WINTER 1976
HIVER 1976

The Peace River area presents a challenge. See articles on pages 19 and 27 for interesting research developments.

La région de la Rivière de la Paix offre un défi. Pour résultats de recherches, voir pages 19 et 27.

CANADA AGRICULTURE

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Agriculture Canada

THE FUTURE OF CEREAL PROTEIN

V. D. BURROWS

Un accroissement de la teneur en protéines des céréales, de leur valeur nutritive et de leur rendement peut s'avérer très bénéfique, même s'il est faible. Ce n'est que récemment, par suite de la pénurie de céréales, qu'on s'est intéressé à l'amélioration de la valeur nutritive des céréales par voie de modification des protéines qu'elles renferment. L'avoine devrait être la première céréale fourragère à être transformée pour l'alimentation humaine.

Although pulses and oilseeds are classed as the seed protein crops of the world, humans and domestic animals derive vast quantities of seed protein from cereals. However, the nutritional qualities of different crops are not equal. For cereals, even small improvements in percentage protein, nutritional quality or grain yield can be of significant benefit. Due to grain shortages, it is only recently that there has been a movement toward improving the nutritional quality of cereal grains by modifying cereal storage proteins.

There are three major problems in breeding cereal plants that are rich in protein. First, total seed yield potential of high protein cultivars is less than for low protein cultivars. This negative association between yield and protein content is also found in pulses and oilseed crops. The physiological basis for this is not known, but such information would be useful in breeding both high protein cultivars and high yielding low protein cultivars.

The lower yield of high protein cultivars such as the oat, Hinoat, could be a deterrent to use by growers. However, food processors like Gen. Foods of Canada may continue to pay producers a premium to grow the crop. The use of a crop with a high percentage protein may be the only economical way food processors can meet a nutritional requirement in their product. The processor may also find it to be a good starting material to use to fractionate the grain into various components.

The second problem in breeding for high protein in cereals is the decline in the nutritional quality of the protein as the protein level is increased. This occurs because the nutritionally inferior alcohol soluble protein fraction that is low in essential amino acids is preferentially increased as total protein levels rise. Some cereals already have a substantial portion of their reserve proteins in alcohol soluble form (see table), whereas in rice and oats the content of alcohol soluble protein is low. Thus, for oats and rice, it makes sense to breed high protein cultivars because the nutritional quality of the protein is not reduced significantly as protein levels increase. For crops with a high content of alcohol soluble protein, it is probably better to breed for higher yield potential than for increased protein content.

The third problem is associated with the environment. Because the environment plays a major role in determining the protein content of seed, it creates problems in selecting plants in segregating generations for their genetic capacity to produce high protein. At the Ottawa Research Station, we have developed a screening test ("excised leaf senescence technique") to identify high and low protein cultivars of oats. Our evidence indicates that the test will be useful in selecting high

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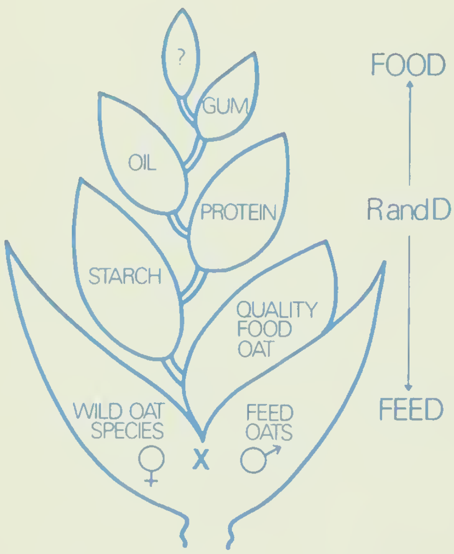

protein cultivars of oats.

Higher nutritional quality of a cereal protein can be obtained by raising the level of the deficient amino acids. Lysine is the most deficient amino acid in all cereals. Second position is shared by threonine in oats, barley, rye and wheat and by tryptophan in maize. The technique that has been used to modify protein quality is to locate genes that modify the relative amounts of the various protein fractions.

Breeders of commercially acceptable high lysine cultivars of maize and barley have encountered problems of reduced yield potential, storage, insect damage and public acceptance. In maize, yields were low and the flour did not have the functional quality of standard hybrids or inbreds. Also, the kernels were soft and easily broken. However, progress has been made in breeding harder seeded strains of maize and plumper kernels of barley with the high lysine characteristic.

Improvement in nutritional composition of cereal protein will likely result in a reduction in the conventional quality of flour. However, a change in handling characteristics of flour does not necessarily mean an inferior flour. New foods produced by the food industry from this flour will likely be nutritionally superior to foods made with conventional flours.

Yields of protein per acre can be increased by raising the yield potential of cereals and growing cereals on land that is now not occupied by cereals. The greatest advances in yield can be obtained by breeding objectives or cultural techniques that produce more kernels per flowering head. The other components of yield such as tiller number per unit area and seed size can be controlled or selected more readily, but seed number per head is more difficult to change. Seed number per head is determined during the semi-reproductive phase of apical development. This is the period between the termination of leaf initial differentiation and the onset of anther and ovary differentiation.

The length of the semi-reproductive phase of apical development is also conditioned by temperature. Early planted cereals have large heads because there is more time to grow under cool conditions to initiate more seeds per head. With oats, we are developing the "dormoat" crop to take advantage of early spring temperatures and moisture. This experimental crop consistently develops large flowering panicles with many seeds. Yield increases of 10-25 percent have been obtained by sowing "dormoats" in the fall rather than in the spring at Ottawa. In addition to establishing management practices for "dormoats", we are developing high protein "dormoats". Hopefully, the higher yield potential of "dormoats" will offset the lower yield potential of high protein oats. We will likely be ready to test the "dormoat" crop on selected Canadian farms within 2 years.

In the future, plant breeders should concentrate on making cereals more suitable for direct human use. Research should be continued on raising the protein level and lysine content of barley. Oats will probably be the first traditional feed grain to shift to a predominant food use. The rye crop remains an unexploited crop in Canada in spite of the fact that it is high yielding, very winder hardy, has good adaptability and good quality protein. Problems associated with its "feeding characteristics" need clarification through research.

However, future protein development in cereals will only be achieved by cooperation between imaginative and persevering scientists and technologists. ■

CONTENT OF ALCOHOL SOLUBLE PROTEIN IN VARIOUS CEREAL GRAINS

Crop	Alc. sol. fraction	% of total protein
Millets	penicin	60
Sorghum	kafirin	60
Wheat	gliadin	50
Maize	zein	50
Rye	secalin	40
Barley	hordein	40
Oats	avinin	12
Rice	oryzin	8

PRECIPITATION GOES METRIC

S. N. EDEY

When is a million dollars measured in millimetres? Since September 1, 1975, the proverbial million dollar rain has been measured and given in millimetres rather than in the usual inches. A rainfall that breaks a 2 or 3 week drought in the growing season, regardless of its amount, is worthy of the name "million dollar rain". More specifically, Prairie grain growers can benefit by $200 million if an additional 25 mm of rain falls during the growing season. This money comes from an increased yield of up to 2 bu/ac (135 kg/ha) for wheat as a direct result of extra soil moisture. A 25 mm increase in rain during July can result in an increase of 5 bu/ac (315 kg/ha) of corn. If expressed in dollars and cents, it could be worth over $20 million. That's the value of a few millimetres of rain at the right time.

It takes a lot of water to grow crops. For example, a corn crop will use at least 2.5 mm of water on an average day and up to 10 mm on a peak day. Throughout the growing season, an individual corn plant alone will use 225 ℓ (50 gal) of water. It takes about 500 to 640 mm of rain during the growing season (April 15 to October 15) to produce maximum yields of corn. Crops require the most rainfall (between 150 and 180 mm) during July. However, this month is usually deficient and soil moisture reserves must be brought into use. The amount of precipitation needed for optimum plant growth also varies from crop to crop. Cereal crops use 400 - 450 mm, alfalfa uses 600 - 760 mm.

Mr. Edey is a climatologist with Agrometeorology Research and Service, Chemistry and Biology Research Institute, CDA, Ottawa.

Snowfall is also now expressed in metric units. Farmers in eastern Canada will "clean up" after 25 cm of snowfall this winter rather than the usual 10 in.

Snowfall statistics for Canada show some interesting extremes. For instance, the greatest snowfall in one winter season occurred in 1971-72 at Revelstoke, B.C. and totaled an astronomical 2446 cm. The greatest snowfall in one day was on June 29, 1963, when 112 cm fell at Livingstone Ranger Station, Alta

To the farmer, 30 cm of snow is worth a great deal, despite the inconveniences it creates. Snow provides protection for overwintering plants from temperature extremes through its insulating effect. Although air temperatures may drop to −40°C, soil temperature under 30 cm of snow will only be −8°C. Seven centimetres of snow on the ground permits soil surface temperatures to fluctuate only 49 percent as much as air temperatures and each 30 cm of snow cover reduces frost penetration by 60 cm.

Snow melt in the spring adds to the soil moisture reserves that are critical to grain growing areas of western Canada. Twenty-five cm of snow will give 2.5 cm of water. Over 50 per cent of this precipitation is added directly to the soil during melting in spring.

On April 1, 1976, wind observations will also be given in metric units, km/hr, (1 km = 0.62 miles). Accordingly, the weather forecast will no longer read: sunny and cool, winds 15-20 MPH, but rather: sunny and cool, winds 25-30 km/hr.

The accompanying table relates the observed wind effects to wind speed and may help to metrically interpret wind speed.

During cold, winter days, the terms, wind chill, wind chill factor and wind chill temperature, are used to describe weather. The wind chill factor is the rate of cooling or heat loss from a warm body when exposed to factors favorable for the loss of heat. You may feel more comfortable with the temperature at −10°C with little or no wind than with a temperature of 0°C and a moderate wind of 30 km/hr (19 miles/hr). Under the latter conditions, the cold seems to penetrate through protective clothing.
The following table gives the relationship between temperature and wind velocity.

The wind chill temperature is only an indication of the rate of cooling. The actual temperature of a body or article is not colder than the temperature of the surrounding air regardless of wind speed. ■

Wind Term Used	Km/hr	Observed Wind Effect
Light	1 - 5	Virtually calm; smoke rises almost vertically; wind direction shown by smoke's drift rather than by wind vanes.
	6 - 11	Wind felt on face; leaves rustle; ordinary vane moved by wind.
Gentle	12 - 19	Leaves and small twigs in motion; wind extends light flag.
Moderate	20 - 29	Wind raises dust and loose paper; small branches move.
	30 - 39	Small trees in leaf begin to sway; crested wavelets form on inland waters.
Strong	40 - 50	Large branches in motion; whistling heard in telephone wires; umbrellas used with difficulty.
	51 - 61	Whole trees in motion; inconvenience felt when walking against wind.
Gale	62 - 74	Wind breaks twigs off trees; generally impedes progress.
	75 - 87	Slight structural damage occurs, such as shingles blowing off.
	88 - 119	Trees uprooted; considerable structural damage.
Hurricane	120+	Widespread damage.

WIND CHILL INDEX

Wind Speed	Thermometer Reading (°C)				
Calm	0	−5	−10	−20	−30
	Wind Chill Temperature Equivalent[1]				
10 km/h	−1	−7	−13	−21	−32
20 km/h	−8	−14	−20	−32	−57
30 km/h	−13	−19	−25	−38	>−60
40 km/h	−15	−22	−28	−45	>−60

[1]The indicated values are approximated.

PLUIE, NEIGE ET SYSTÈME MÉTRIQUE

S. N. EDEY

Depuis le 1er septembre 1975, la pluie d'or dont on parle si souvent à la campagne, est mesurée en millimètres plutôt qu'en pouces. Une pluie après une sécheresse de 2 ou 3 semaines durant la croissance, quelle que soit la quantité puisque le temps est plus important, est une pluie d'or. Ainsi, les céréaliers des Prairies peuvent gagner jusqu'à 200 millions de dollars si une pluie d'or de 25 millimètres tombe durant la croissance. Ceci à cause d'une augmentation de production allant jusqu'à 2 boisseaux à l'acre (135 kg/ha pour le blé) grâce à une plus grande humidité du sol. De même, les producteurs de maïs, surtout en Ontario, profitent des pluies puisqu'une chute de 25 millimètres en juillet peut augmenter la production de 5 boisseaux à l'acre (315 kg/ha) et, en dollars, ceci vaut plus de 20 millions. Telle est la valeur de quelques millimètres de pluie au bon moment.

Il faut beaucoup d'eau pour les cultures. Ainsi, une récolte de maïs nécessite au moins 2,5 mm d'eau au cours d'une journée moyenne et 10 mm au cours d'une journée très chaude. Tout au long de la saison, un seul plant de maïs absorbe 225 litres d'eau (ou 50 gallons). En général, il faut de 500 à 640 mm de pluie au cours de la saison (du 15 avril au 15 octobre) pour produire un rendement maximal. Au mois de juillet, il faut une plus grande quantité de plus (entre 150 et 180 mm). Cependant, il n'y en a généralement pas assez au cours de ce mois et les réserves d'humidité du sol doivent être utilisées. L'importance des précipitations nécessaires pour une croissance optimale des plants varie aussi de récoltes en récoltes. Les récoltes de céréales ont besoin de 400 à 450 mm alors qu'il en faut de 600 à 760 mm pour la luzerne.

Outre la pluie, les renseignements sur les chutes de neige sont aussi donnés en unités métriques depuis le 1er septembre 1975. Ainsi, les fermiers de l'est du Canada devront nettoyer après une chute de neige de 25 centimètres plutôt qu'après les 10 pouces habituels.

Les statistiques sur les chutes de neige au Canada renferment quelques données intéressantes. Par exemple, la chute de neige la plus importante au cours d'une saison hivernale a eu lieu en 1971-1972 à Revelstoke, Colombie-Britannique et s'élevait à 2446 cm. C'est à Livingstone Ranger Station, Alberta qu'on a enregistré la plus importante chute de neige en une journée, soit 112 cm et elle s'est produite, aussi curieux que cela puisse paraître, le 29 juin 1963.

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Pour le fermier, 30 cm de neige a une grande valeur même si elle entraîne des inconvénients et d'autres problèmes. Comme elle agit en tant qu'isolant, la neige protège les plantes en hibernation des températures rigoureuses. La température de l'air peut tomber à −40°C mais la température du sol, sous 30 cm de neige, ne sera que de −8°C. Avec 7 cm de neige la température du sol ne varie que de 49% par rapport à la température de l'air et chaque couche de 30 cm de neige réduit la profondeur de pénétration du gel de 60 cm.

Lorsque la neige fond au printemps, elle accroît les réserves d'humidité du sol qui sont si importantes dans les régions de culture des céréales de l'Ouest. Vingt-cinq centimètres de neige donnent 25 mm d'eau et plus de 50% de cette précipitation s'ajoute directement au sol au cours de la période de fonte au printemps.

A compter du 1er avril 1976, la vitesse du vent sera aussi exprimée en unités métriques, soit en kilomètres à l'heure (un kilomètre équivaut à 0.62 mille). Ainsi, les prévisions météorologiques ne se liront plus comme suit: ensoleillé et frais, vent de 15 à 20 milles/heure, mais plutôt: ensoleillé et frais, vent de 25 à 30 km/h.

Le tableau suivant fait état des aspects de la vitesse du vent.

Intensité du vent	Kilomètres à l'heure (km/h)	Effets observés du vent
Faible	1 - 5	Presque calme; la fumée s'élève presque verticalement; la direction du vent est indiquée par le mouvement de la fumée plutôt que par les girouettes.
	6 - 11	On peut sentir le vent sur le visage; les feuilles bruissent; les girouettes ordinaires indiquent la direction du vent.
Léger	12 - 19	Les feuilles et les brindilles sont en mouvement; les petits drapeaux se déploient sous l'action du vent.
Modéré	20 - 29	Le vent soulève la poussière et les feuilles de papier; les petites branches bougent.
	30 - 39	Les petits arbres feuillus commencent à se balancer; de petites vagues à crête se forment sur les cours d'eau.
Fort	40 - 50	Les grosses branches sont en mouvement; on entend un sifflement sur les lignes téléphoniques; on peut difficilement tenir un parapluie.
	51 - 61	Tout l'arbre est en mouvement; il est difficile de marcher contre le vent.
Violent	62 - 74	Le vent casse les brindilles des arbres; il empêche généralement d'avancer.
	75 - 87	Les bâtiments subissent de faibles dégâts; par exemple, les bardeaux s'envolent.
	88 - 119	Arbres déracinés; dégâts importants causés aux bâtiments.
Ouragan	120 et plus	Dégâts étendus.

Au cours des journées très froides de l'hiver, la radio, la télévision et la presse emploient pour décrire la température extérieure les expressions: froideur du vent, facteur de refroidissement du vent et température de refroidissement du vent. En résumé, le facteur de refroidissement du vent est l'indice de refroidissement ou de perte de chaleur d'un corps chaud lorsqu'il est exposé à des facteurs favorisant cette perte. On peut supporter plus facilement une température de −10°C en l'absence presque complète de vent qu'une température de 0°C avec un vent de 30 km/h. Dans ces conditions, le froid semble pénétrer vos vêtements.

Le tableau donne une idée du rapport entre la température et la vitesse du vent.

INDICE DE REFROIDISSEMENT

Vitesse du vent	Température au thermomètre (°C)				
calme	0	−5	−10	−20	−30
	Equivalence de températures de refroidissement du vent[1]				
10 km/h	−1	−7	−13	−21	−32
20 km/h	−8	−14	−20	−32	−57
30 km/h	−13	−19	−25	−38	>−60
40 km/h	−15	−22	−28	−45	>−60

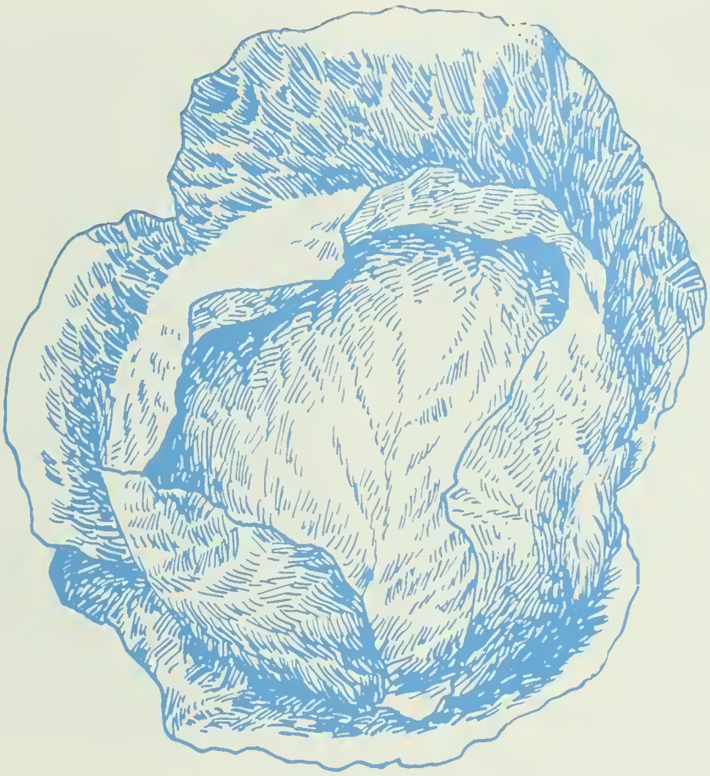
[1]Les valeurs indiquées sont approximatives.

Il faut se souvenir que la température de refroidissement n'est qu'une indication du taux de refroidissement. La température réelle d'un corps ou d'un objet ne peut devenir plus froide que la température de l'air ambiant, quelle que soit la vitesse du vent. ■

REDUCING DISEASE LOSSES IN STORED CABBAGE

C. L. LOCKHART

La lutte contre les maladies du chou, en entrepôt, pourrait accroître de façon significative sa durée de conservation. A condition de n'entreposer que les choux verts de fin de saison, de les manipuler avec soin et de régler judicieusement la température et l'humidité dans l'entrepôt, on peut conserver les choux jusqu'à six mois tout en réduisant les maladies de conservation.



Decay of cabbage in storage has been a problem for many years. Grey mold rot caused by *Botrytis cinerea* Pers. and rots caused by *Alternaria* spp. are the most important storage diseases. Control of these diseases on cabbage in storage would significantly increase storage life. Losses from other microorganisms such as *Fusarium* spp, and bacteria are minimal.

Over 815 ac (330 ha) producing about 12,956,128 lb (5 876 900 kg) of cabbage are grown in the Atlantic Provinces each year. Nova Scotia grows 346 ac (140 ha) of which 60 percent is usually stored from 2 weeks to up to 4 months. Up to 75 percent disease losses have been observed in commercial cabbage storages. In general, decay losses average 10 percent although many storage operators often have trimming losses of 25 to 30 percent in cabbage stored over 2 months. The trimmings losses may be due to one or more of the following factors: disease; insect injury; stem cracking; yellowing of outer leaves; and broken leaves due to improper handling at harvest time.

Cabbage keeps better when sound heads, free of disease and insect injury, are harvested near maturity. Cabbage should be handled carefully without breaking off wrapper leaves or bruising when they are being placed in storage bins. Dropping cut cabbage into hampers and then dumping into bulk bins will break off wrapper leaves and split the heads. These damaged areas make excellent sites for decay.

Late-winter, green-type cultivars, such as Huston Evergreen or Storage Green, produce firm solid heads, and are more suitable for storage than early fall cabbage cultivars. Storage Green keeps longer than Huston Evergreen probably because it takes longer to mature. Overmature cabbage of any variety tends to crack at the base of the outer leaves, resulting in yellowing, wilting and subsequent development of disease.

Ideally, cabbage should be stored in clean slatted bulk bins at 0°C and 95-100 percent R.H. (relative humidity) with fast flowing air to prevent buildup of free water on the surface of cabbage. These storage conditions are nearly provided by the Filacell storage system. When crates are properly stacked in this type of storage, temperatures are generally more uniform throughout and air temperatures range from 0.6-1°C. Cabbage can be successfully stored for 6 months in this system.

Jacketed cold storage also provides high humidity storage. But in these large, 2500 ton (2756 short tons) commercial storages, serious decay problems often arise after 3 months. This is largely caused by

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the presence of free water on the cabbage and variations of temperatures within the storage. These conditions favor the development of storage disease.

Air-ventilated or common storages rely on outside cool air and ambient temperatures for maintaining storage temperature. Air-ventilated storages will provide good storage conditions provided outside air is at 0°C or below. However, outside air temperatures tend to fluctuate considerably during November and December, making it impossible to provide required storage temperatures at all times. Consequently, cabbage may show stem cracking and yellowing after 4 to 6 weeks, and development of storage decay. This often makes it necessary to market cabbage early in the season to avoid heavy trimming losses.

Considerable progress has been made in the control of storage diseases caused by *Botrytis cinerea* and *Alternaria* spp. After harvesting cabbage and before placing in storage, dipping cabbage individually or spray-drenching in containers with a mixture of benomyl and dichloran has provided significant control of both these diseases on stored cabbage. However, these fungicides are not cleared for use at the present time. ■

CANADA'S TWO-PRICE WHEAT POLICY

MURRAY PEARSON

Les agriculteurs canadiens bénéficient depuis 1969 d'un système de paiement à double prix pour le blé vendu sur le marché intérieur pour la consommation humaine. Du mois de septembre 1973 au 31 juillet 1980, le gouvernement canadien versera aux producteurs la différence entre le prix stabilisé payé par les meuniers et le prix d'exportation jusqu'à concurrence de $1.75 le boisseau. Même si le paiement est fait aux producteurs, c'est en réalité une subvention à la consommation destinée à prévenir la montée des prix du pain et des produits du blé.

Murray Pearson is an agricultural officer, Grains Division, Production and Marketing Branch, CDA, Ottawa.

Canadian farmers have benefited from a two-price wheat system since the Federal Government pegged the price millers must pay for their domestic wheat supplies at $1.95½/bu. This happened in 1969 at a time when world wheat markets were trading at levels of 20¢ to 30¢ below the support level.

Farmers continued to receive this premium over the international price on wheat sold domestically until 1972, when the Government of Canada agreed that farmers should receive a better return on wheat sold domestically. Millers continued to pay the $1.95½ pegged price, but under this new plan, the Government boosted producer returns to $3.00/bu by a $1.04½/bu payment on every bushel sold domestically.

Producers in eastern Canada were paid directly on a per bushel basis. Western producers received their share in an acreage payment, based on a maximum of 640 ac listed in the Canadian Wheat Board permit books under crops, forages and summerfallow. This method of distribution discouraged any possible distortions in cropping patterns in favour of wheat. The Government's contribution during the 2 years this program was in effect amounted to over $134 million.

The summer of 1973 marked a dramatic and unprecedented turnabout in the international commodities market. Pressure from shortfalls in supplies coupled with heavy demand drove the world wheat price to about $6.00/bu.

In view of this sudden turnabout, Canada's two-price program for wheat required substantial revision to reflect world prices in the returns to producers from domestic sales. After an adjustment period when Canadian consumers paid higher levels for bread, pasta and bakery products, the Federal Government announced a two-price program that isolated Canadian consumers from skyrocketing world prices without denying producers similar benefits for both domestic and export sales. The Government "repegged" the price millers must pay for domestic wheat supplies at $3.25/bu. for No. 1 Canada Western Red Spring wheat, and at a maximum of $5.75/bu for No. 1 Canada Western Amber Durum wheat. The minimum price millers could pay for durum and No. 1 Canada Western Red Spring wheat was set at $3.25/bu. This meant that if durum export prices fell below $5.75/bu, millers would pay the export price for domestic requirements to a minimum of $3.25/bu. Under the terms of the Two-Price-Wheat Act, the Government agreed to make up the difference between these fixed limits for domestic sales and the export price to a maximum payment of $1.75/bu, beginning September 1973 and ending July 31, 1980. This means that regardless of how high the export price rises in this period, the most that producers can receive is $5.00/bu for bread wheats and $7.50/bu for durum wheats sold domestically.

At first glance, it would appear that producers do not stand to gain from an agreement that limits the top end of their returns to a price level that has been significantly below the level of the international price since the agreement began. However, although producers have

been receiving somewhat less for domestic sales than for export, they have secured a long-term agreement guaranteeing that returns for domestic sales will not fall below $3.25/bu, regardless of the international price. The Two-Price Wheat Act also contains a provision for an annual review of the costs of producing wheat. If costs increase significantly over the length of the agreement, an adjustment could be made to allow increased costs to reflect in producer returns.

Producers now have an arrangement for domestic wheat sales that should provide a stabilizing influence on the returns of a commodity that is extremely vulnerable to the "boom-bust" cycle that is common in the international grain marketplace.

This arrangement is also important to consumers, since it has a considerable influence on the cost of some basic staples, such as bread and pasta. Pegging the price millers pay for domestic wheat purchases has meant that consumers have paid about $280 million less for bread and pasta products than if millers had been charged the export price since September 1973, the start of the program. The Federal Government is committed to paying producers the difference between $3.25 and the export price up to a maximum payment of $1.75/bu under the terms of the Two-Price Wheat Act. The government's commitment under the Act for the 2 years it has been in effect is $216 million — about $64 million less than the amount producers would have received on the export market. This is a 7-year program, however, and this "bonus", as well as the need for protection from the export marketplace, could disappear at any time over the next 5 years.

The payment under this legislation is distributed through a direct payment into the wheat pool account of both the Canadian Wheat Board in Winnipeg and the Ontario Wheat Producers' Marketing Board in Chatham. Both these Boards hold agency marketing power, and are responsible for price pooling of all export and domestic sales of wheat in the Prairies and Ontario. Monthly payments accumulate over the crop year, and are distributed in the Boards' final payment. Payments to Quebec and Maritime producers are made directly from Agriculture Canada to each producer. Since no marketing board exists in these areas, dealers and millers must supply the appropriate information before the payment can be made. ■

CARBON DIOXIDE — A POTENT ATTRACTANT FOR WIREWORMS

J. F. DOANE, Y. W. LEE and N. D. WESTCOTT

Il est difficile de lutter contre le taupin des céréales des prairies, qui attaque les céréales et les cultures des champs, à cause de son long cycle évolutif, des générations qui se recoupent et des divers taux de croissance larvaire. Des chercheurs de la Station de recherches de Saskatoon ont découvert que les taupins sont fortement attirés vers les semences qui germent par l'acide carbonique (CO_2). Cette constatation ouvre plusieurs voies de recherches prometteuses qui pourraient finalement aider au programme de lutte contre le taupin.

Wireworms, particularly the prairie grain wireworm, attack grain and field crops throughout the prairie region and require a major control program. Many pest species of wireworms are a problem only 1 or 2 years following new breaking. But populations of the prairie grain wireworm continue to thrive in fields that have been cultivated for many years. A long life cycle, complicated by overlapping generations and differential larval growth rates, makes the effect of environmental conditions and control practices on populations difficult to assess. Therefore, any information on the behavior and feeding activities of wireworms and soil pests is valuable.

Recent work has shown that wireworms are strongly attracted to germinating seeds by carbon dioxide (CO_2). During germination of a wheat seed in soil, for example, the CO_2 produced during metabolism diffuses away from the seed forming a concentration gradient that is strongest at the seed and decreases as the distance from the seed increases. By means of sense organs, likely located on the mouthparts, a wireworm larva is able to "zero in" on the germinating wheat seed by following the CO_2 gradient to its source. In addition to wheat seeds, on which most of the research has been done, the prairie grain wireworm and the sugar-beet wireworm were attracted to germinating seeds of barley, fall rye, bromegrass, timothy, alfalfa, rape, sweet clover and sunflower.

The response of wireworms to germinating wheat seed or to commercially-produced CO_2 was ob-

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LIFE HISTORY OF THE PRAIRIE GRAIN WIREWORM

The prairie grain wireworm *(Ctenicera destructor)* is the most important and widespread soil pest in the prairie region. The adults (click beetles) begin emerging about the end of April after overwintering in the pupal cells. The males are very active on the soil surface during sunny weather, but the females remain hidden. The females release a sex pheromone that attracts males and mating ensues. After mating, the females remain in the soil for about 3 weeks while their eggs mature. They then begin to move on the soil surface.

They are capable of laying 200-300 eggs per clutch and lay several clutches over about 1 month. Females that were caged in the soil in the field laid an average of 900 eggs during the season. The eggs are about 0.5 mm (0.02 in.) long when laid and are covered by a sticky fluid to which soil and sand particles adhere (Fig. 2). They are deposited in soil cracks or close to the soil surface under lumps of soil that help to retain the soil surface moisture. In order to complete development, which usually takes about 1 month in the field, the eggs must absorb water from the soil.

After emerging from the egg, the young larvae grow rapidly, apparently feeding mostly on fine plant roots. The larvae reach maturity in 3-5 years, after going through about 9-11 instars during growth. There are no definite characteristics to separate the instars (Fig. 2). Larvae that hatch in year 1 may mature in year 4, 5 or 6, or even later. Even larvae that hatch from one clutch of eggs differ greatly in growth rates and in the time required to reach maturity.

Ultimately, the individual wireworm reaches maturity, forms a cell in the soil and pupates. This usually occurs during the last 2 weeks of July or early August (Fig. 2, Fig. 3). This period appears to be remarkably constant and well defined. The pupae transform to adults in about 2 weeks. The newly-formed adult remains in the pupal cell until the following spring emergence occurs.

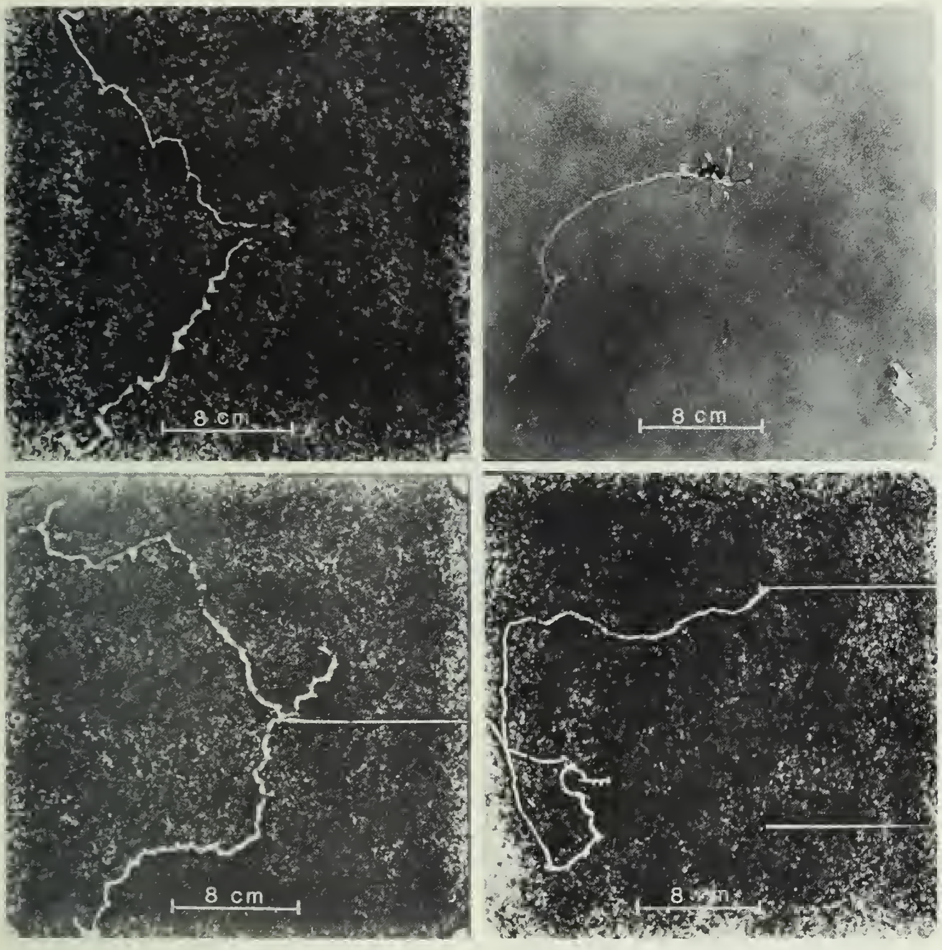

Fig. 1. Orientation trails of the larvae of the prairie grain wireworm *(Ctenicera destructor)* to CO_2 sources between glass plates. Top left — trails of two wireworms in soil to three germinating wheat seeds. Top right — trail of a wireworm in talc-dusted agar to three germinating wheat seeds. Bottom left — trails of two wireworms in soil to the point of a hypodermic needle releasing CO_2 at the rate of 1 ml/hr (0.036 oz/hr). Bottom right — trail of a wireworm in soil to the point of a hypodermic needle releasing CO_2 at the rate of 1.5 ml/hr (0.054 oz/hr). The bottom needle is a control releasing air at the same rate.

served between glass plates 30 x 30 cm (1 ft x 1 ft) containing a thin layer of soil or talc-dusted agar (Fig. 1). The glass plates were held apart by 2.5 mm (.1 in.) supports and were open along the edges to allow CO_2 to diffuse outward. The time required for a larva to orient from point of entry to the CO_2 source, 16-18 cm (6.25-7 in.), varied from 15 minutes to 2 hours. The strength of the CO_2 gradients to which wireworms responded was measured using a combination of gas chromatography and mass spectrometry. Larvae of the prairie grain wireworm are apparently able to follow CO_2 gradients that ascend by as little as 2 parts per million/cm. Repellent effects of CO_2 on wireworms were also noted as the concentration was increased.

Entomologists have been impressed with the speed and apparent accuracy with which wireworms locate germinating seed. The demonstrated attractancy of CO_2 to wireworms shows that the location of food does not occur haphazardly. Ecologically, it makes sense for a plant feeder, with a wide spectrum of host plants, such as a wireworm to be attracted by an unspecific attractant such as CO_2 because it allows location of a wide range of potential food plants.

The knowledge that wireworms are attracted to CO_2 opens up several promising lines of research that may ultimately aid in the wireworm management program. Observations have shown that wireworm feeding is often irregular. Even in the laboratory, some larvae, although active, cease to feed and may enter a fasting phase that may last from one week up to several months. Irregular feeding patterns have also been observed in the field.

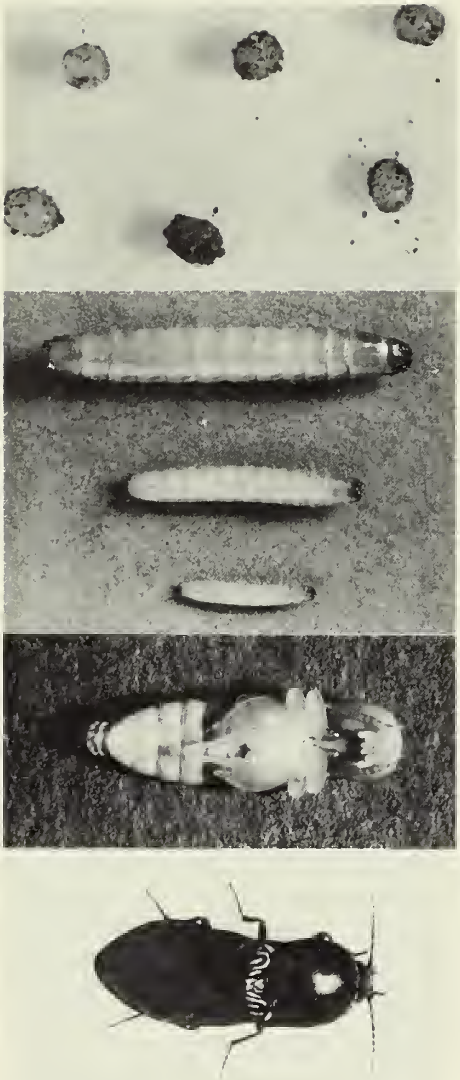

Fig. 2. From top to bottom; eggs, different-sized larvae, ventral view of a pupa, and an adult of the prairie grain wireworm *(Ctenicera destructor)*. Actual length of the four stages is about 0.6, 21 (large wireworm), 14 and 13 mm (0.024, 0.827, 0.551, 0.512 in.) respectively.

Fig. 3. Pupa in soil cell; cells are made by wireworm larvae just before they pupate.

In our research, the CO_2 response by wireworms collected at different times of the year from different populations has varied from 50 to 90 percent. There is a distinct possibility that "hungry" wireworms physiologically ready to feed will show a positive response to CO_2, while those in a non-feeding phase will not. Possibly, the CO_2 response can be used as an indication of the percentage of a wireworm population that is ready to feed. This information would be useful in predicting the damage potential of a population.

Often, it would be useful to determine the response of wireworms or other soil pests to particular insecticides or candidate repellents or attractants. The glass plate method of detecting a wireworm's response to CO_2 and the general methods used in sampling and measuring gradients should also be applicable to other volatile materials placed on the seeds.

Finally, the CO_2 response may also prove useful as a survey tool to detect wireworm infestations. Development of a CO_2 trap that would collect larvae in the soil is now under study. ■

VIRUS CONTROL IN GREENHOUSE TOMATOES

R. STACE-SMITH

Malgré l'élimination de tous les foyers de contamination probables dans les serres, les producteurs n'ont pu se débarrasser du virus de la mosaïque du tabac (TMV) qui réduit la nouaison de la tomate. Des scientifiques de la Station de recherche de Vancouver ont cependant découvert que la prémunition ou inoculation d'une souche moins virulente aux plantules de tomate permet de combattre la maladie avec succès. Deux cent mille plantules ont été inoculés contre le virus de la mosaïque du tabac en 1975.

Flat of tomato seedlings inoculated with a mild strain of tobacco mosaic virus to protect them against infection by severe forms.

The greenhouse tomato industry has been plagued with virus problems for years. One of the most serious is tobacco mosaic virus (TMV). This virus is worldwide in distribution and, sooner or later, appears in virtually every commercial greenhouse. Infection reduces the fruit set of one or two trusses, and fruit that has already set at the time of infection may be malformed or blotchy. Moreover, the virus is readily spread from plant to plant during routine cultural operations.

Possible sources of TMV in the tomato crop, and the relative importance of the different sources, have been thoroughly investigated. Infected seed, tobacco smoking by greenhouse staff, and contaminated glasshouse structures are all considered important. Tomato root debris in the soil can also be a source, although it is often impossible to determine whether affected plants acquired the virus through the roots or by contamination of foliage. Growing the plants in expendable media such as sawdust, rather than soil, has reduced soil-borne contamination. However, this practice adds to the cost of production and cheap, expendable media is in short supply.

The disease can sometimes be excluded from new greenhouses by eliminating all possible sources of contamination. However, the virus is extremely persistent, surviving for months in debris from infected plants, on pruning tools, wire supports, and wood surfaces. Even in new greenhouses, where all precautions have been taken to exclude the disease, infected plants can usually be found.

In those greenhouses where TMV infection appears to be inevitable despite rigorous sanitation, other methods of control must be sought. One of these is protection against severe strains of the virus by deliberately inoculating the plants with a mild strain. The basis of this method of control is similar to the control of human disease such as smallpox by inoculation with a mild or attenuated strain of the virus.

The technique was first suggested by workers in Britain as a method of minimizing losses in yield and fruit quality. The use of common tomato strains of TMV as inoculum produced encouraging results. The method was further improved by selecting attenuated strains of the virus in order to obtain the desired protection without seriously affecting the growth and yield of the inoculated plants. A mutant isolate, first developed in the Netherlands, is now widely used in commercial greenhouses in Europe. Although they have encountered some problems in Europe, the technique has been accepted by the industry.

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Blotchy ripening symptoms on tomato fruit, frequently induced by tobacco mosaic virus.

Inoculation with the mild strain of tobacco mosaic virus induces no symptoms (left). Foliage of plants that have not been protected show mosaic symptoms and a reduction in leaf size (right).

This technique was tested in 1973 in a cooperative project between officials of the British Columbia Department of Agriculture and of Agriculture Canada. We encountered no major difficulties and the growers involved were convinced that the control was valuable. The program has been expanded and, in 1975, we inoculated an estimated 200,000 tomato seedlings, which represents approximately 20 percent of the local industry.

The procedure we have devised is relatively simple. The mild isolate is propagated in tobacco plants. The virus is extracted from the tobacco leaves and a stock solution of highly infectious virus is prepared. A small amount of carborundum is added to the stock solution and it is applied under pressure to the tomato seedlings using a paint sprayer. The pressure, and the distance between the nozzle and the seedlings, are adjusted to assure complete infection without mechanical injury to the seedlings. The stage at which the seedlings are inoculated is not critical, but we prefer to do it 2 to 3 weeks after sowing, just prior to transplanting. At this stage, infection is close to 100 percent and seedling density allows about 30,000 seedlings to be inoculated in an hour. Seedlings can be successfully infected after transplanting, but the process is much slower.

Although there have been no major complications, we still have some reservations about the widespread use of this method of control. The mutant strain of TMV that we are using is unstable and tends to revert to the common form. For this reason, a continuing selection process is carried on to make certain that only mild forms are propagated for inoculum. Also, in some greenhouses the protection is incomplete and, despite being inoculated with the attenuated strain, seedlings are invaded by more severe strains. In spite of these problems, the procedure is welcomed by those growers who previously suffered losses due to TMV infection of established plants. ■

ESTIMATIONS DE TEMPÉRATURES NORMALES DU SOL

C. E. OUELLET

Soil temperature plays a major role in plant growth and survival. Scientists at the Agrometeorology Research and Service have developed a method of estimating monthly normal soil temperatures at 623 locations in Canada. These estimates can be used in farm management, pest and disease control, and to differentiate regional climates.

Au Canada, l'observation de la température du sol a été sporadique jusqu'en 1958. Les premières mesures connues ont été effectuées en 1894 par le professeur H. L. Callendar de l'Université McGill. D'autres observations suivirent à différents endroits du pays de façon discontinue et en vue d'objectifs spécifiques. En 1958, la création d'un réseau de postes d'observations vit le jour. La plupart de ces postes ont été localisés dans les institutions de recherche du ministère fédéral de l'agriculture. De 8 postes qu'il comportait au début, ce réseau en comprend maintenant 60. C'est relativement peu, comparativement au réseau de stations météorologiques canadiennes qui compte environ 1800 stations.

La connaissance de la température du sol revêt une importance particulière en agriculture. La température joue un rôle majeur dans la croissance des plantes durant la période de végétation et dans leur survie durant la période de repos, sans compter son influence sur le développement des insectes et des maladies. Conscient de ce fait, le Service de recherches agrométéorologiques a développé au cours des dernières années une méthode en vue d'estimer la température mensuelle normale du sol pour le plus d'endroits possibles au Canada.

La technique développée consiste essentiellement dans un ensemble d'équations du type de régression multiple. Chaque équation est applicable à un mois et à une profondeur spécifiques. Ces équations renferment de 5 à 10 variables relatives à la température de l'air, à la pluie et à la neige. En plus, comme la température change plus lentement dans le sol que dans l'air, particulièrement en hiver, la température estimée du mois précédent a aussi été utilisée comme variable pour le mois suivant. Pour établir les coefficients de régression de ces équations, on a utilisé les températures du sol déjà connues pour plusieurs stations. Les coefficients de régression sont des constantes par lesquelles les valeurs des variables sont multipliées lors des estimations.

Grâce à cette technique, les normales mensuelles de la température du sol ont été estimées pour 623 sites, soit 5 dans les territoires du Yukon et du Nord-Ouest, 108 en Colombie-Britannique, 169 dans les

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Tableau 1 NORMALES ESTIMEES DE LA TEMPERATURE MENSUELLE DU SOL A FREDERICTON, N.-B.

Profondeur cm	Janv.	Fév.	Mars	Avr.	Mai	Juin	Juil.	Août	Sept.	Oct.	Nov.	Déc.
1	−1,4	−1,0	−0,2	4,0	11,9	18,3	22,0	20,7	15,4	9,2	3,4	−0,5
10	−0,9	−0,8	0,2	3,2	10,4	16,5	20,4	19,1	15,3	9,5	4,1	0,2
20	−0,7	−0,7	0,1	2,7	9,6	15,3	19,0	18,4	15,0	9,7	4,6	1,1
50	0,9	0,7	0,8	2,7	8,4	13,9	17,5	17,8	15,3	10,8	5,9	2,4
100	2,7	2,1	2,1	3,0	6,8	11,7	15,4	16,6	15,0	11,9	8,2	4,8
150	3,9	3,1	2,7	3,0	5,5	9,4	12,8	14,8	14,3	12,3	9,3	6,4

Tableau 2 MOYENNES REGIONALES DES TEMPERATURES (°C) DU SOL AU CANADA

Région	No. de sites	Mois le plus chaud				Mois le plus froid			
		1 cm		150 cm		1 cm		150 cm	
		Mois	Temp.	Mois	Temp.	Mois	Temp.	Mois	Temp.
Terr. du Yukon	2	Juil.	18,4	Sept.	6,4	Janv.	−8,3	Mai	−1,5
Terr. du N.-O.	3	Juil.	18,0	*Août*-Sept.[3]	6,8	Janv.	−7,8	Mai	−0,6
Col.-Brit. (CH)[1]	5	Juil.	21,3	Août	15,7	Janv.	2,4	Fév.	5,5
Col.-Brit. (SS)[2]	5	Juil.	27,1	Août	18,6	Janv.	−0,9	Mars	3,8
Col.-Brit. (Nord)	5	Juil.	18,8	*Août*-Sept.	12,2	Janv.	−1,7	*Mars*-Fév.[3]	2,0
Prairies (Sud)	10	Juil.	21,9	*Août*-Sept.	12,3	Janv.	−5,0	*Mars*-Avr.	1.0
Prairies (Nord)	10	Juil.	20,0	*Sept.*-Août	9,9	Janv.	−6,3	*Avr.*-Mars	0,4
Ontario (Sud)	5	Juil.	24,0	*Août*-Sept.	16,9	Janv.	−0,9	Mars	3,3
Ontario (Nord)	5	Juil.	18,3	Sept.	10,7	Janv.	−3,6	Avr.	1,3
Québec (Sud)	5	Juil.	22,7	Août	15,4	Janv.	−1,4	*Mars*-Avr.	2,7
Québec (Nord)	5	Juil.	19,5	Août-Sept.	12,1	Janv.	−1,9	*Avr.*-Mars	2,1
Maritimes	10	Juil.-Août	20,1	Août-Sept.	13,2	Janv.	−0,8	Mars-Avr.	2,8

[1]CH-Région côtière humide.
[2]SS-Région sud sèche.
[3]Lorsque deux mois sont indiqués, le premier représente le mois généralement le plus chaud ou le plus froid; si aucun n'est souligné, l'un ou l'autre peut être le mois le plus chaud ou le plus froid selon les localités.

provinces des Prairies, 134 en Ontario, 118 dans le Québec, et 89 dans les provinces atlantiques. Ces estimations sont contenues dans le bulletin 85 «Estimated monthly normals of soil temperatures in Canada» distribuée par le Service de recherches agrométéorologiques, Ferme expérimentale centrale, Ottawa. Le tableau 1 illustre la façon dont ces estimations sont présentées pour chaque localité.

Les températures estimées représentent celles qui prévalent en sols minéraux (loam argileux à loam sableux) plats, recouverts d'un court gazon, convenablement drainés, et protégés en hiver par une couche normale de neige pour la région. Les températures observées sous des conditions très différentes peuvent donc s'écarter sensiblement des valeurs estimées. Ainsi en est-il pour les températures observées d'une année donnée, puisque les estimations représentent des moyennes de plusieurs années.

Le degré d'exactitude de ces estimations (fig. 1) justifie leur usage là où les observations font défaut. Basés sur les données de 32 stations, les écarts entre les températures estimées et celles observées ont varié de 0 à 1,0 C dans 72,5% des 768 cas considérés, de 1,1 à 2,0 C dans 21,9% des cas, de 2,1 à 3,0 C dans 4,8% des cas, et de 3,1 à 4,0 C dans 0,8% des cas. Dans l'ensemble, les écarts se sont avérés plus faibles pour l'est du Canada et la Colombie-Britannique que pour les Prairies, de même que l'automne et le printemps comparativement à l'été et à l'hiver. Cependant, ces déviations n'indiquent pas toujours une erreur. En bien des cas, les estimations, parce que surtout basées sur le climat de l'atmosphère, peuvent être plus représentatives d'une localité donnée que les observations en un point précis.

Ces estimations peuvent servir à plusieurs usages: différencier les climats régionaux (tableau 2), déterminer le cycle annuel d'une localité, et calculer les variations et gradients mensuels de température. En rapportant sur graphique les températures estimées en fonction du temps, on obtient pour une localité donnée des courbes qui décrivent les périodes de végétation et gélive à diverses profondeurs.

Les normales mensuelles de température du sol ont été estimées pour 623 sites au Canada.

Même si elles ne peuvent être substituées aux observations quotidiennes de température du sol, les estimations des normales mensuelles devraient être utiles en plusieurs domaines, notamment, dans la régionalisation agricole, la gestion des fermes, et la lutte contre les insectes et les maladies des plantes. ■

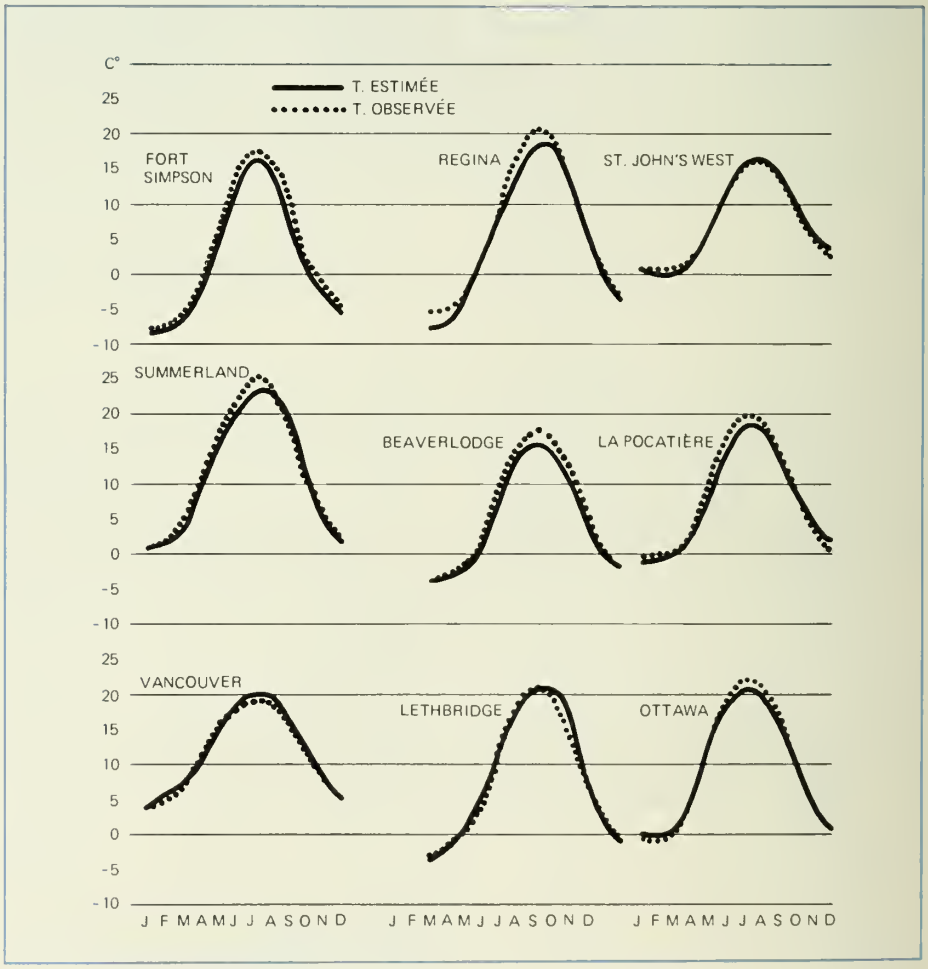

Fig 1. Températures normales du sol à 10 cm de profondeur observée et estimée.

BREEDING STRAWBERRIES FOR NORTHERN CANADA

R. E. HARRIS

Avant 1950, les dégâts commis par l'hiver, le faible rendement et un fort pourcentage de fruits déformés étaient monnaie courante pour les producteurs de fraises, dans le nord du Canada. En 1964, le programme d'amélioration entrepris à la Station de recherche de Beaverlodge a abouti à l'homologation d'un cultivar rustique de fraisier et la production commerciale n'a cessé d'augmenter depuis. Par sélection et croisements, les généticiens de la station ont créé de nouvelles lignées à rendement plus élevé et à croissance plus rapide.

Cluster of a promising selection of strawberries, NRG7257.

The climate of the Peace River and other northern regions of Canada is probably better for growing strawberries than any other part of Canada. Early snowfalls that usually remain all winter provide adequate protection in most years. Thus, there is no need to apply costly artificial winter protection. In the past 16 years, serious winter injury to hardy cultivars without artificial cover has occurred in only 1 year.

Strawberries were first planted at Beaverlodge Research Station in 1918 and up until the 1950's crop failure was usually attributed to drought or lack of hardiness. Under irrigation, winter injury, low yields, and a high percentage of nubbins were frequent problems. To overcome these problems, a cooperative breeding program with Morden Research Station was started in 1953.

In the first stage of breeding from 1953 to 1970, 31 cultivars were crossed and the progeny evaluated. The progeny from many crosses were hardier than their parents making it no longer necessary to apply coverings of straw for winter protection. Even without straw, it was often difficult to assess the relative hardiness of progeny in the field. As a consequence, it was necessary to develop a laboratory method for assessing the relative hardiness of the selections. Several methods were tried and the electrical conductivity method was selected as the most suitable.

Senator Dunlap, Early Dakota and Gem, the three cultivars recommended for the Peace River region, were very poor parents and few of their progeny were selected for further testing. On the other hand, the cross Glenheart x Cheyenne produced some outstanding progeny. Of the 143 selections on test in 1975, 121 included Glenheart x Cheyenne progeny in their breeding.

The cultivar Protem, that was released in 1964, was a selection from the Glenheart x Cheyenne cross. This cultivar has resulted in a steady increase in commercial strawberry production in Alberta and to a lesser extent in northern British Columbia, the Yukon and Alaska. However, Protem has a relatively low yield and long picking season. Therefore, it is only suitable for home garden and 'pick-your-own' commercial production. It became apparent that if the fruit was to be marketed in stores and supermarkets the yield would have to be increased and the picking season shortened.

Microscopic examination of the strawberry crowns revealed that flower formation in Protem did not occur until October, and even later in cultivars from more southerly regions. The low yields and increase in number of nubbins in the summer following an early freeze-up appeared to be due to poor flower production, and incomplete development of the flowers. Flower formation is reported to be controlled by day length. It would appear that in

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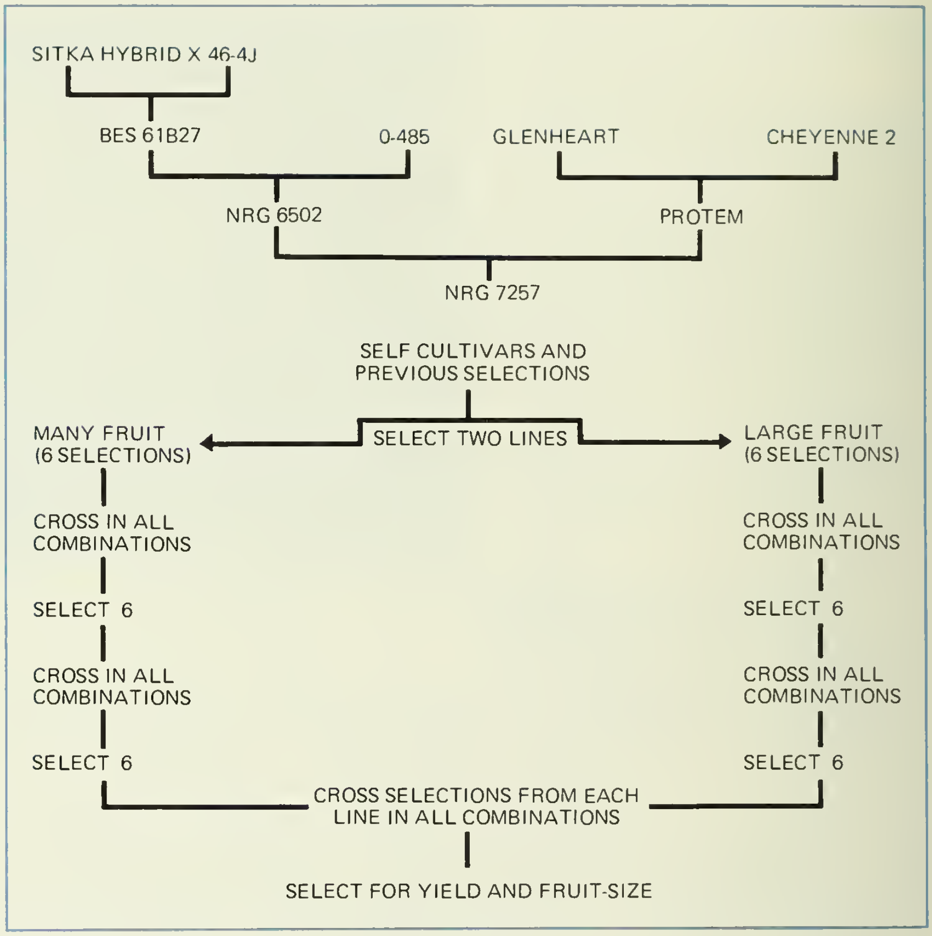
northern regions the days are too long for flowers to form early. Consequently, there were not enough days before freeze-up for large numbers of perfect flowers to be produced.

High flower production is often associated with small fruit size. To break this association, two main approaches were tried. In the first approach, selections with large numbers of small fruit were crossed to large-fruited selections and the process of selecting and crossing repeated for several generations. Each selection was as hardy as Protem with as many other desirable characters, such as good shape, color and quality and uniform fruit size and ripening. Selections from this program are in second and replicated tests. The most promising is NRG 7257 which produces about twice the yield of Protem in about half the time, and is equal or better in all other respects except flavor.

The second approach was to develop two breeding lines; one with a high number of fruit per plant, and the other with large fruit size. Hardiness equal to Protem was mandatory, and as in the previous approach, as many as possible of the other desirable characters were included. The first step was to self-pollinate a number of cultivars and selections, and select the plants with the highest numbers of fruit for one line and the largest fruit for the other. Selections in each line were crossed together, reselected, and crossed and reselected once more. The resulting selections from each line were then crossed to selections from the other line.



The progeny from many of these final crosses were high yielding with large fruit. In subsequent tests, one selection produced over 22 400 kg/ha (20,011 lb/ac) of which 50 percent were large. Other selections produced over 85 percent large fruit.

There does not appear to be any advantage to one approach over the other. Of the 143 selections on test in 1975, 70 came from the continued selection and intercrossing method, and 73 from the 'two breeding lines' approach.

Preliminary crosses were also made to determine whether genotypes could be developed that would produce uniform size fruit during the picking season, and also genotypes with fruit that ripen at one time. Both the continued selection and crossing, and breeding lines approach were tried. But the most promising appeared to be crossing commercial cultivars to a wild species of *Fragaria virginiana* ssp *glauca* once described as *F. yukonensis.* However, it will take several generations of crossing to obtain the necessary size and quality, and plants that do not produce unisexual flowers under some climatic conditions. ■

CALCIUM FOR GOOD SHELL QUALITY

J. R. HUNT

Le calcium joue un rôle important dans le régime des pondeuses car il donne aux œufs une coquille plus résistante. Les chercheurs de la Station de recherches d'Agassiz ont découvert qu'il n'y a aucun avantage à donner aux poules du calcium en particules plus grosses que du sable. Car des particules plus grosses peuvent accélérer la détérioration de la machinerie. Ils ont également trouvé que la pierre calcaire moulue est aussi efficace que les coquilles d'huîtres comme source de calcium.

Poor shell quality is a major factor in reducing a poultry producer's income. Despite modern improvements in housing, management and genetics, shell quality has continued to be a problem.

Adequate calcium in the hen's diet is required to form good quality egg shells. Layers in floor pens received additional supplies of calcium in the form of oyster shell or limestone grit. However, with the advent of cages and modern housing, it was not practical to supply every cage with a limestone or oyster shell feeder. Therefore, additional calcium was incorporated into the layer diets.

Recently, research has shown that the physical form of calcium source is an important factor. Oyster shell particles improved egg shell quality more than oyster shell flour. The assumption was that the gizzard retained large particles of oyster shell while finely ground flour passed through the gizzard. The retained oyster shell particles were a calcium source which could be absorbed for egg shell formation during the night when most of the shell material is deposited.

Because egg shell quality is a major problem, the industry quickly adapted particled calcium feeding either as oyster shell or limestone grit. However, large particles of oyster shell or limestone in feed cause excessive wear on the machinery distributing feed to the cages. Research at the Animal Research Institute, Ottawa, determined the actual size of particles necessary to obtain this beneficial effect and whether there was any advantage to feeding oyster shell rather than limestone particles. Oyster shell particles imported from the Gulf of Mexico are more expensive than locally produced limestone.

In the initial experiment, two sizes of particled oyster shell and limestone were compared to a control of pulverized limestone that contained very fine sand-like particles as well as flour. These diets were fed to pullet hens over a full laying year. Economic traits of egg production and shell quality were recorded.

Throughout this test, none of the experimental treatments influenced the traits measured. Because this was contrary to previously published reports, we decided to investigate gizzard contents. At the conclusion of the test, birds from all treatments were starved for 12 hours and then killed. The contents of the gizzards were removed and the feed particles separated from any heavy material. As expected, the birds fed particles had large particles in their gizzards. However, birds fed the control ration also had fine, sand-like particles of limestone in their gizzards. This could explain the relatively good performance of the controls as the sand-like particles in the control ration were of sufficient size to be retained in the gizzard and supply calcium over the entire shell formation period.

In the second experiment, birds were placed on a control diet of finely ground calcium, with a particle size comparable to talcum powder. Again, limestone and oyster shell particles were compared. In this test, the control ration produced eggs with poorer egg shell quality. These results were comparable to other published reports, demonstrating that sand-sized particles of calcium were responsible for the good egg shell quality of the control in the first experiment. Both experiments demonstrated that limestone and oyster shell particles were equally effective.

All of the 17 strains of birds in the tests responded similarly to particle size and calcium source. We found that the particle size required for retention in the gizzard of the hen is extremely small, comparable to sand-like particles. There was no advantage in feeding larger particles of calcium, especially since such larger particles increase machinery wear. Producers are cautioned to avoid very fine powders as calcium sources as they do not promote maximum egg shell quality. ■

Dr. Hunt is a poultry physiologist, formerly at the Animal Research Institute, Ottawa, and now at the CDA Research Station, Agassiz, B.C.

DEFECTS OF THE BOVINE SPERM HEAD

G. H. COULTER

Les défauts de la tête des spermatozoïdes des taureaux ont été examinés en détail parce qu'on y associe souvent une diminution de la fertilité. Les chercheurs de la Station de recherche de Lethbridge ont utilisé un microscope électronique pour examiner, en détail, leur composition et leur développement. Il a été observé que la qualité séminale est médiocre lorsque la fréquence d'un «cratère» à la tête d'un spermatozoïde dépasse environ 30%.

Mammalian sperm cells can contain many structural defects. They affect a wide range of species and can occur throughout the cell. Artificial insemination is widely used in the cattle industry and because of its importance more attention has been directed towards defects of bull sperm. In fact, more research has been done on bull sperm than on human sperm.

Defects of the bull sperm head have been examined in detail because they are often associated with reduced fertility. With an electron microscope, these structures can be examined in great detail. This allows their composition and development to be more clearly understood. However, a defective sperm, although abnormal, is often only the expression of a deficiency in the sensitive mechanisms that control its development.

Sperm defects result from several potential sources. These include genetic, physiological, or pathogenic disorders. External environmental changes such as high temperature, have also been observed to increase the incidence of abnormalities. Semen from bulls of normal fertility contain at least a few abnormal cells. This may indicate that departure from optimal physiological conditions in the testes can significantly increase their incidence. As the proportion of abnormals increases, the fertility of that semen decreases — particularly when the defects are in the sperm head.

Many sperm head defects can be seen with a conventional microscope. These include giant, micro, pyriform, asymmetric, thick, narrow, and tailless sperm. Defects that have been examined in more detail include 'knobbed', 'decapitated', and 'diadem' sperm.

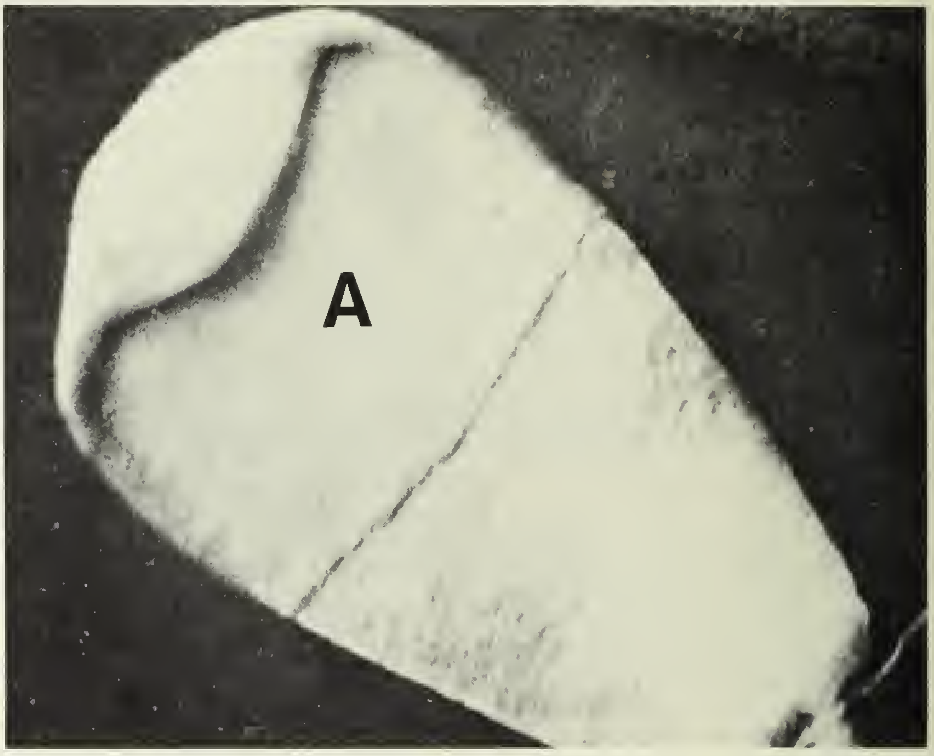
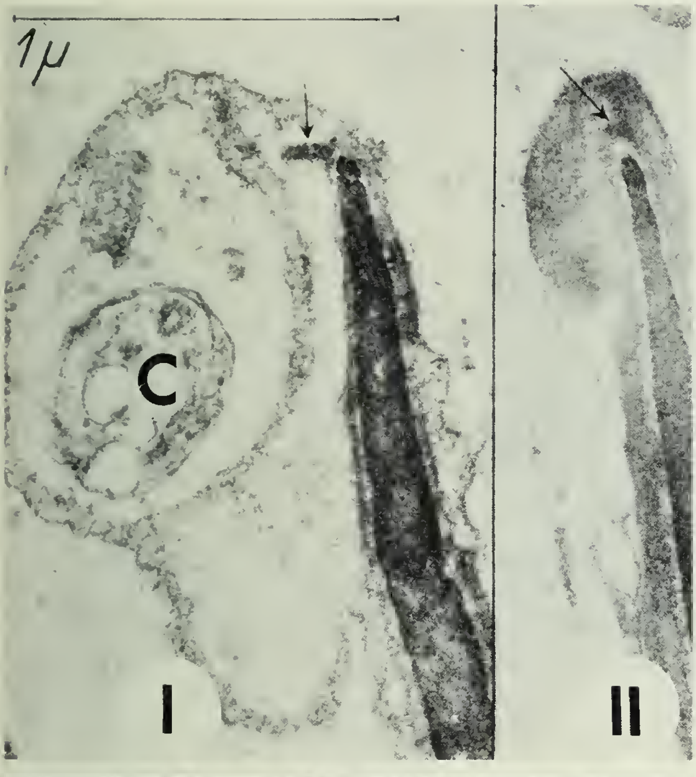


Fig. 1. 'Knobbed' sperm with an enlargement of the front portion of the acrosome (A). (*From* J. L. Handcock. Journal of Experimental Biology 30: 50-56. 1953).

'Knobbed' sperm have an enlargement of the front portion of the acrosome (Fig. 1, A), which covers the front half of the head. Sections cut through this structure and examined by electron microscopy, reveal a cyst-like structure (Fig. 2, C). Materials foreign to that part of the cell are found within the structure. This defect of bull sperm is apparently inherited and results in subfertility or sterility. Defects having comparable fine structure have been observed in both rabbits and swine.

The 'decapitated' defect has been found almost exclusively in sperm from Guernsey bulls. All of the

Dr. Coulter is a reproductive physiologist at the CDA Research Station, Lethbridge, Alta. Electron microscopy on the crater-like sperm defect was performed in cooperation with R. J. Oko and Dr. J. W. Costerton, Biology Department, University of Calgary, Calgary, Alta.



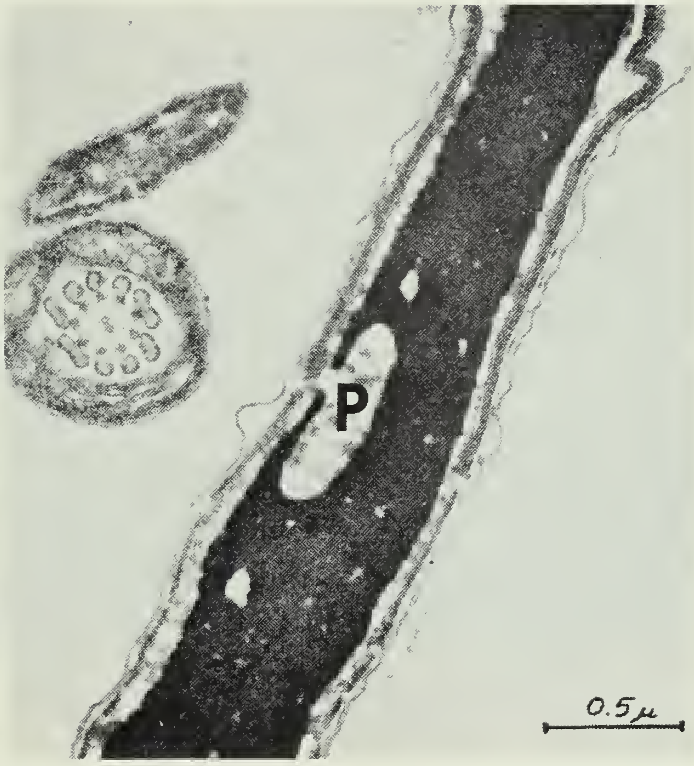


Fig. 2. Cyst-like structure (C) in head of knobbed sperm (I) contrasted with normal sperm (II). (*From* E. Blom and A. Birch Andersen. Nature 194: 989-990. 1962).

Fig. 3. Pouch-like formation (P) typical of the 'diadem' defect. (*From* E. Blom. Atti del 7 Simposio Internazionale di Zootechnia. pp. 125-139. 1972).

Fig. 4. Crater-like structures (C) as seen under differential interference contrast microscopy.

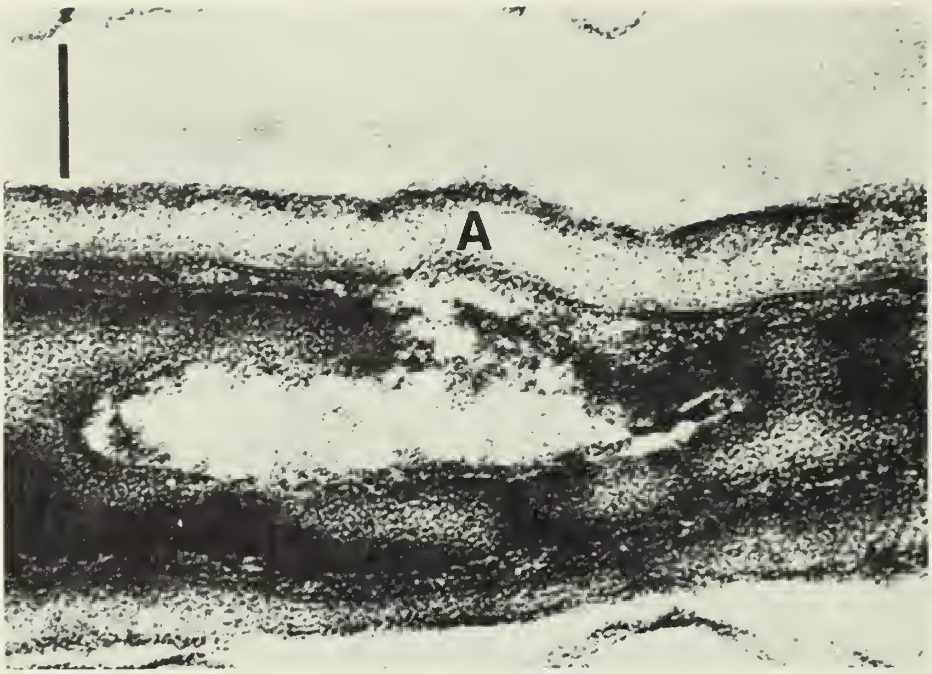


Fig. 5. Cross-section of crater-like structure showing nuclear invagination underlying acrosome (A). Bar indicates 0.1 μm.

heads and tails of the sperm cells may be separated in affected bulls. Most heads and tails remain loosely joined until ejaculation. This defect is probably also genetically controlled.

The 'diadem' sperm defect has been referred to as a developmental abnormality. Fine structural analyses have shown that pouch-like impressions form into the incompletely developed nucleus. These result in an invagination of the nuclear envelope. Sections examined by electron microscopy (Fig. 3) show that the pouch formations are open to the nuclear surface. These structures have been reported in both cattle and swine. Other reports describe similar nuclear vacuoles opening to the surface in sperm cells from cattle and man.

At the Agriculture Canada Research Station at Lethbridge, we have been examining another defect of the sperm head. It appears as a 'crater' under the differential interference contrast microscope (Fig. 4). Most commonly, one or two of the 'craters' are located near the very front of the sperm or across the head about halfway to the tail. In heavily affected bulls, as many as 12 scattered 'craters' have been seen in a cell. Crater-like structures have been observed in up to 95 percent of the sperm cells in ejaculates from individual bulls. These bulls are from several beef and dairy breeds. A low level of 'craters', less than 5 percent, apparently has no effect on seminal quality and fertility; however, additional studies are needed to confirm this. Poor seminal quality (i.e., few or no live sperm either immediately after collection or after low temperature storage, along with increased levels of other defects) has been observed when the incidence of 'craters' exceeded about 30 percent. One would expect that semen of this inferior quality would result in sub-fertility or sterility.

Electron microscopy has shown that the 'craters' (Fig. 5) are narrow-mouthed invaginations that extend as much as 0.3 μm into the nucleus and are as much as 0.6 μm wide. In their common form, the invaginations are lightly stained areas in contrast to the dark staining nucleus and appear similar to the "diadem" defect.

Generally, their occurrence does not disturb the integrity of the adjacent cellular components. In more severely affected cells, the degree of change ranges from a slight bulging of the adjacent structures to extreme distortion of the entire sperm head. Sperm with an incomplete set of tail fibers have also been seen in semen heavily affected with 'craters'. An interesting aspect of the ultrastructural work on this defect is that virus-like particles have occasionally been found associated with the defect. We also have observed a similar crater-like defect in all the sperm cells of a human. Research is continuing on the defects in both these hosts in an attempt to more clearly determine their origin and effects.

Defects of the sperm head are important in the fertilizing ability of the sperm of all species. Future research in reproductive physiology may provide insight into the causes of developmental malfunctions. This, in turn, may have direct application in the cure of, or in selection against, reproductive disorders. ■

CANADA'S LIVESTOCK SHOWCASE HERDS

DOUG LOUSLEY

La vente de bovins aux pays étrangers en vue de constituer des troupeaux de reproduction de base est devenue une importante entreprise agricole au Canada. La mise sur pied d'une exposition permanente de troupeaux laitiers et de boucherie à la Ferme expérimentale centrale d'Ottawa a favorisé le développement de ce marché. Ces troupeaux donnent aux acheteurs éventuels l'occasion de juger de la qualité de bovins des principales races qu'ils peuvent s'attendre à trouver au Canada.

Officials of the Livestock Division of CDA view the Showcase Herd.

The sale of live cattle to foreign countries as foundation breeding stock has developed into a major industry contributing substantially to the cash income of Canadian cattle breeders. From 1972 to 1974, average annual sales of 16,772 head returned $15 million a year. This market development and promotion has been encouraged by the establishment, in 1965 and 1966 respectively, of the Canadian Livestock Showcase Dairy and Beef Herds at the Central Experimental Farm in Ottawa. The Showcase Herds are maintained by the Livestock Division, Agriculture Canada and are representative of quality cattle found in Canada.

The Ottawa location was selected because of the concentration of foreign embassies in the area. Delegations of prospective buyers have the opportunity to view, in one location, the quality of cattle of the major breeds that they can expect to find across Canada. The Livestock Division's Livestock Merchandiser arranges for foreign visitors to see the Showcase animals and endeavors to bring foreign buyers and Canadian sellers together. These merchandising activities are carried out in cooperation with the breed associations and the Department of Industry, Trade and Commerce.

The dairy breeds on display are Holstein-Friesian, Ayrshire, Guernsey and Jersey. There are 13 cows of each breed in the herd.

In 1973, 19,389 Holstein, 978 Ayrshire, 792 Jersey and 105 Guernsey cattle were sold to foreign buyers. In 1974, 13,442 Holstein, 230 Ayrshire, 264 Jersey and 96 Guernsey cattle found homes in foreign countries. Export sales of registered animals for 1973 and 1974 totalled $20 million and $13 million respectively.

The beef herd contains 14 cows and 1 bull of each of the Aberdeen-Angus, Hereford and Shorthorn breeds. The addition of the Charolais breed is planned. Sales of the Showcase breeds totalled 10,217 head in 1973 valued at $12 million and 11,738 in 1974 valued at $21 million.

All animals in the Showcase herds are enrolled on Record of Performance (ROP). ROP programs evaluate factors that have an influence on the economics of production. In addition, animals are type classified according to standards approved by the respective breed organization.

Recent ROP results indicate that the Holstein herd produced an average of 15,641 lb of milk and 569 lb of butterfat in a 305-day lactation period for a Breed Class Average (BCA) of 153 for milk and 152 for butterfat. Similar statistics for the other breeds in the herd are as

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follows: Ayrshire — average milk production 11,916 lb, average butterfat production 489 lb, BCA milk 157, BCA butterfat 156; Guernsey — average milk production 10,638 lb, average butterfat production 541 lb, BCA milk 147, BCA butterfat 147; and Jersey — average milk production 9,567 lb, average butterfat production 496 lb, BCA milk 149, BCA butterfat 142.

ROP results from the beef herd show that the Showcase Aberdeen-Angus calves had an average 200-day adjusted weight of 483 lb, an average yearling weight of 836 lb and an average daily gain of 2.26 lb. The Hereford calves had an average 200-day weight of 498 lb, an average yearling weight of 908 lb and an average daily gain of 2.60 lb. Shorthorn calves had an average 200-day weight of 492 lb, an average yearling weight of 870 lb and an average daily gain of 2.70 lb.

Each year a number of cows from all breeds are replaced. With the exception of at least one heifer from each breed retained for replacement within the herd, all other replacement cattle are purchased from purebred breeders across Canada. Cows are selected for type and performance records. Replacement cattle are selected by the Livestock Merchandiser in conjunction with the secretary of the breed organization. This ensures that the most representative animals from the breed are on display.

Cows culled from the herd are sold for slaughter to an abattoir or through a local auction or may be exchanged with a breeder for replacement cows. Dairy heifers born in the Showcase herd are retained for a year, and all beef breed calves are raised to market weight. However, dairy bull calves are sold for veal production unless requested by a breed association for an A.I. Unit. Selected yearling beef bulls are assigned to the Sire Loan Program or are offered in breed consignment sales. The remaining yearling beef bulls are sold for slaughter. Selected heifer calves are offered annually for sale by tender. Announcements of these offerings are made in the breed journals.

Australian visitors pause for a closer look at one of the Showcase animals.

The cows in the dairy Showcase are bred by artificial insemination to bulls in A.I. Units across Canada. Beef cows are bred by Showcase bulls purchased from Canadian purebred breeders or artificially to bulls in Canadian A.I. units. Showcase bulls are selected by the Livestock Merchandiser from nominations made by the breed association.

The Showcase Dairy Herd is maintained indoors during the day for visitors to observe. The cows are on pasture during the night in the summer months. Similarly, the beef herd can be seen at the beef barns during the day and on pasture during late afternoon and evening. In 1974, 13,457 visitors in 373 organized groups visited the Central Experimental Farm. This included 398 foreign visitors from 22 countries.

Canadian cattle are in demand around the world and the Canadian Livestock Showcase Herds are an important part of the promotion and marketing of Canada's purebred cattle. ■

BREEDING TOMATOES FOR THE SUB-ARCTIC REGIONS

R. E. HARRIS

Le programme d'amélioration des tomates de la Station de recherche de Beaverlodge a débuté en 1938 et en 1970, trois sélections, pouvant former ses fruits à température élevée et mûrir uniformément, avaient été mises au commerce. En 1974, des sélections de tomates-cerises et de tomates à gros fruits étaient aussi mises au marché. Dans la région de la Rivière-de-la-Paix, le rendement de fruits mûrs s'élevait à 14 000 kg/ha (77 775 lb/ac) et on a obtenu 100% de nouaison sous l'éclairage continu de l'été à Inuvik.

The tomato is a warm season crop, and is usually believed to set fruit only at night when temperatures are over 15°C. It is, therefore, generally assumed that tomatoes will not ripen in the short, cool summers and very short nights of the sub-arctic regions. However, tomatoes do not appear to know about these restrictions on their growth. Yields of 14,000 kg/ha (77,775 lb/ac) of ripe fruit have been obtained in the Peace River region, and 100 percent fruit set has been achieved in the continuous light of summer at Inuvick on the shores of the Arctic Ocean.

Tomato cultivar testing started at Beaverlodge in 1918 and was followed by management studies on the effect of dates of seeding, mulching, fertilizing, plant protectors, etc. During the early years, there were frequent reports of poor crops and late ripening; it was evident that the cultivars then available were not suitable for sub-arctic climates.

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Fig. 1. Under high temperatures the stigma of many cultivars is outside the antheridial cone.

There is, however, a great deal of genetic variability in all crops. In 1938, Dr. John Moore started a breeding program to produce tomato cultivars specifically for the Peace River region. The program involved the crossing of 21 cultivars and selections of tomatoes in many different combinations. Other genotypes were added between 1945 and 1949, and selecting continued until 1959 when nine selections were retained. Two of these were from the cross (Farthest North x Fargo Yellow Pear) x L3700#2 and the remaining 7 selections were from the cross, [(Farthest North x Fargo Yellow Pear) x Firesteel] x L3700#2. It was from the latter cross that Professor Emeritus T. Graham, University of Guelph selected Sub-Arctic Delight, the first of the Sub-Arctic tomato types.

In the meantime, the breeding program was interrupted in 1954 to concentrate on the Prairie Cooperative Tomato Breeding project. Unfortunately, Earlinorth, one of the parents used in the program, transmitted rough fruit genes to the progeny in the cool growing temperatures at Beaverlodge and the project was discontinued at Beaverlodge in 1959.

The second phase of the Beaverlodge breeding program started in 1960. The nine early, high yielding selections from the previous phase were each crossed to Fireball, Bush Beefstake, BB_3 and an Alaskan selection 2817-4-3-38. The F_1 progeny from each cross were backcrossed to both parents, and the succeeding generation from the F_2 and backcross progeny were selected in the field until 1970 when

Fig. 2. Rapid branching from the axils of the cotyledons produces three flower and fruit trusses, developing and ripening at the same time.

Fig. 3. Flowers on the main stem, and cotyledonary and leaf branches at the same time result in uniform ripening.

five selections were retained for their earliness, and high yield of ripe fruit. Three of the selections were released under the names Early Sub-Arctic, Sub-Arctic Midi and Sub-Arctic Plenty.

These cultivars have received considerable international recognition for their ability to set fruit at high temperatures and ripen uniformly.

Most growers are satisfied to have a cultivar with the right characteristics, but to the plant breeder, knowledge of why a plant has certain characteristics will often help in breeding and selecting still better cultivars in a shorter time. This was the case with the Sub-Arctic tomatoes. Studies showed that the earliness, high and low temperature fruit set, uniform ripening, and high yield of ripe fruit were due to four easily identifiable morphological characters.

The most important of the four characters was the position of the stigma in the antheridial cone. In most cultivars, the stigma is inside the sterile part of the antheridial tube. Under cool conditions the tube forms a tight sleeve around the stigma and prevents the pollen reaching the stigma (Fig. 1). At higher temperatures the stigma is usually pushed outside the antheridial cone. In the Sub-Arctics, however, the stigma is situated in the antheridial cavity close to the source of pollen. The short style also means the pollen tube has a shorter distance to travel to reach the egg and, in poor conditions, the tube is less likely to die before reaching the egg.

The second most important character of the Sub-Arctics is the rapid branching from the axils of the cotyledons. In most tomato cultivars, the flower clusters are produced one after the other, ripening the fruit trusses in succession. In the Sub-Arctics, strong branches start to develop in the axils of the cotyledons soon after the first leaves are formed (Fig. 2). As a result, three branches, and flower and fruit trusses develop and ripen at the same time (Fig. 4).

The third character involves the development of the first fruit trusses between the fifth and sixth leaf instead of the seventh to the twelfth leaf in most cultivars. This results in earlier fruit production in direct seeded plantings, and stockier plants that are not set back as much when transplanted to the field.

The fourth character is the large fruit trusses that produce over 20 fruit per truss in some cultivars (Fig. 4).

Four easily identifiable characters were now available to identify early, high yielding, uniform ripening tomatoes capable of setting fruit at high and low temperatures. To test the feasibility of selecting tomatoes in the greenhouse for field production, a program was started in the winter of 1969-70 to develop a cherry type and a large fruited tomato.

To produce the cherry-type tomato Early Sub-Arctic and Sub-Arctic Plenty were each crossed to the cherry-sized cultivars Mini Rose and Nagcarlang, and the F_1 backcrossed to each of the parents. A similar procedure was followed to produce the large-fruit type. Fireball and Sub-Arctic Plenty were each crossed to two green-shouldered early, medium to large fruited selections from the 1960-70 phase of the program. However, because there appeared to be an association between green shoulders and cracking of the fruit, green shoulders were eliminated and only the uniform green parents Fireball and Sub-Arctic Plenty were backcrossed. All plants with green-shouldered fruit were discarded.

As soon as the first flower opened on each of the F_2 and first backcross plants, all progeny with short styles, strong cotyledonary branches, flowers below the sixth leaf and large flower trusses were selected and planted in the field. The remainder were discarded. In the field, plants were selected for appropriate fruit size, shape, color, and other desirable characteristics. Seed from each selection was grown in the greenhouse, and selected as before for the 4 characters, desired fruit size, and color for two more generations.

The surviving selections were planted in the field in 1971. Many lines were quite uniform. The most promising lines were grown in replicated tests for two years and miscellaneous trials in several parts of Canada. In 1974, the best selection in each group was released under the name Sub-Arctic Cherry and Sub-Arctic Maxi.

Fig. 4 A large truss of Sub-Arctic Cherry.

It took nearly 20 years to identify the causes of poor tomato production, and another 20 years of breeding and selecting to produce parents with the ability to produce in a Sub-Arctic climate. After the parents were produced it took only 10 years to breed and select three new cultivars and once the reason for the earliness, cold set ability and concentrated ripening was known it took less than five years to breed and select two new types of cultivars.

The tomato breeding program at Beaverlodge has had many beneficial results:

- extended the area in Canada where tomatoes can be grown.
- extended the season in other parts of Canada by providing ripe tomatoes earlier in the season.
- provided breeding parents for earliness, high and low temperature fruit set, and uniform ripening.
- demonstrated that the potential of a crop for a particular area cannot be judged on the performance of cultivars developed for a different climate.
- showed that there is enough genetic variability in some crops to develop cultivars for a different climate.

Considerable progress has been made, but there is still room for improvement. For example, cotyledonary branching in the Sub-Arctic cultivars is inhibited at high temperatures but a similar type of branching in Nagcarlang is heat stable. If the heat stable type of branching was incorporated into a Sub-Arctic type tomato, evenness of ripening could be greatly improved. ■

ECHOES
FROM THE FIELD AND LAB

SHELTER CATTLE FROM FLIES Black flies are a serious pest of cattle in northern Alberta and Saskatchewan. Their outbreaks have limited the cattle industry in that area. However, according to Dr. M. A. Khan, a toxicologist at the CDA Research Station, Lethbridge, Alta., darkened shelters will protect grazing cattle and newborn calves until they can develop tolerance to black-fly toxins.

Dr. Khan says that during a black-fly outbreak, yearling steers with access to a shelter gained 1 lb/head a day more than those without shelter. The steers were not attacked in the shelters and grazed during lulls in black-fly activity and at night. He also suggests that in black-fly areas calving could be scheduled about March or in the fall when black flies are least troublesome. This would protect nursing cows and calves, but it may not be feasible because of cold weather, although the shelters would provide protection.

If the entrance to a shelter is equipped with a backrubber charged with a recommended insecticide, the animals will also receive relief from cattle lice and mosquitoes. Even without backrubbers, Dr. Khan says that a shelter will protect cattle from warble flies.

A cattle shelter, similar to this experimental design used by scientists in northern Alberta, will protect cattle and newborn calves until they can develop tolerance to black-fly toxins.

THE RABBIT AS A RUMINANT The world demand for grain for human food may result in increased costs or reduced supplies of grain for livestock feed. If this happens, the ruminant will be the major source of animal protein. According to Dr. J. R. Hunt, a poultry physiologist at the CDA Research Station, Agassiz, B.C., the rabbit may supply animal protein using limited quantities of feed grains and more roughage than either poultry or swine can use efficiently.

Dr. Hunt says that the rabbit also has some other advantages. The cost of maintaining the dam is low in relation to meat yield, and also the meat to bone ratio in rabbits is very favorable.

Dr. Hunt notes that for the first time in decades reports on rabbit production have been included in the Poultry Science Association meetings. "To keep research in advance of industry demands for information, we have started to investigate rabbit production to assess the potential for meat production using rations with little or no grain", says Dr. Hunt. Research is needed to develop efficient high-roughage diets, to mechanize rabbit production, and to decrease disease problems.

CANADA AND THE WORLD METEOROLOGICAL ORGANIZATION Canadian agriculturalists will benefit from the new and expanded agrometeorological activities in aid of food production at the national and international levels. According to Dr. W. Baier, head of Agrometeorology Research and Service, Agriculture Canada, this is a result of a resolution adopted by the Seventh World Meteorological Congress. Dr. Baier says that the Congress allocated special funds to be used exclusively for the development of the agrometeorology activities.

There are six areas of activities proposed — agrometeorological development and planning, agrometeorological data, research and investigations, technical assistance, and training. "Canadian professionals are already participating in various activites of the technical program of the Commission for Agricultural Meteorology," says Dr. Baier, who is also president of the Commission. Several Agriculture Canada scientists are already cooperating in international experiments for the acquisition of wheat/weather data, lucerne/weather data, and studies into meteorological aspects of land use and agricultural management systems under severe climatic conditions.

"Through this participation, valuable information, special data and experience are being exchanged with agrometeorologists around the world," Dr. Baier says. Both developed and developing countries will eventually benefit from these activities to improve production and distribution of food on a global scale.

HIGHBUSH BLUEBERRIES — A POSSIBILITY Although some American scientific publications say it is impossible to grow highbush blueberries commercially north of New Jersey, where winter temperatures drop to −30°C, scientists at the CDA Research Station, St-Jean, Que., disagree. Two Quebec producers have been growing them for 12 years and have never reported any serious damage due to severe winters. Scientists at the St-Jean Research Station are studying the feasibility of growing the crop commercially in Quebec.

"There are some advantages to growing blueberries in Quebec," says Michel Lareau, a horticultural crop management expert at the research station. A large domestic market already exists for imported blueberries. Cultivation practices have been developed and a mechanical harvester already exists. Mr. Lareau says that once the bush is established, it lasts more than 40 years.

The researcher is studying the feasibility of adding peat moss, sawdust, and sulphur to improve the condition of soil for blueberry production. The plant needs constant water supplies, acid soils (optimum pH is 4.8), and soils rich in organic matter.

Researchers expect it will take several years to learn all the answers about high-

ECHOS
DES LABOS ET D'AILLEURS

bush blueberries. "But we are confident that this new commercial culture will succeed, at least in selected sites," Mr. Lareau says.

THE FORGOTTEN FOWL What's good for the goose is good for the gander, but it's also proving to be good for the strawberry grower. Strawberry producers in Nova Scotia have been using geese to control weeds in their fields at a saving of $30 to $100 an acre.

Ralph McQueen, an animal nutritionist at the CDA Research Station, Fredericton, N.B., sees geese as North America's forgotten fowl, the modern potential of which is overlooked by most farmers. "There are thousands of wasted acres around buildings and along roadsides and ditches that are suitable for raising geese," he says. Many farmers could get supplementary income, meat in their freezers and weed control in crops such as strawberries, raspberries, tobacco and asparagus with very little effort and a gaggle of geese.

Geese grow faster than any other domestic fowl, are more resistant to disease, need only shelter from wind during the winter in most areas of Canada, and do well on pasture.

"The larger breeds of geese will gain 1 lb a week when full fed, reaching market weight in 10 to 12 weeks," Dr. McQueen says. This fast growth to 10 or 12 lb can be achieved with only 40 lb of feed. Raising geese solely on pasture takes longer (15 to 22 weeks), but grain requirements are minimal when good pasture is used. Dr. McQueen also says that geese can be grazed alongside cattle and sheep.

MARAUDING BLACK BEARS With the legalized use of the Aldrick spring activated animal snare for catching bears, farmers and particularly beekeepers now have a defence against increasing ravages of black bears. Dr. H. B. Specht, an entomologist at the CDA Research Station, Kentville, N.S., says that when given a choice, the black bear will find a discarded beef head or scraps of meat more attractive than a hive of honey bees, even after feeding on bees and honey for a week or more.

With this knowledge, Dr. Specht says that it is easy to set a harmless leg snare as a bear will return to its feeding areas or an attacked apiary nightly until there is nothing left. "Set the trap in a small vee-shaped enclosure of brush with a 6-in. diameter tree at the apex to secure the leg snare to and to which a beef head can be attached. Two small poles an inch in diameter can be set criss-crossed at the open end of the enclosure with the veepart of the crossed poles about 6 in. above ground. The loop should be inside of the lowest part of the crossed poles," Dr. Specht says.

According to Dr. Specht, a bear has a short leg and will probably approach the bait cautiously. A shallow hole, a foot in diameter and 4 to 5 in. deep, can be dug beneath the loop and filled with twigs and moss. The loop should be supported a few inches above ground level on several upright forked twigs.

"There's no need to worry about leaving human or dog scents and signs as bears are not easily deterred," Dr. Specht says.

APPLE GROWING IN EASTERN CANADA Apple growing is fascinating. It can be fun, but it can be frustrating too. Apples will grow themselves with very little or no care. Yet, because they respond to care, apple growing can become an involved and technically specialized subject.

A new Agriculture Canada publication, "Apple Growing in Eastern Canada", will be useful to two groups of people. For those who wish to learn something about apple growing, it will serve as an introduction to the subject; for those who are now growing apples, it will serve as a general review and updating of ideas.

This publication contains information on planning for commercial apple growing, planning the orchard, selecting and growing planting stock, planting, culture, training and pruning, quality control, harvesting, control of pests and diseases, trees for the home garden, and description of varieties. The publication also gives background information on using chemicals for nutrition, for pest control including weeds, and for various types of control of development and growth. However, the author warns that specific details of use for every chemical are not covered, and therefore readers should the Information Division, Agriculture Can- check the label before using a chemical.

Publication 1553 may be obtained from ada, Ottawa, K1A 0C7.

LA RECHERCHE AGRICOLE EN UNION SOVIETIQUE Dr. Roger Paquin, de la Station de Ste-Foy, qui revient d'Union soviétique nous fait part que, selon son opinion, ce pays possède un excellent potentiel en recherche. Il a visité quatre instituts.

L'Institut de physiologie végétale Timiriazief, fondé en 1940 possède une équipe de 35 chercheurs dans le seul domaine de la résistance des plantes au gel. Cette équipe dirigée par le Prof. Toumanof jouit d'une réputation mondiale et utilise le Jardin botanique de Moscou (400 ha) pour ses recherches.

L'Institut Pavlov de physiologie animale à Leningrad compte 35 laboratoires où s'affairent plus de 600 chercheurs. Un ordinateur et un centre de données facilitent l'orientation vers un travail d'équipe.

L'Institut de recherche Vavilov pour les productions végétales à Leningrad étend ses ramifications dans toutes les républiques de l'Union et possède un excellent réseau de stations de sélection et de pépinières où sont gardées plus de 200 000 plantes. Cet institut effectue des échanges avec plus de 80 pays.

L'Institut Dokoutchaiev à Moscou qui s'occupe des sols est divisé en 12 départements et autant de laboratoires. Plusieurs centaines de chercheurs y travaillent et cela est compréhensible dans un si vaste pays. Selon le Dr. Paquin, le drainage semble être la pierre d'achoppement de l'agriculture soviétique.

Si l'Union soviétique met le même effort en recherche agricole qu'en recherche spatiale on peut s'attendre à des changements spectaculaires.

SILO FAILURES Every year, there's a story of another tower silo collapsing. Silo failures are too common and unnecessary according to John Turnbull, chief of the structure and environment section of Agriculture Canada's Engineering Research Service. Mr. Turnbull says the solution to the falling silo problem is knowing the strength of the soil and building the right kind of foundation.

Silage piled 100 ft deep in a 30-ft diameter silo exerts 6,000 lb pressure per sq ft on the soil at the base. Not many soils will stand that kind of load. Mr. Turnbull says the farmer has several options if the soil won't hold the size of the silo he needs. He can build a reinforced concrete ring or pad wide enough and thick enough to spread the load over a larger area; he can sink piles to bedrock; he can build two shorter silos; or he can use a horizontal silo.

"But the first thing he should do is to get a soils engineer to make tests of the soil to determine the bearing strength," Mr. Turnbull says. He has prepared tables showing how large a reinforced concrete base is required for different sizes of silos on different soil types. That information is available to farmers through their provincial extension engineers.

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