the lamb he prefers. The producer will benefit to the extent that he is able to profitably produce the type and quality of lamb carcasses which command a premium price on the market.

CULTURE DU POIS SEC Cultivé surtout au Manitoba tant pour la consommation humaine que pour l'alimentation des animaux, le pois sec appartient à la famille des légumineuses, plantes qui par leur propriété de fixer l'azote atmosphérique, enrichissent en azote le sol où elles sont cultivées.

La publication 1493, résultat de travaux effectués par M.M. S.T. Ali-Khan et R.C. Zimmer de la Station de recherche de Morden au Manitoba, traite de la culture du pois sec et donne des renseignements tant sur les façons culturales, les sols qui conviennent à sa culture, que sur la lutte contre les maladies.

On peut se procurer la *Culture du pois sec* publication 1493, en s'adressant à la Division de l'information, Agriculture Canada, Ottawa, K1A 0C7.

DUCKS FOR THE BACKYARD FARMER. A new publication for the hobbyist or backyard farmer on the management of a small duck flock is now available from the Information Division, Agriculture Canada, Ottawa K1A 0C7; it is not intended as a guide for a large-scale commercial operation.

Managing a Small Duck Flock, publication no. 1524, provides the amateur with management and marketing tips for small duck flocks. Sections on the care and handling of a duck flock include breed selection, selection and care of breeders, incubation, brooding, feeding, marketing, and problems caused by management.

This publication is available on request and is free of charge.

ENERGY FROM ANIMAL WASTES The conservation of energy is creating interest in new forms of energy for Canadian agriculture. Methane gas production from animal wastes has prompted interest in the possible use of digesters to process manure in Canada. However, the feasibility of producing methane gas from animal wastes under Canadian climatic conditions has yet to be demonstrated.

To consider the potential suitability and use in Canada of digesters, some research and development was initiated a few years ago at the University of Manitoba. *Methane Gas Production from Animal Wastes*, publication no. 1528, outlines the process, problems and progress made to date. It describes the environmental conditions that are important for successful operation of methane-producing anaerobic digester and an example of potential gas production through anaerobic digestion of the manure from 1000 hogs. A schematic diagram of an experimental livestock waste

digester is provided for the interested reader.

This publication, written by engineers of the Agricultural Engineering Department, University of Manitoba, is published by Agriculture Canada under a Federal-Provincial agreement. It is available from the Information Division, Agriculture Canada, Ottawa K1A 0C7.

FUMIGANT ACTION Although CO₂ has often been used to stun adult insects to facilitate handling, and reports have been made of mortality over extended periods of exposure, CO₂ has not, until recently, been considered as an insect fumigant. A preliminary study was undertaken to determine the effects of CO₂ on several insects in fruit. CO₂ was introduced into plastic bags or glass jars containing the insects under study, and the concentration of CO₂ was maintained above 90%. Mortality of insects was determined after ½, 1, and 2 days exposure at ambient (70-80°F) temperature. Percent mortality on the following insects was:

- San Jose scale on apples
 - 99% after 1 day
- Cherry fruit fly larvae in cherries
 - 100% after 2 days
- Codling moth larvae in cherries
 - 100% after 2 days
- Codling moth larvae in apples
 - 96% after 2 days
- Codling moth larvae in synthetic media
 - 99% after 2 days
- Codling moth larvae in (diapause) in cardboard strips
 - 99% after 2 days

In all cases except the cherry fruit fly, shorter periods of exposure were tried but they resulted in lower mortality. Many of the treated larvae, although still alive, appeared to be in a moribund state and were judged incapable of surviving. If these moribund larvae were counted as dead, the 100% mortality period could be considered to be: San Jose scale—1 day; cherry fruit fly—2 days; codling moth in cherry and apples—2 days; codling moth larvae in synthetic media and diapausing larvae—1½ days.

POS PILOT PLANT A POS (protein, oilseed, and starch) pilot plant will be constructed in Saskatoon. The \$4,000,000 complex will offer facilities for development of technology needed to produce protein, oil, starch, and other components from Canadian grains, oilseeds, and other crops. Examples include starch and gluten from wheat, pectin from sunflowers, and protein from rapeseed, wheat and barley. New protein products such as peas, faba beans, and others will be researched and evaluated.

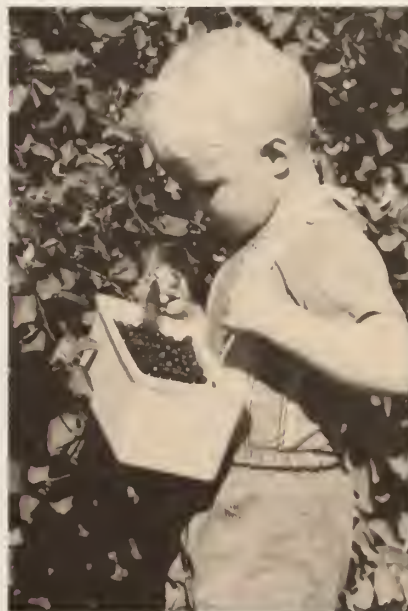
The Federal Government is willing to supply up to 90 percent of the capital cost and to assist with operating costs during the first five years. This plant will be industry operated and its facilities widely available on a rental or fee

basis to users. Membership in the newly formed POS Pilot Plant Corporation includes five grain processing companies, four food processors, three oilseed crushers and handlers, a meat packer and a consulting firm. The plant is expected to be in operation by 1975.

TANGY TASTE OF WILD FRUIT Dr. R. E. Harris, Agriculture Canada scientist who has spent 17 years with the federal department's northern research group located at the Beaverlodge Research Station says there's a definite case for developing small fruit industries based on native produce growing in northern Alberta and adjacent areas.

The variety of native fruit growing in the area is amazing, he says. Some species are concentrated in localized areas, others occur in large numbers over wide areas. Gooseberries, black and red currants, cranberries, pincherries, elderberries, chokecherries and baked-apple berries are all there. Many communities such as Lac la Biche, Fort Vermillion, High Prairie, Slave Lake, Hay Lake and New Fish Creek have surrounding fields and bush loaded with blueberries, saskatoon berries, cranberries, lingonberries or raspberries. Dr. Harris believes some of these areas could go into commercial picking of the wild fruit in a manner similar to the extensive wild blueberry harvests in Quebec and the Maritimes. Some of the more exotic possibilities include a popular rose hip marmalade which has been processed at Anzac, Alta.

This lad shows appreciation for the potential of saskatoons, and other native fruits in northern areas.





Early instar larva with a black head



Late instar larva with a brown head.

THE STRAWBERRY TORTRIX

A NEW PEST ON
THE PACIFIC COAST

W. T. CRAM

Une tordeuse du fraisier, *Acleris comariana* (Zeller), insecte très nuisible en Europe septentrionale, a été observée pour la première fois au Canada en 1972, causant des dégâts importants sur les plants de fraisiers dans la région de Vancouver. Des observations sur le comportement et le cycle évolutif de ce parasite sont en cours.

In the summer of 1972 several commercial strawberry plantings in a small area near Vancouver were heavily infested by a new leaf roller which was identified as the strawberry tortrix, *Acleris comariana* (Zeller). This was the first recorded field infestation of this important Northern European pest in Canada. Damage was so severe in a third-season planting that the 10 acres was picked only once before it was plowed under. Adjacent first and second-season plantings were less severely damaged. In a survey of nearby strawberry plantings the pest was found 5 miles east of the original infestation, although it had not reached the major strawberry growing areas around Langley and Abbotsford, 30 miles to the east.

The behavior of this new pest has been carefully observed by scientists at the CDA Research Station, Vancouver, B.C. since its discovery, and now its

Dr. Cram is a specialist in strawberry insects at the CDA Research Station, Vancouver, British Columbia.



Pupa in webbing.



(Top) Resting moth showing conspicuous dark patches on the wings

(Bottom) Sequin-like shell of a hatched summer egg.

complete life history in this area is known. The first-generation larvae hatch between late April and mid-May from overwintered eggs laid at the base of the leaf stems. These larvae feed on opening leaflets and the blossom parts, which may fail to develop or may produce deformed berries. By picking time the full-grown leaves are ragged with large holes, resulting from the early feeding before these leaves unfolded. When there are many larvae per plant even normal berries may be tunneled. Usually worms of different sizes are found on the same plant. Small worms have black heads whereas the full-grown worms have brown heads. The greenish pupae are usually found at the tip of folded mature leaflets or where leaflets overlap.

The first-generation moths begin to come out of the pupae during harvest in mid-June to late June and they fly until early August. Although not strong fliers, they can still fly out of sight. They usually hide under leaves during the day, but are easily flushed out by disturbing the foliage, and captured when they settle on a nearby plant. After dark they appear to swarm about the plants. The moths are from $\frac{1}{4}$ to $\frac{3}{8}$ in. long with a wing span of about $\frac{5}{8}$ in. The fore wings have a dark patch along the leading edge near the tips, but the general wing color varies from very dark brown to silvery gray.

Females lay eggs on both surfaces of mature leaves. After the eggs hatch the tiny empty shells reflect light like a sequin. These shiny specks readily indicate the presence of second-generation larvae

which feed on the leaves from July until about mid-September. Since these second-generation worms feed on unfolding or mature leaflets the direct damage at this time may not be important. However, they pupate as before and second-generation moths emerge. These fly from early September until late November and lay the overwintering eggs at the base of the leaf stems. Hence, this pest could easily be spread by transporting runner plants that carry overwintering eggs.

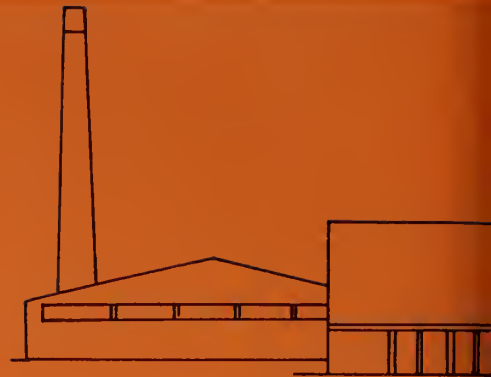
The importance of the strawberry tortrix as a pest in British Columbia will depend on whether it spreads to the main centers of strawberry production. Unfortunately, it can live on several other plants including azalea, apple, rose, hardhack, a very common fence-line woody weed, and potentilla, a buttercup.

Adequate chemical control of the first-generation larvae before strawberries bloom is possible by using the existing recommendation for control of leaf rollers. However, reinfestation by first-generation moths flying from surrounding wild hosts results in some post-harvest damage to the foliage by the second-generation worms. These are often more abundant than the earlier worms which hatched from overwintered eggs, but since foliage is abundant, sprays are usually not recommended.

Although parasites are abundant in late summer and kill many mature larvae and pupae, the large number of surviving moths observed indicates that overwintering eggs must be widely distributed in the plantings and their surroundings. ■

FERTILIZER SUPPLY AND DISTRIBUTION

Les représentants de l'industrie des engrais ont répondu à quelques-unes des questions posées au sujet de l'approvisionnement et de la distribution des engrais à la conférence nationale sur les engrais. Ils ont signalé que la présente pénurie mondiale d'engrais se poursuivra indéfiniment, étant donné que les perspectives de la consommation mondiale d'engrais indiquent que la demande doublera probablement au cours de la prochaine décennie.



In view of our resources, can Canadian farmers expect adequate supplies of fertilizer in the future?

Representatives of the industry responded to some of the questions being asked about fertilizer supply and distribution at the National Fertilizer Conference sponsored by the Ontario Ministry of Agriculture and Food, and the plant food industry of Canada.

LONG TERM OUTLOOK

The present worldwide shortage of fertilizer will continue indefinitely, at least for the next 5 years, and possibly for the rest of human history.

Worldwide fertilizer demand strengthened rather dramatically in reaction to crop shortages caused by widespread droughts in 1972. This caused many countries to increase fertilizer imports last year to help regain this lost crop production. At the same time, demand for agricultural products on international markets remains at record levels because of a 2 percent growth rate.

The total world consumption of fertilizer was about 72 million metric tonnes in 1971-72, while total production was marginally greater. Forecasts of world fertilizer consumption in 1975, 1980 and 1985 indicate requirements at 94.1, 123.6, and 155.4 million tonnes respectively. That's doubling of current consumption in the next decade. Unfortunately it is unlikely that production can catch up, because there may not be enough investment capital forthcoming to expand the industry fast enough to keep up with the increase in demand.

Another limiting factor may be technical manpower. There may be only 4,000 to 5,000 engineers in the world qualified to design, build and operate fertilizer plants. Many of these will be occupied with the design and construction of chemical plants, oil refineries, coal conversion plants, nuclear plants and other types of plants requiring the same skill. *R. W. Neal, Canadian Fertilizer Institute*

FERTILIZER USE RELATED TO GRAIN SALES

There is a direct relationship between farmers marketing grains, and the demand for fertilizer in the following year. For example, prairie farmers marketed 826 million bushels in the 1966-67 crop year and used 1 million tons of fertilizer in 1968. Farmers marketed

601 million bushels in 1967-68 and used 583,000 tons in 1969. Thus, with a reduction of 225 million bushels in marketings, farmers used 400,000 tons less fertilizer. In 1968-69, grain marketings decreased 25 million bushels to 576 million bushels and fertilizer use was reduced by 121,000 tons in 1970. Since this period, grain marketings have been increasing as has the use of fertilizer.

Given assurance of continuous markets for their produce at reasonable prices, the majority of farmers in western Canada would be using fertilizer on a continuous basis. In this situation, fertilizer use could be as high as 2.5 million tons. *Hon. J. R. Messer, Saskatchewan Minister of Agriculture.*

FERTILIZER INDUSTRY IN CANADA

The three basic fertilizers, N, P, and K, are produced in Canada. The greatest volume is potassium or potash, of which Canada possesses the world's largest known resources. In both nitrogen and phosphates, production capacity exceeds domestic demand for fertilizer. There are, however, competing demands from other industries and other markets for these products.

The development of Canada's fertilizer industry, largely within the last 5 decades, has been marked by periods of very rapid growth followed by severe depressions. Large expansion of facilities in Canada in the 1960's, paralleling the similar expansion in the U.S., coincided with an unanticipated slowing of growth in domestic consumption resulting in excessive inventories, idle production capacity, intense competition, and depressed prices commencing in 1969 and continuing until 1973. By actual measure, the fertilizer industry in Canada lost money in 1969, 1970 and 1971, only breaking even in 1972. Those collective losses were about 25 percent or more in the worst year.

No new capacity has been added for 5 years and virtually all of the announced new building, chiefly in nitrogen, will not produce new products until 1976 or later.

Home market consumption of fertilizer increased at an average of 6.5 percent until the 1972-73 fertilizer year when growth skyrocketed to 13 percent, with most of that in Western Canada during a poor spring planting season. Current demand is exceptionally strong and it appears another 13 percent overall increase in fertilizer consump-

tion is likely in the current year which ended June 30, 1974. *R. W. Neal, Canadian Fertilizer Institute*

NITROGEN POTENTIAL

It does not appear that the U.S. feedstock problems will be solved quickly. It is natural therefore that many are looking for feedstock, and in particular natural gas, in Alberta and overseas. At last count, there were over 20 potential manufacturers considering plants in Alberta. Obviously all of them won't build for a variety of reasons, but there is little doubt that at least six new nitrogen plants will be established in the province. A firm supply of gas on a long term basis is important. It must also be available at prices which will ensure that the finished products are able to reach logical markets and compete profitably with nitrogen from other sources. The Government of Alberta understandably encourages more industry to establish in the province, and it has the feedstock for leverage. However, the pricing of gas must be realistic and some measure of control of new construction must be applied to avoid a repeat of the overproduction which occurred in the mid-sixties. There is a market in the U.S., but the major segment is not very close to Alberta. There should be several new ammonia plants in Alberta, but there are marketing problems to solve before investing \$80 to \$100 million per plant.

We have a very precious resource in natural gas and we must ensure that it is fully exploited for the maximum long term benefit of Canada. For example, 35,000 cu ft of natural gas at 50¢/10,000 cu ft is worth \$17.50; the one ton of ammonia it produces is worth \$100, and the 1.7 tons of urea that can be produced from one ton of ammonia is worth \$200. These are examples in the fertilizer industry; even greater upgrading is possible in the chemical industry. These opportunities are available to us now: the longer we wait, the more we provide our potential customers with incentives to look elsewhere. *W. A. Taylor, Canadian Industries Limited*

RELATIVE COST OF P

Phosphate rock is the primary feedstock used in the manufacture of wet process phosphoric acid. In 1968 and 1969, 72 BPL rock was selling at \$5 per short ton f.o.b. Florida Mines. Rail freight costs from Florida to points in Ontario and Quebec were about \$9 per ton,



yielding a delivered cost to the producers located there of \$14. It required 1.6 tons of rock to produce a ton of triple superphosphate for a feedstock cost on rock of \$22.40. In comparison, the Florida producer charges rock into process at \$5 per ton and his rock cost in triple superphosphate is \$8. It costs \$2.30 to move that ton of triple superphosphate to Tampa and another \$4 per short ton to land the material at ports east of Montreal. The total delivered cost then of the phosphate rock portion only is \$14.30 or about \$8 less than the Canadian producer.

Phosphate rock occurs abundantly in many parts of the world. Total reserves have been estimated at 50 billion tons and are sufficient to supply the world for 500 years at the current rate of consumption. The mining and beneficiation techniques are simple and the principal producing areas are the United States, Africa and the U.S.S.R. *M. S. Scott, Noranda Mines*

HOME MARKET PRIORITY

While recognizing that the Canadian market is our primary market, we cannot as an industry turn our backs on markets in the U.S. and abroad. Canadian wet process phosphoric acid capacity is 845,000 tons of P2O5; Canadian consumption of phosphatic fertilizers is about 450,000 of P2O5. We need export business to be able to run our plants at economic rates. Furthermore, we must import a large tonnage of phosphate rock to keep these plants operating. With rock in short supply, those who have it for sale are beginning to ask for a portion of P2O5 content back in the form of superphosphate, and in some cases this phosphate is destined for U.S. or other offshore markets. *M. S. Scott, Noranda Mines*

POTASH

There is no doubt that there will be a shortage of potash in the North American market this fertilizer year (1973-74). There are three main reasons for this:

- Unprecedented demand.
- Drop of 75 percent of potash imports to the U.S. in 1973.
- Restriction of production at Canadian mines.

A shortage of over 1 million tons KCl on the North American market for 1974-75 can be alleviated in several ways:

- More production from Canadian mines.

- Less exports overseas.
- More off-shore importation of potash into the U.S.A. (which usually occurs to the extent of 600,000 tons KCl).

To assure sufficient supplies of potash throughout the year, Canadian buyers must now:

- take product in the "off-season".
- be willing to schedule shipments to their plants over many months.
- be willing to pay fair prices for the product.
- estimate their needs well ahead of the season and arrange for delivery in advance of the season.
- be willing to provide storage in the "off-season". *A. F. Henry, Sylvite of Canada*

STORAGE

Because of the process involved, many fertilizer plants are best operated on a continuous basis. Contrast this with a demand or movement of 75 percent of the annual tonnage during a 6 week period in the spring in Eastern Canada.

This type of shipping pattern has resulted in the need for fertilizer manufacturers to develop:

- Storage warehouses to provide for between 30 percent and 50 percent of annual volume.
- Dependable inbound transportation arrangements with alternative of rail or truck movement where practical.
- Arrangements with several basic supply points so that a major plant or transportation break down in season does not cripple a complete manufacturing system.

New warehousing today costs from \$35 to \$60 per ton depending on the size, type of structure and type of material handling equipment installed. The most economical location for warehousing is either as close as practical to the point of end use or where the mode of transport changes, such as a marine terminal where inbound vessel movement changes to outbound truck or rail.

We will probably see a continuing trend in fall plowdown application of phosphates and potash, and summer application on hay and pastures. This makes good agronomic and economic sense for both the industry and the farmer, and allows for better use of storage facilities, delivery and application equipment.

Future trends in bulk versus bags, and in season versus preseason farm delivery, depend on a number of factors such as farm

labor availability, packaging costs, service costs and product availability. *G. M. Mather, United Cooperatives of Ontario*

TRANSPORTATION

The fertilizer industry in Canada is reasonably well served under the current National Transportation Policy. Let us be very careful about tampering with the National Transportation Act.

Seasonality has been a major problem in the past and will be in the future.

The producers' demand for phosphate rock, the exciting growth in U.S. and off-shore potash sales, early market pressure on bulk fertilizer associated with serious service problems, all have conspired to place an almost overwhelming burden on the covered hopper fleet. Product repatriation and advance ordering of bagged fertilizer has been impossible to match with adequate box car coverage due again to service deficiencies, tremendous grain demands and an extraordinarily heavy movement of general commodities.

Given a return to normal rail operations, continued assistance from the highway carriers and extraordinary efforts by shippers, carriers and receivers, we still have a fighting chance to satisfy consumer deliveries. *F. E. Pethick, Imperial Oil*

BULK BLENDING COSTS

Analysis of 38 bulk blending plants in Ontario has shown that the average plant achieved an operating profit of approximately 83¢/ton. However, when interest charges of 8 percent on the total investment were considered, a net loss of \$3.28/ton was experienced.

Detailed analysis of various cost categories showed that total operating costs (including operating, administrative, selling, depreciation, and interest on investment) amounted to \$19.44/ton. Similar analysis showed that materials costs (including bags) were \$56.89/ton while the average selling price was \$73.05/ton. Thus, the gross margin for the average bulk blending plant was only \$16.16/ton. The difference between the total operating costs and the gross margin was \$3.28, which was the net loss experienced by the average bulk blending plant in 1972.

To improve the profits of bulk blending firms, total operating costs must be lowered, margins increased or some combination of the two. *Prof. T. F. Funk, University of Guelph* ■

G. BARNETT

L'intérêt pour les fumiers, en tant que source d'éléments fertilisants et comme modificateurs du sol, augmente de plus en plus, principalement en raison de la hausse du prix des engrais. Parfois, des applications de plus de 20 tonnes de fumier (à l'état détrempé) par acre peuvent avoir des effets nuisibles sur les sols, les cultures et le bétail. L'auteur analyse quelques-unes des informations récentes sur les effets que peut causer l'épandage de fortes quantités de fumier contenant divers produits chimiques.

Those familiar with farm operations are probably aware of the phenomenon where the field closest to the barn frequently gets the most manure. Furthermore, the advent of low cost fertilizers and their ease of handling compared to livestock wastes, often causes farmers to spread their manure in the quickest possible manner, leading to high rates, even in low stocking-rate dairy operations. Manures are now becoming more attractive as a nutrient source compared to fertilizers, but they still are costly to handle. For broiler and feedlot operations, high manure rate applications are encouraged because of the volume of waste and generally limited land associated with such operations. In spite of the various systems to handle and treat manure, it is the soil and crops that ultimately must handle these wastes. The soil is still the least expensive means of disposal.

The fertility value of manure and its utility as a soil

Mr. Barnett is a soil fertility specialist at La Pocatière Experimental Farm, Quebec.

conditioner are often cited, particularly as fertilizers rise in price. It is not the express object of this article, however, to treat the conventional fertility aspects of manure, but to review some recent work on the deleterious effects of high manure rates—rates over 20 tons (wet) per acre—to soils, crops, animals and humans. Applications of up to 20 tons per acre rarely cause the problem discussed in the following sections.

Various additives are used by the animal industry: antibiotics, feed conversion promoters, and growth promoters. For example, 1 percent salt is included in most rations of feedlot animals to prevent the formation of urinary calculi by increasing water consumption. Feeder hogs are often fed 250 ppm copper sulphate to increase feed conversion. Of this, 95 percent is excreted in the manure.

Recent information has revealed new facts on the effects of adding large quantities of manures containing various chemicals on crops, soils and livestock.

EFFECTS ON SOILS

Soil Sealing High rates of liquid manure can cause soil structure breakdown and sealing of the soil, thereby decreasing infiltration and increasing runoff. Manure contains salts that cause peds to break down and it contains waxes that mechanically seal the soil. It is recommended that liquid manure not be applied at over half the recommended irrigation rate for clear water.

Salt and Ammonia Toxicity High rates of manure applied to soils mean high rates of salt application. This has sometimes caused saline conditions in the soil. Corn and potatoes are most sensitive to salts, grass is less sensitive, and legumes are comparatively tolerant. It has been suggested that stocking rates on

Manure applied at 15 to 20 tons per acre is an invaluable fertilizer and soil conditioner. However, at rates exceeding 20 tons, it can cause pollution, crop yield reduction, and physiological disorders.



TOO MUCH



pasture should be kept to three cows/ac or less due to salt accumulation.

Manure applied to soils may contain or may result in high ammonia concentrations. Ammonia concentrations over 500 ppm are potentially dangerous and can retard or kill some plants.

Soil Fixing Capacities Soils have the capacity to fix phosphorus, potassium and nitrogen. However it has been shown that percolating water will often follow the same channel which results in a saturation of P fixing capacity in the channel. Once this fixing capacity is exceeded, then leaching of P to groundwater will occur. Each soil has a limited fixation capacity and once exceeded, pollution of groundwater will occur if either excess fertilizer or manure is applied.

POLLUTION

Up to a certain point, plants and soils can fix most of the nutrients applied to a soil, but as more and more are added, fewer and fewer are fixed. This means more is left to leach into groundwater or appear in runoff. Excessive manure application leads to pollution.

The pollution dangers to water supplies from runoff is particularly real, especially when manure is applied to frozen soils. The shallower the well the greater is the probability and seriousness of contamination.

Pollution from manure and silo sources have caused many problems. In Kansas, drainage from manure, feedlots and silo sources into streams caused fishkill from 1964 to 1967. In 1964, 8 percent of the fishkill in the U.S. was attributed to these sources. The fishkill increased to 12 percent the next year. A dairy herd was decimated after drinking from a well contaminated by runoff from a feedlot up stream. So

pollution from manure sources may affect the farmer directly and can have striking adverse effects.

Salt Toxicity in Water Supplies Manure runoff can cause high salt levels in water which will reduce feed conversion, increase water consumption, and cause or aggravate several diseases in animals. Water with over 3000 ppm salts is not acceptable for poults and over 4000 ppm is unacceptable for any class of poultry. Young pigs should not have levels over 2500 ppm and for older stock 5000 ppm is the limit.

Nitrate Contamination of Water and Plants Excess nitrate in water can cause grave health problems in animals and humans. Babies up to 6 months, piglets, and human adults or animals suffering from dysentery are particularly susceptible to nitrate-nitrogen levels over 10 ppm, the accepted safe limit. The nitrate is reduced in the blood to nitrite which reacts with hemoglobin and hence reduces the oxygen carrying capacity of the blood. An afflicted person becomes listless and drowsy, the skin takes on a blue color, heart and breathing rates increase, and the blood turns to a chocolate-brown color.

Even though toxic levels in water or forage are not reached, there may be sub-lethal effects such as increased abortion, reduced milk production, stiffness and lameness. For example, one farmer who applied high rates of manure near his buildings, found milk production dropped when nitrate-N levels attained 185 ppm in his well. Substituting spring water raised milk production by 20 percent.

Excessive rates of application of manure or manure runoff can pose a definite threat to animal and human health. In a survey of Quebec, Warkentin found 4 percent of the wells had nitrate-N levels over 10 ppm, indicating the need for care in animal waste disposal.

MANURE—ITS EFFECTS



Disease The scourge of history has been the transmission of diseases by water. Salmonellosis, leptospirosis, hog cholera, tuberculosis, brucellosis, anthrax, hepatitis, diarrhea and respiratory diseases can all be transmitted by water contaminated by manure. Disease represents a real threat where careless manipulation of manure occurs. Often water supplies and animal concentrations are close together and contamination by careless handling of manure often occurs. In Manitoba, 75 percent of 300 wells in one study were contaminated by fecal bacteria. The shallower the well, the higher the probability that it will be contaminated.

PHYSICAL EFFECTS ON CROPS

At greater than 1 ac-in of 10 percent suspended solids or over 15 tons solids, grass-legume stands can be severely affected. Because of the prostrate growth of legumes compared to the upright growth habit of grasses, heavy manure rates will cause a differential selection in favor of grasses. Corn can withstand up to 5 ac-in without being smothered. The differential effect is not due to nitrogen in the manure favoring grass growth. At La Pocatière some results indicate that alfalfa will profit from nitrogen fertilizer, even in a grass-alfalfa association.

The addition of any growth factor (eg. rain or fertilizer) produces less and less yield increase for each increment of that factor. Furthermore, past the optimum rate, yield decreases as manure increases with a cumulative year to year affect.

PHYSIOLOGIC DISORDERS AND PATHOLOGICAL EFFECTS

Nitrate Poisoning When high nitrate concentrations occur in the soil, plants tend to concentrate nitrate in their vegetative parts. Pasture and plants cut for silage or hay can be high in nitrate. Levels over 0.21 percent nitrate-N are potentially toxic. Grains do not concentrate nitrate. Nitrate poisoning from plants or from water has the same characteristics.

High manure applications have caused nutritional unbalance in plants. Such crops fed to animals have led to disorders other than nitrate toxicity.

Grass Tetany Animal manures often contain large amounts of potassium compared to calcium plus magnesium. When such manure is added to soils, the potassium to calcium plus magnesium ratio may be unbalanced causing plants to accumulate relatively more potassium. When this ratio exceeds 2.2 (meq per kg dry) grass tetany becomes a danger and is caused by reduced magnesium in the forage.

Agalactia Another condition that may be related to high poultry manure fertilization is agalactia or failure of the cow to develop her udder and secrete milk at parturition. Agalactia was observed to occur with a higher frequency than normal on heavily manured pastures; no cause—effect relationship has been established. A grain supplement 4 to 6 weeks before

calving has prevented this condition.

Muscular Dystrophy Reduced blood selenium levels have been noted in cows grazing on pastures which have received high broiler manure rates. Lack of selenium is implicated in muscular dystrophy ("white muscle") which often occurs in Abitibi and the Lower St. Lawrence in Quebec. High manure rates may increase the incidence of muscular dystrophy, particularly on low or medium selenium soils.

Fat Necrosis A problem that has occurred in animals grazing on poultry manured pastures is fat necrosis. This is the occurrence of irregularly shaped and sized masses of hard dead fat in the abdominal cavity of cows. These accumulations of dead fat can cause calving problems and can strangulate the small intestine and stop the urinary process causing death. Death comes suddenly without apparent cause in fat necrosis cases. It has been noted that high alkaloid accumulations have occurred in litter fertilized grass. The problem seems to be more prevalent on pastures which have received 10 tons of broiler manure over a period of several years. So far, this problem has been discerned only in the southern United States.

Micro and Minor Element Toxicity It has been noted that hog manure contains high copper levels when CuSO_4 is included in the diets of hogs. High rates of manure application can result in rapid copper increases in soil and plants. To date no copper toxicity caused by heavy manure applications has been reported. Nevertheless, manure can dramatically increase copper in soils and plants and 8.5 lb Cu/ac/year has been suggested as a limit. Manure should be applied when the grass is short and should not be grazed before several rains have fallen, as manure attached to plants can raise copper levels.

CONCLUSION

As with all chemical materials, manure is not necessarily beneficial and harmless. Both depend on rate of application.

To limit any harmful effects, it has been suggested that the maximum should be 300 pounds N per acre as manure for corn in Ontario. Warkentin believes that 450 pounds N can be applied per year in Quebec on a short term basis because of low mineralization. These rates exceed corn nutrient requirements, but are rates that did not cause pollution or crop yield reductions under experimental conditions. Rates should be based on nitrogen content. Nevertheless, for each soil, crop, and farm operation, special care should be taken to prevent any of the above deleterious effects.

Engineering reports indicate that present day machinery can apply very high rates of manure. It is not the engineering capacity, however, that will determine the rate. It is the capacity of the soil and plant to safely handle manure that must be the determinant criterion. ■

Les aliments «fabriqués», que l'on pourrait aussi appeler aliments de composition, et qui renferment une proportion importante de «composants» séparés, occupent une place de plus en plus large sur le marché des produits alimentaires. Or, leur valeur nutritive constitue un problème qui nécessite une attention particulière. Si le Canada veut s'assurer une proportion accrue du marché intérieur et des marchés étrangers pour ces aliments fabriqués, il nous faudra intensifier les travaux de recherche et de mise au point dans le domaine de la technologie alimentaire.

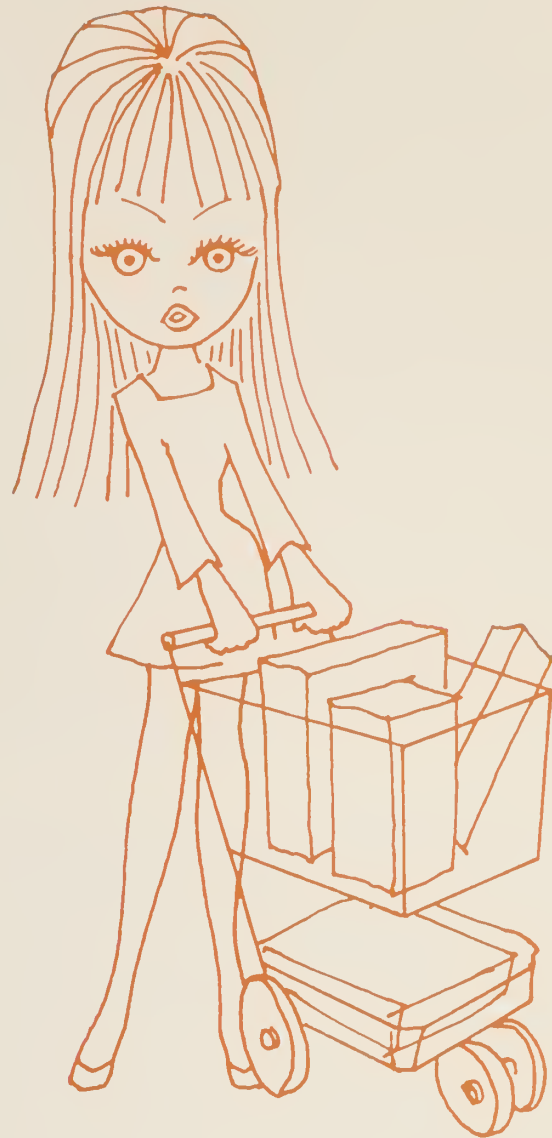
"Designed foods", sometimes called "Fabricated foods", are manufactured foods that contain a significant amount of separated "component" as contrasted with the traditional whole commodity. The agricultural commodity is processed into components which are then modified to produce food ingredients with specific desirable attributes. The major components are proteins, carbohydrates and lipids, which have desirable functional properties that allow them to serve as binders, emulsifiers, thickeners, stabilizers, gelling agents, extenders, whipping agents, nutrients, flavors, etc. "Designed foods" occur in many classes including baked goods, meat products, snacks, baby foods, pet foods, pasta products, desserts, puddings, soups, beverages, breakfast cereals and so on. Designed foods are capturing an ever increasing share of the food market. It has been estimated they will make up about 8 percent of the total North American food sales by 1980.

Last summer, spurred on by the increased price of meats, hamburgers with one-quarter to one-third of their meat protein replaced by soy protein extenders came onto the market. The simulation of traditional foods with less expensive alternative components will become more widespread as the cost of living increases and as component technology improves. However, there is another aspect to consider. We enjoy a very high standard of living wherein food and food service takes less than one-fifth of the average Canadians' expendable income. This affluence allows consumers to indulge themselves, so it is unlikely that such luxury items as meats for the gourmet trade, for example, will be displaced by substitutes or extenders. It is probable, however, that new designed foods will satisfy consumers' criteria for acceptability. That is to say, designed foods can be prestige foods!

NUTRITIONAL VALUE

A problem that requires careful attention is the nutritional status of designed foods. When the designed food is an extender of, or a substitute for,

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DESIGNED FOODS



Unlike many present snack foods that are high in calories, there may someday be a place for "zero-nutrient" foods as snacks for the obese.

a traditional food, the nutritional status of the traditional food must be considered. When the designed food is a new food concept the situation is more complicated. The role the food will play in the total diet may not be readily apparent. There may, in fact, even be a place for "zero nutrient" foods, for example as diet foods or as snacks and between meal tid-bits for the obese.

Nutritional status is likely to be one of the constraints on designed food developments. As an example, it is technically possible to make a synthetic milk that looks and tastes like real milk. It is extremely difficult, however, to incorporate the same quantity of nutrients that occur naturally in milk. Milk is so important in the Canadian diet that it is unlikely health authorities will approve a milk substitute that is not nutritionally equal to milk. It is not likely that we will see an acceptable synthetic milk in the near future. By contrast, coffee whiteners, and whipped toppings are substitutes for dairy products that are not so important in nutrition and are accepted on the basis of their other functional properties.

CHALLENGES FOR A COMPONENTS INDUSTRY

Canadian agriculture must gain a fair share of home and foreign markets for ingredients of designed foods. A great deal of research and development at the food technology level is needed to ensure that competitive technology is developed and used to the advantage of our economy.

Agriculture Canada conducts research in food

technology at three research centers in Canada; the Kentville Research Station, Nova Scotia, the Summerland Research Station, British Columbia, and the Food Research Institute, Ottawa. Some of this research is devoted to development of specific ingredients such as flavors and proteins, but most is aimed at conventional food technology problems.

Stated in bare outline, the requirements for a "components" industry are as follows:

- A source of raw material. We are very fortunate in Canada to have sufficient production of cereals, legumes and oilseeds for raw material. We should be able to compete well with such imported raw materials as rice, cassava, soybeans, peanuts, etc.
- Processing plants. Capital investment in facilities and equipment is required.
- Technology. This can best be provided through research and development. We are seriously short of technologists and research facilities in the Canadian food industry.
- Marketing expertise. Both domestic and export markets must be studied and the full impact of modern technology brought to bear on each problem.

If we are to capitalize on the shift to designed foods, we must sell designed food ingredients both at home and abroad. In Canada, at the present time, imports of processed agricultural materials exceeds exports by a substantial amount. This reflects the fact that we export wheat, rapeseed etc. and import corn starch, soy protein, coconut oil, etc. It goes without saying that the optimum strategy in trade is to sell the



Designed foods, like this soyburger with part of the meat protein replaced by soy protein extenders, will become more popular as component technology improves.

maximum amount of "added value" that is economically possible.

EDIBLE OILS

We export more edible oils than we import if we consider oil-seeds as oil. We import a substantial amount of special oils such as coconut oil and cocoa butter for food ingredient purposes. We need to improve our technology on the utilization of Canadian oils in competition with imported oils.

CARBOHYDRATES

Carbohydrates are a large class of components covering both starch and sugar products. We import much of our sucrose and a substantial amount of starch and starch derivatives such as dextrin and dextrose. We import about one-fifth of our total needs and nearly all of the expensive specialty starch products having "tailor made" qualities.

Starch surpluses are likely to be a problem for Canadian agriculture if we develop a component technology in proteins from legumes or cereals. New technologies are being developed for converting starch to sugar products. These should be exploited and Canadian industry encouraged to supply the Canadian market and compete for foreign markets. We need a great deal of research on new uses for starch and starch products.

PROTEINS

Proteins are the most important class of food ingredients because protein is the most critical factor in world nutrition. In addition, proteins play an impor-

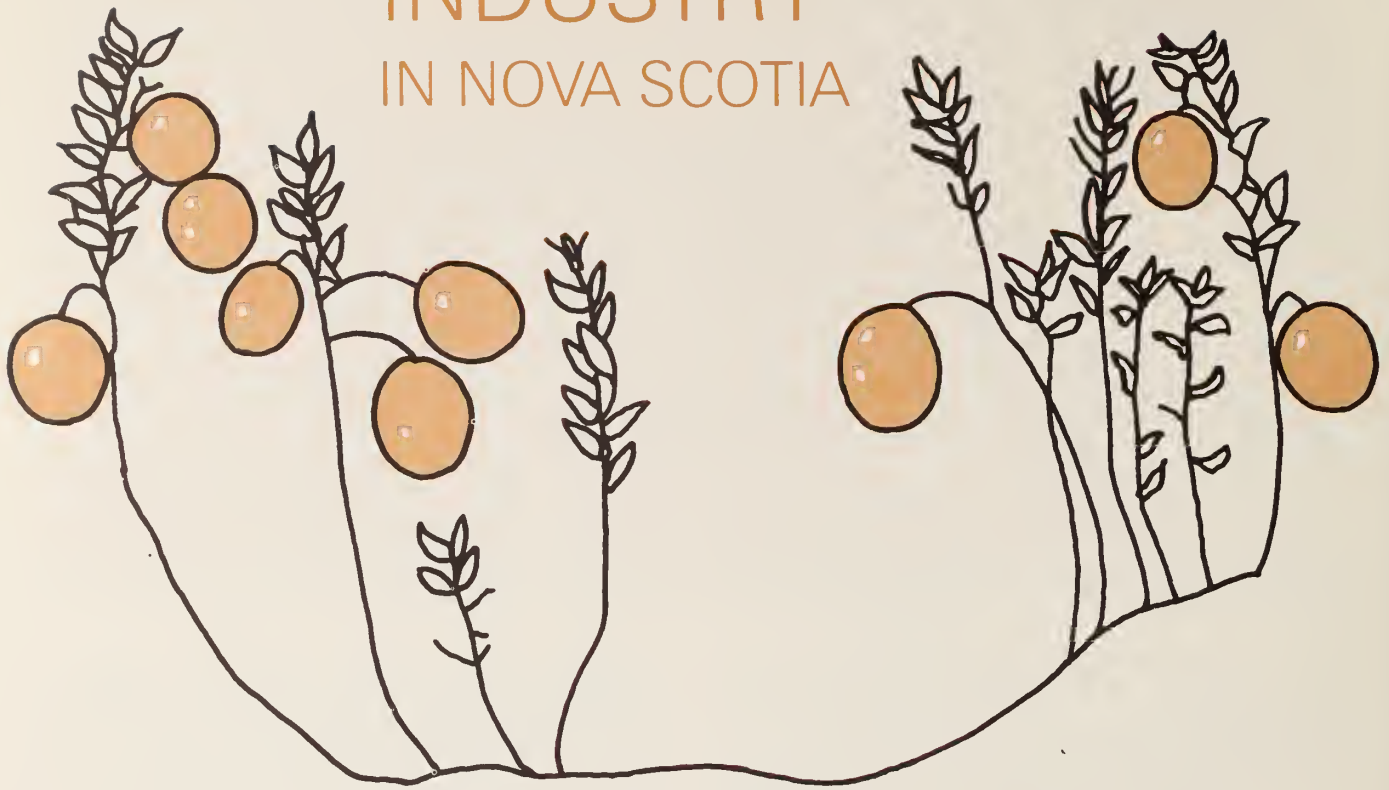
tant role in texture and consistency of many foods. It is predicted that the use of vegetable proteins in human foods will sky-rocket in the next few years.

Increasingly as time goes on, single cell proteins of non-agricultural origin will move into the food chain. At present, substantial experimentation is underway overseas on the feeding of livestock with yeasts and bacteria grown on hydrocarbons. If the economics of such operations prove favorable, an increasing amount of livestock feeds will be produced in this way. It is quite conceivable that single cell protein will become the starting point for protein ingredients in designed foods for human consumption. Such a development, however, is still several years away.

Another potential development area is the extraction of protein from green leaves where yields per acre can be very high. I expect we will see a concerted effort to develop protein technology that will allow us to select and modify proteins with specific functional properties for specific food uses. The food technologist of the future will have a wide range of functional proteins to choose from.

In conclusion, the quantity of designed foods will increase steadily both in domestic and foreign trade. Canada is in a good position to compete in these markets with ingredients from cereals and oilseeds. We will continue to be dependent on imports of plantation food products and many highly specialized food components. Our success with designed foods will depend in large measure on research and development. If we compete successfully, Canadian agriculture and the Canadian economy will benefit. ■

THE CRANBERRY INDUSTRY IN NOVA SCOTIA



R. STARK, I.V. HALL and R.A. MURRAY

Après plusieurs années de stagnation, la production de canneberges remonte en Nouvelle-Écosse. La création de nouveaux produits et de nouvelles techniques d'entreposage de la canneberge sauvage par la Section de technologie alimentaire de la Station fédérale de recherches de Kentville a favorisé cette relance.

Thomas Carlyle, the Scottish historian once said, "History is the story of famous men." The history of cranberry growing in Nova Scotia is the story of many outstanding men. The pioneers of the late 1800's and early 1900's surveyed what was considered useless bogland and had a vision that it could be converted into cranberry bogs. They built dams to impound water for frost protection, selected vines

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from the wild, fought the fruitworm with the insecticides available and set the vines by hand. They were men of strong determination as there were many setbacks.

It is interesting to read the records of cranberry development in Nova Scotia from 1870 onward. In the 1874 report of the Nova Scotia Fruit Growers' Association, it is recorded that a shipment of berries was sent to Boston that year and arrived in excellent condition. In 1892, the first carload of berries was shipped from the Annapolis Valley to Montreal. In 1899 and 1900, small consignments of berries were shipped to London, England.

Early production figures for the province are incomplete. There was sizable production from certain areas. The Annapolis Valley recorded 1,500 barrels in 1894, 3,000 in 1896, 5,000 in 1908 and 6,000 barrels in 1916 when 300 acres were in production. By 1955, there were some 30 cranberry growers in Nova Scotia cultivating approximately 230 acres.

Like all men, they grew old and their enthusiasm

for cranberries waned. Economic changes, removal of protective duties from United States' berries after World War II, resulting in poor prices dampened growers enthusiasm. By 1965, the number of growers had fallen to less than 12, and there were probably no more than 60 acres. Today the trend has been reversed.

Backed by a viable processing industry and modern technology the cranberry industry in Nova Scotia is reversing the trend of the early 1960's, with production increasing over the last 8 years.

The optimistic findings of the 1966 A. R. D. A. Cranberry Survey has renewed the enthusiasm of a few Nova Scotia cranberry growers. With encouragement from cranberry growers and specialists in Wisconsin and Cape Cod, they have revived an industry that goes back, at least to 1870.

A new generation of growers have bought existing bogs, and have started to re-develop them. They have introduced electric power to run irrigation pumps, levelled bogs for water harvesting, and planted more productive cultivars. They believe that a wider range of cranberry products was a partial answer to marketing problems.

Assistance in the development of products from native cranberries was provided by the Food Technology Section of the CDA Research Station at Kentville, N.S. A cranberry cocktail with high quality flavor and color has been developed. This product was followed closely by a cranberry-apple drink. It is a sweeter, less astringent product aimed particularly at children or people with a 'sweet tooth'. To maximize yields and maintain the highest possible quality, extraction procedures had to be studied. Both products have added vitamins to compete with other breakfast drinks. A well flavored cranberry wine is another recent development.

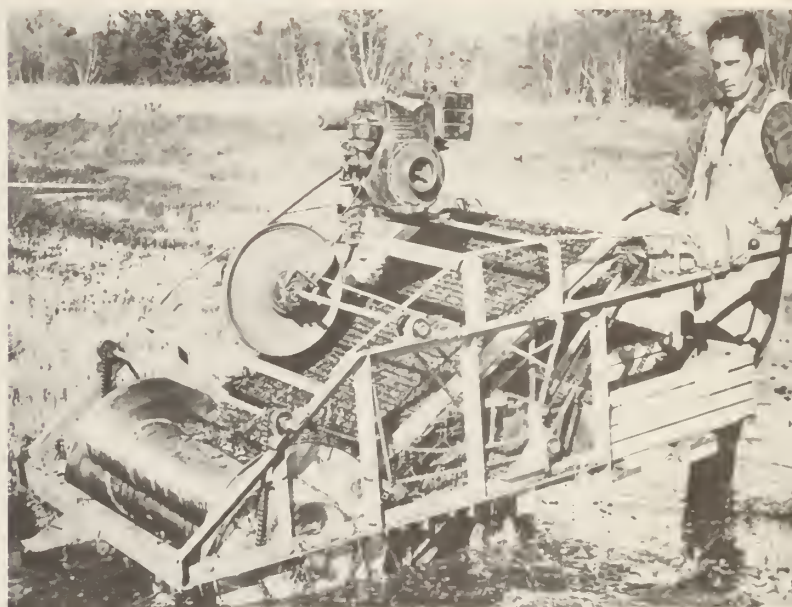
Some emphasis has been placed on the effects of various storage techniques on the processing quality of cranberries. Tests indicate that storage in 100 percent nitrogen atmospheres for extended periods is possible, in the event that freezer space is unavailable. Sauce produced from these berries has been of excellent quality.

Tests to determine the reasons for the high quality and superior color of the native cranberry indicate that lower temperatures, such as those found in more northerly climates during the development of the cranberry fruit, enhance the formation of anthocyanin pigments. ■

(Top) Cranberry bogs showing automatic sprinkler irrigation system in operation. The system is also used for frost protection and application of fertilizers.

(Middle) A cranberry water harvester removes the cranberries from the vines. The bogs are partially flooded to lift the cranberry bearing shoots and make them more accessible to the harvester.

(Bottom) Sorting and grading the cranberries, removing foreign material and immature berries.





FERTILIZING CROPS ON SOLONETZ SOIL



R. R. CAIRNS

Les chercheurs de la Sous-station des sols solonetziques du ministère de l'Agriculture du Canada ont trouvé que la gestion de ces sols était extrêmement difficile. La réaction des cultures céréalières aux engrais a été imprévisible tandis que les plantes fourragères ont réagi tel que prévu. L'amélioration de la productivité du sol est possible si l'on connaît bien la nature des solonetz.

At the CDA Solonetzic Soil Substation, Vegreville, Alberta, cereal crop response to fertilizers has not always been productive or profitable. Forage crop response has been more predictable.

This difference is a reflection of the nature of Solonetz soils. Solonetz soils have a shallow Ap horizon, or surface soil, underlain by a very heavy and hard layer known as the Bnt horizon. The Bnt horizon presents a physical barrier to root penetration. Since cereal crops are seeded each spring, there is very little time for the roots to penetrate the Bnt horizon before the onset of summer drought. Perennial forage crops

also encounter the Bnt barrier, but have more time to establish an extensive root system.

FORAGE CROP RESPONSE

Grasses are well adapted to Solonetz soil and they normally respond to nitrogen fertilizer. Just how profitable the response will be depends on regional annual moisture supply. Response can be a near certainty under natural conditions in the Black and Dark Brown soil zones at certain levels of nitrogen. In the Brown soil zone where annual precipitation is normally less than 14 inches, profitability is not so certain.

During the period 1961 to 1971 inclusive at Vegreville, the unfertilized check and the 100, 200, 400 and 800 lb/acre annual applications of ammonium nitrate (34-0-0) gave average annual brome grass yields of about 1000, 1900, 2400, 3500 and 4400 lb/acre respectively. The annual profits, using one-cent/lb as the value of hay and \$78.00/ton as the cost of the fertilizer, were \$5.11, \$6.60, \$10.02 and \$3.30 for the 100, 200, 400 and 800 lb/acre treatments respectively. In 1969, a very dry year, the 100 lb/acre application gave a profit of only \$1.26 and the higher rates gave losses of \$1.45, \$2.22 and \$11.68/acre respectively.

Results of similar studies on Solonetz soils throughout the Black and Dark Brown soil zones have led to the conclusion that the annual application of

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Three inches of water and 400 lb of 34-0-0 made the difference in the Brown soil zone.

200 lb of ammonium nitrate/acre to grass will invariably yield a reasonable profit to the producer. On certain soil types a higher rate will prove more profitable and the producer who wishes to maximize profits will soon discover the optimum rate.

Generally speaking, rates higher than 200 lb/acre annually will be profitable only on those soils with an Ap horizon of six or more inches in depth. In the Brown soil zone there is some evidence that crop response could be assured by applying nitrogen fertilizer in about three inches of irrigation water. However, profitability is by no means assured.

Application of other nutrients such as phosphorus and potassium often produces a response in grass crops. However, this has not been demonstrated to be profitable. Part of the reason may be that the overriding nitrogen deficiency restricts crop growth where the other nutrients are applied in the absence of nitrogen. Where nitrogen is applied it appears to correct some of the apparent deficiencies in the other nutrients. For instance, the simple application of nitrogen fertilizer has been found to nearly double the potassium content of the crop even in the absence of added potassium.

INCREASED ACIDITY

There are some precautions to be observed in the application of nitrogen fertilizers. Solonetz soils generally have a relatively low pH. Nitrogen fertilizers

commonly available in Canada, such as urea, ammonium nitrate and ammonium sulfate, increase soil acidity. During a 10-year period, the annual application of 100 lb of nitrogen/acre as urea or ammonium nitrate lowered the soil pH from 5.6 to about 4.8 while a similar application of ammonium sulfate lowered it to 3.9. In a separate study where the soil pH was lowered to 3.3 by the application of flowers of sulfur, all cereal crop production was eliminated. Ammonium nitrate and urea are thus fairly acceptable from a pH standpoint, but the former improves Solonetz soil by increasing the infiltration rate of water. Of these three nitrogen fertilizers, ammonium nitrate is the most acceptable. Calcium nitrate would be a much more desirable form on these low-calcium, low-pH soils.

FERTILIZER ON LEGUMES

Legume crops are uncertain at best on Solonetz soil and a fertilizer treatment has not been found that would make them a sure and profitable crop.

Cereal crop response to fertilizer is variable and uncertain on Solonetz soil and no good diagnostic method has been developed to predict profitability. However, 15-years experience at Vegreville and elsewhere has indicated an average annual profit of about \$5.00/acre from drilling in 50 lb of 11-48-0/acre or 63 lb of 27-14-0/acre with wheat on fallow, or 80 lb of 27-14-0/acre with stubble crops. Numerous minor or nuisance changes are made in fertilizer analyses from time to time. A producer may assume that what is labelled 27-14-0 is for all practical purposes the same as 26-13-0 and so on.

Serious financial losses can result from certain fertilizer practices. For instance, serious losses have resulted in nine years out of ten at Vegreville by following the widely recommended practice of broadcasting nitrogen fertilizer for the production of stubble crops. With cereal crops, the possible profits are so attainable and the losses so unacceptable that every producer should pay very close attention to response, crop value, fertilizer cost and other factors.

SUMMARY

The judicious use of nitrogen fertilizers on grass crops grown on Solonetz soils will improve the productive capacity of the soil and lead to almost certain profit. There are opportunities, even though less certain, to obtain substantial profits from the skillful use of fertilizers on cereal crops and opportunities to lose considerable money through the inept use of fertilizer. There is also a possibility of causing long-term damage to the soil by using the wrong fertilizer. Fertilizer will not overcome poor surface drainage, poor seeding, soil crusting and poor farming in general. However, it behooves any serious farmer to pay a great deal of attention to this factor in crop production, since production is the ultimate basis of his prosperity. ■

Les chercheurs de la Station de recherches de Charlottetown ont étudié les effets de divers facteurs comme le pH du sol, la texture et la teneur en matière organique du sol sur le degré d'assimilation du bore; cet élément intervient dans la prévention du cœur brun chez le rutabaga. La teneur en B était plus élevée dans les sols à texture fine que dans les sols à texture grossière et le pH du sol peut influencer sur l'action du B dans le sol.

The role of Boron (B) in the prevention of brown-heart of rutabagas was known more than 30 years ago. However, the precise amounts of B required to correct this disorder and the factors that affect the B requirement of the crop were not known. Even today we have only a few answers to these questions. In general, the chemistry of most micronutrients in soils and the reactions that micronutrient fertilizers undergo with soil constituents are extremely complex. Soil factors, such as water content, soil texture, and pH changes affect the availability of micronutrients (or trace elements) and make the problem of soil testing for micronutrients difficult. The availability of these elements can also be affected by the quantities of macronutrients (N, P, and K) applied. Consequently, we conducted a study at the Charlottetown Research Station to determine the effect of various factors, such as soil pH, soil texture, and organic matter on the availability of B in the soil.

There are two compounds generally used as sources of fertilizer B in P.E.I. (1) Borate 65 ($\text{Na}_2\text{B}_4\text{O}_7$), labelled as containing 20 percent B, is most commonly used in N-P-K fertilizer mixes. (2) Solubor ($\text{Na}_2\text{B}^{10}\text{O}_{16} \cdot 10\text{H}_2\text{O}$), labelled as containing 20 percent B, is mostly used as a spray for orchards.

Addition of lime to soils has been found to decrease the uptake of B by crops. The amount of B applied to the soil must be increased at higher soil pH values to control B deficiency problems (Table 1). It has been found that soil B contents of 2.5 to 3.5 lb/ac are necessary to overcome B deficiency in rutabagas. The greater amount of B required at Location 2 was due to a high pH of the soil. It has been established that leaf tissue B concentrations of greater than 38 ppm, when the roots begin to enlarge, are associated with roots free from brown-heart.

Results from analyses of soils from the three Maritime Provinces indicated that the available B content was higher in fine-textured soils than in coarse-textured soils (Table 2). However, we do not know how such soil texture affects the uptake of B by crops,



Boron deficiency symptoms on rutabaga.

THE AVAILABILITY OF BORON TO RUTABAGAS

Dr. Gupta is a micronutrient specialist, and Mr. Cutcliffe is head of the Horticulture Section, CDA Research Station, Charlottetown, Prince Edward Island.

since most of our field work in Prince Edward Island has so far been carried out on sandy loam soils. A significant relationship has been established between the available B content and the organic matter content of soil. Generally, the B content of soils increased with an increase in the organic matter content of soil.

Analysis of rutabaga leaf tissue samples and corresponding soil samples from various locations on Prince Edward Island during the summer of 1972 indicated that most fields were fertilized with adequate quantities of B (Table 3). The B concentration of tissue was well correlated with the corresponding soil B. A slight brown-heart condition was noted only at Summerville; this was related to the below optimum levels of B in the soil and plant tissue.

Analyses of root tissues have shown small differences in B content between healthy roots and those affected with brown-heart. Root analysis, therefore, is not considered to be a good indicator of the B status of this crop.

It should be pointed out that under severe conditions of B deficiency the roots become rough, netted and elongated and thus the disorder can be detected by examining the external appearance of the roots. Under severe B deficiency, the outer edges of the leaves become yellow and purple in color with some scorching. Such symptoms are not uniformly distributed on the leaf surface and are distinguishable from those of N or K deficiency.

More research is necessary on the effects of methods of applying B to the soil, e.g., banded versus broadcast. Banding was used in all of our field trials, since this method will likely be the most popular for

applying B. Also, we need information on foliar application of B during the early growth stages to see whether or not B deficiency can be corrected by this method. Researchers at Guelph, Ontario, have had some success in getting B into the plant by this method. However, it must be remembered that the soils of that area have pH values of 7.0 or higher. On most Prince Edward Island soils containing less than 1 lb/ac available B, with a pH less than 6.0, an application of 2 to 2.5 lb B/ac, when applied in bands, should completely eliminate the brown-heart condition. On soils with a pH value greater than 6.0, having less than 1.0 lb/ac available B, an application of 2.5 to 3 lb B/ac applied in bands may be required.

Our experiments on Island soils have shown that 60 percent or more of the applied B is lost within 6 months of application. Therefore, soils receiving about 3 lb B/ac for rutabagas had a residual amount of 1.5 lb/ac or less.

Experiments have shown that cereals were not adversely affected by rates of B up to 2.0 lb/ac. Therefore, even where high rates of B (up to 4 lb/ac) are applied for rutabagas, it is safe to follow with cereals in the rotation.

Soil pH can affect the action of B in the soil, but if the levels of B indicated here were applied to the soil for rutabagas, there should be no brown-heart problems. The occasional field that did show brown-heart was a mistake on someone's part. Either the farmer did not get a high enough percentage of B in the fertilizer, or he did not apply enough fertilizer to have a total B application capable of controlling the deficiency, or possibly the B was not mixed properly with the fertilizer. ■

TABLE 1 RELATIONSHIP OF SOIL B TO TISSUE B CONTENT AND BROWN-HEART OF RUTABAGAS

B in soil (lb/ac)	Location 1 (sandy loam) soil pH 5.4	Location 2 (fine sandy loam) soil pH 6.3
	Tissue B (ppm)	
1.5	6 ¹	12 ¹
2.5	41	30 ¹
3.5	75	42
5.5	222	74
9.5	305	128

¹Roots showed brown-heart condition.

TABLE 2 RELATIONSHIP OF SOIL TEXTURE WITH THE AVAILABILITY OF B IN SOILS

Texture	No. of samples	Available B (ppm)
Sandy loam	32	1.0
Fine sandy loam	15	0.7
Sandy clay loam	17	2.0
Loam to silt loam	14	2.5
Clay loam	22	2.2
Silty clay loam	8	2.8

Value of r for soil O.M. vs available B=0.6 (90 samples).

TABLE 3 BORON CONTENT OF SOIL AND RUTABAGA LEAF TISSUE COLLECTED IN P.E.I.

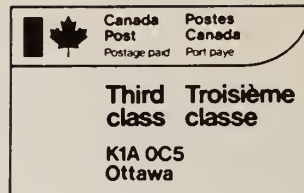
Location	Soil B		Tissue B (ppm)
	(ppm)	lb/acre	
Bear River	2.3	4.6	168
Tryon	2.1	4.2	81
Alma	1.8	3.6	87
Souris	1.8	3.6	75
Mill River	1.5	3.0	82
Alberton	1.2	2.4	50
Summerville	0.9	1.8	30

ERRATUM

Volume 19, Number 1, Winter '74

Page 18, column 1, paragraph 4, line 4—The article as printed states: "An insecticide at \$6.00 per acre will save \$1.20 per acre of sugar beets . . ." This should read: "An insecticide at \$6.00 per acre will save \$120 per acre of sugar beets . . ."

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