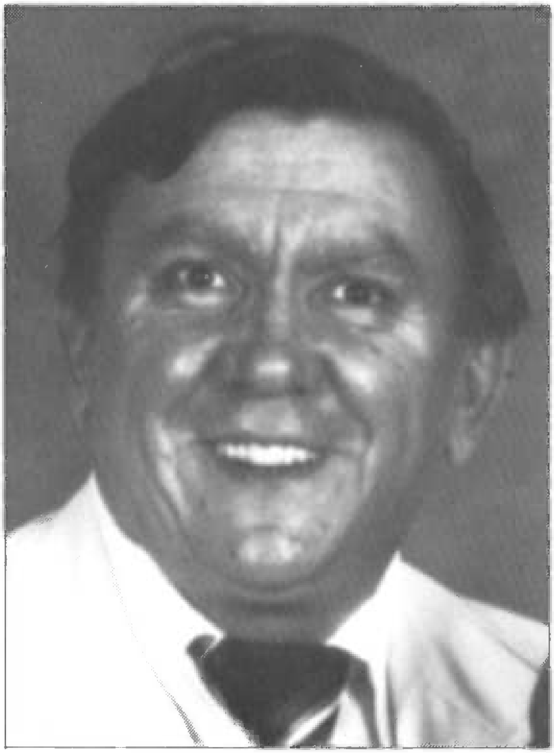
The Very Basis of Genius

Gordon Yaciuk Memorial Lecture



GORDON YACIUK

1940-1983

* * *

His life was gentle and the elements so mixed
in him that nature might stand up and say
to all the world: this was a gentle man.

THE VERY BASIS OF GENIUS

Gordon Yaciuk Memorial Lecture

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It is indeed an honour to be invited to present the Gordon Yaciuk Memorial Lectures at the Universities of Manitoba and Alberta. It is, however, a difficult assignment: how adequately to pay tribute to Gordon Yaciuk the man, the scientist, and above all the compassionate humanitarian, without resorting to a level of emotional sentimentality that Gordon would neither welcome nor approve of. I strongly suspect that as we are gathered together here, Gordon is amusing the Heavenly Host with a perceptive and piquant commentary on what we are about.

Although every responsible manager must seek to be fair and evenhanded, it is difficult in some special instances to restrain or repress a particularly strong feeling of admiration and affection. I say unreservedly that Gordon Yaciuk was among the most admirable and lovable colleagues with whom I have ever been privileged to work. Although it was never the intention that this memorial lecture take the form of a Mark Anthony style Caesarean eulogy, it would be inconsiderate not to share with this audience a few of the revealing comments honestly made about Gordon by his colleagues and associates.

First from a man who worked closely with him in Africa:

> The two most important qualities in a person are persistence and being liked by others: the significance being that people who are liked are also listened to, cooperated with, and followed. I cannot think of anybody better liked or loved than Gordon Yaciuk and, in a world such as Africa, where professional and other relations are very personalized, this quality of his considerably extended the reach and impact of his work and ideas. Gordon was precisely what he appeared to be: forthright, friendly, and true.

Others write in a similar vein:

> Gordon didn't go to Africa just to get a job: he went to better the lives of poorer people. It was instinctive in him to help others less fortunate than himself. When he was not poking good-natured fun at his colleagues in IDRC, his conversation was invariably about his work and his hopes for what good it could do for others.

> I shall always remember his willingness to adapt to difficult situations; his generosity and thoughtfulness; his insistence on putting the needs and desires of others ahead of his own.

> I remember most his generosity and the fun we had in traveling together because nothing seemed to bother him.
>
> His sense of humour was exquisite. Once when visiting a new controlled-atmosphere grain-storage facility equipped with a pressurized pumping system with which to inject fumigants into the grain, he sardonically remarked 'I'm sure this will keep the insects out but, if they don't put some protective covers over the lights, one broken light bulb and this will turn into the fastest grain-distribution system we've ever seen'.
>
> On another occasion, sitting in a small overloaded aircraft that was trying for the fourth time, unsuccessfully, to lift off in an air temperature above 40°C, Gordon was heard to comment 'Do you think I could interest the pilot in a little bit of basic probability theory?'

But his instinctive, ever present, evident sense of humour and capacity for making fun of the ridiculous tended to obscure the exceptional professional intellect that complemented the practical good sense typical of his ethnic origins and Prairie farming background. His extraordinary affinity for statistical data analysis and computer programing was the natural outcome of a well developed mathematical mind. A senior Asian scientist was heard to comment following a lengthy technical discussion over dinner one evening,

> If I'd known that Dr Yaciuk was going to explain not only how to apply complex analytical techniques but also the basic theory underlying these techniques, I would have brought my tape recorder to the dinner.

Gordon's professional life began as a primary-school teacher in rural Manitoba. It was not until his mid-20s that he entered the University of Manitoba where he successively obtained Bachelor's degrees in both agriculture and education, a Master's degree in food science, and a PhD in agricultural engineering. His natural ability as a teacher was remarked upon by many African and Asian scientists whose work IDRC supported. A comment from an Asian project leader is typical:

> I don't always like what Dr Yaciuk has to say about my work but I know he is right and he always shows me how my work can be improved. I only wish he would stay longer when he visits.

No one in the history of IDRC voluntarily carried a greater work load and his influence is to be found throughout many countries of West Africa, the Middle East, and latterly throughout South and Southeast Asia.

We first met in 1973 in Winnipeg after he had applied for a position with IDRC as a project adviser in Senegal. All of his future colleagues-to-be in the Agriculture, Food and Nutrition Sciences (AFNS) Division were older scientists, all of whom had considerable experience working in developing countries. Gordon had never set foot in a developing country. His knowledge of French, the working language of Senegal, was barely rudimentary, and my decision to offer him a job was greeted with scepticism and predictions of a very uncertain outcome.

Sending Gordon to West Africa never appeared to me as a particularly speculative gamble. For many years, I have held an immense admiration for the remarkable attributes of the Ukrainian and Polish people who were Gordon's progenitors. Their extraordinary ability to survive the dreadful persecution and appalling conditions inflicted upon them in sub-Carpathia, Galicia, and Ruthenia during the 18th and 19th centuries and again by Stalin in the 1930s displays their unique character of courageous resilience. Their adaptability to a foreign and often hostile environment provides much of the history of the Prairie provinces. Although a few came earlier, the first major Ukrainian immigration into Canada was in 1896 when there were only about 150,000 people in Manitoba and less than 100,000 in the Northwest Territories. By 1900, over 40,000 and by 1914 close to 200,000 Ukrainians had emigrated to Canada, over 40% settling in Manitoba, with 30% and 23% respectively in what are now Saskatchewan and Alberta.

Early in this century, it was written of the Ukrainian settlers:

> They came with hope in their hearts believing that their long, lean, and harsh journey had ended and that the wide Canadian Prairie would receive them as its own children and take them into its fold.

However, these dreams had to be lived and proved. Without these dreams, the Ukrainian settler could never have had the strength to live through what the future had in store -- oppression, exploitation, and prejudice. But they were resilient: they survived and they succeeded. Early this century, a Canadian immigration officer entered into his record:

> These Ukrainian people have done remarkably well and are permanently settled in good substantial houses which are a credit to them. The evidence goes to prove they are desirable settlers.

Many of the early immigrants settled around Dauphin, the region in which Gordon Yaciuk was born and brought up on a small farm. About the time of the first settlements, only about 50,000 acres of Manitoba were under cultivation. Before World War I, nearly 4 million acres were seeded and of this nearly 2.5 million were growing wheat. By 1912, there were 52,000 Ukrainians engaged in farming in Manitoba, 60,000 in Saskatchewan, and 50,000 in Alberta, by which time the total value of their land, buildings, stock, and equipment was estimated to have risen to close to $270 million.

From ancient times, the Ukraine was known as the granary of Europe. The contribution to the foundation and growth of Canada's agricultural economy by the Ukrainians and settlers from other Eastern European communities is immense and largely unappreciated by most contemporary Canadians. These Europeans who, in the words of one of their poets, "went into the world beyond because our native land will not feed us," brought to the Prairies the skills and practical adaptability typical of good farmers, together with cereal germ plasm from which were bred the unique wheat qualities for which Canada is internationally renowned and which have contributed so much to Canada's subsequent prosperity.

There were no farm-machinery suppliers or trading centres in the Prairie provinces when the first settlers arrived. They therefore salvaged and stored all manner of scrap metal that they turned into useful tools. Histories of the period bear vivid testimony to the incredible physical, environmental, and psychological hardships they suffered in bringing virgin prairie land under the plough.

It was these inherited characters of resilience and adaptability that Gordon Yaciuk took with him and his family to Senegal. Six months after he established himself and his family in the rural agricultural research station at Bambey, I visited him to find, not surprisingly, that none of the equipment ordered had been delivered. But, in the best tradition of his ancestry, Gordon had scrounged the material necessary and cobbled together thermocouples and a simple recorder and was monitoring temperature gradients and changes in grain stored on small farms.

Perhaps more remarkable was the extent of his social integration. His scientific colleagues at the Bambey research station were a mixture of French national expatriates and Senegalese, most of whom had been educated in France. Consequently, the station's kitchen and dining room were strongly influenced by French culinary standards. In less than a year, Gordon was appointed chairman of the catering committee and chief wine steward at the New Year's party. As one of his colleagues remarked:

> When Frenchmen will bestow upon a foreigner jurisdiction over what they eat and drink they really have confidence in him.

It is worthy of mention that, in addition to his onerous responsibilities as an IDRC project adviser, Gordon found time in the evenings to teach English and computer programing to several of his Senegalese colleagues.

Working in developing countries is no easy task, and West Africa is no exception. Activities are inevitably constrained by administrative, economic, logistic, and political difficulties, not to mention personality conflicts within a multinational community. One of his colleagues commented that it was his irrepressible good humour and the liking that everybody had for Gordon that kept relations on an even keel when otherwise they might have become strained.

It would be idle, misleading, and indeed dishonest to suggest that Gordon succeeded infallibly where others had failed. Under the best of conditions, research is essentially a risky business: if it were not so, there would be little point in doing it. In many developing countries, the inherent risks tend to be compounded. Although particular individuals may provide unique insights and inspiration, progress in applied research and development results more often from good team work than from isolated individual brilliance. Consequently, in the various projects and programs described here, Gordon was one of many who contributed to whatever progress was made: to whatever new systems and techniques were attempted, tested, adopted, or rejected. Several pieces of the technical narrative that follows were extracted with little alteration from reports written by him and his colleagues in the Post-Production Systems Group.

Gordon Yaciuk's early work in Senegal did, I believe, give rise to a significant change in the philosophy and practice of research into post-production systems. In fact, it led to the realization that, however primitive or rudimentary the conditions, post-production research must address the system as a whole rather than as a set of isolated, independent, component technologies.

POST-PRODUCTION RESEARCH IN AFRICA

Grain Storage

Few components of the post-production system provide more impressive examples of unreasonable and unfortunate reliance upon the transfer of technology than the storage of food grains. When Gordon arrived in West Africa, a wide and conflicting variety of alternative storage devices, most of them devised elsewhere, were being offered to smallholder farmers and rural communities by different donor and development agencies.

There were prefabricated metal silos, which in the hot African sun turned into pressure cookers -- moisture from the periphery being driven to the centre where it concentrated sufficiently to cook the grain. There were do-it-yourself kits for building small concrete silos, all of the raw materials having to be imported; subterranean, hermetically sealed bins, which tended to crack as the subsoil shifted and, although easy to fill, extremely difficult to empty; second-hand oil drums that were supposed to be hermetically sealed but rarely were because the rims became distorted and the sealing gaskets perished; and containers relying upon a variety of pesticides including, among others, sachets of carbon tetrachloride, lindane, or phostoxin.

It was Gordon and his colleagues at Bambey who decided that perhaps before seeking to offer alternatives and improvements or expensive palliatives from abroad, it might be best first to examine in detail the existing on-farm storage practices. With the assistance of his wife, Anne, and a large group of young home economists (the first time the Monatrices Rurales had been invited to work in close cooperation with agricultural scientists), over 700 farm families in Senegal were interviewed. The survey showed that, assuming no losses, an average family would need to store more than 600 kg of cereal to survive from one harvest to the next. It was further discovered that more than three-quarters of those interviewed possessed inadequate storage facilities and certainly could not afford any of the alternative imported storage technologies being presented to them. It was concluded, however, that without resort to imported materials or structures perfectly adequate facilities could be created using locally available materials.

As every postharvest physiologist knows, the three essential variables to be controlled in stored grain are moisture, temperature, and oxygen content. It was demonstrated on farms that these variables could be controlled in stored grain by adequate grain drying, by appropriate construction of the storage bins, and by observing certain essential procedures and precautions. In general, provided the grain is cool when the bin is filled (a condition best achieved by filling the bin early in the morning), the larger the bin, within practical limits, the more efficient the storage condition. Up to about 1 tonne capacity, height and diameter of the bin should be equal to minimize temperature variations that give rise to the moisture gradients that cause grain losses from mould growth at the points of highest moisture content.

The traditional African grain store is made from woven grain stalks and, with an open weave, the outside temperature and the temperature of the grain will be closely similar, especially if the grain is stored on the head. Solid-wall bins of woven structure reinforced by mud inside and outside provide better insulation from ambient air temperatures and minimize temperature gradients within the grain. Covering the grain bin with a large overhanging roof, shaped like a woven Chinese hat, reduces fluctuations in grain temperatures, the shade provided by the overhang preventing direct heating of the storage-bin walls by the tropical sun. Placing the bins in tree shade gives additional protection.

As stated, bins are best filled early in the morning when the air temperature and humidity are lowest. Because insects tend to proliferate in the air spaces within the stored grain, limiting the amount of air in the storage container by packing tightly and filling to the top helps to reduce insect infestation. Free air within the interstices can be reduced by mixing the grain with sand or ash. Furthermore, sand and abrasive ash scours and impairs the waxy chitinous layer that surrounds the insect's abdomen and causes it to die by desiccation.

A number of indigenous plants that

possess natural insecticidal properties were found to have been used traditionally in other countries of Africa, the leaves being dried and mixed with the grain in the woven bin. A Canadian university is now identifying the active principle in two such African insecticidal plants: Hyptis spicigera and Cassia nigricans.

An assortment of grain dryers, often expensive and elaborate, have been offered by vendors of inappropriate technology. The Bambey team began by determining the zenith angle of the sun for every day of the year and the direction of the prevailing winds in different seasons as a preliminary step to constructing drying racks that took advantage of maximum insolation and cross winds, thus permitting natural cross-flow dryers to be constructed out of inexpensive, locally available materials.

Cereal Milling

The large wheat mills located near the seaport cities of many West African countries are equipped to clean and grade the incoming grain (most of it imported) according to seed size, thus permitting a relatively uniform milling and separation of the various seed fractions. In most rural areas of Africa, however, cleaning and grading of cereal grains is virtually nonexistent. Furthermore, many communities subsist upon different cereal and legume grains at different times of the year depending upon the nature and size of the harvest. Consequently, rural grain mills require much greater built-in flexibility and versatility than their larger relatives in the port cities that mill only imported size-graded wheat.

The rural mill must be able to dehull seeds that differ widely in shape, nature, and genetic and agronomic background, and to provide milled products varying in particle size. Some communities prefer fine flour, others a coarser semolina. Because of its larger seed, sorghum is easier to dehull than pearl millet and, in one of his studies, Gordon Yaciuk found that it takes African women roughly four times as long to dehull pearl millet by hand in the traditional pestel and mortar as it does to dehull sorghum.

Different end uses require different granularities and average particle sizes. Some West African nomads prefer a coarse semolina that they mix in a gourd with camels' milk and blood. The gourd is attached to the camel's saddle and the nutritious components mix to a relatively smooth blend as the camel and rider cross the savannah. A finely particulate flour thus processed would mix to a lumpy unpleasant consistency.

A project that began in the Northeast State of Nigeria illustrates how a rational post-production system composed of appropriate locally developed or adapted component technologies can be established. Maiduguri, a city of about 150,000 people, lies in the middle of an area where the crops are sorghum, pearl millet, maize, and cowpea, with smaller quantities of wheat grown on irrigated land. It would be impractical and uneconomic to establish a separate mill for each different grain but, before deciding what kind of mill to build, it was necessary to determine what qualities the local people preferred in their grain flours.

The project, therefore, began with an extensive socioeconomic study of the existing post-production food-grain systems together with a consumer demand and attitude survey carried out in 1100 households by local women students and home economists. These complementary studies showed that most of the grain produced was retained on the farms for the families' own needs and that only about 15% entered market channels. Most of the grain that entered the market moved from a central market place to secondary and terminal markets through various speculators who bought, stored, and resold the grain at widely different prices throughout the calendar year. Whatever grain was mechanically processed was ground on a custom basis in small, relatively inefficient plate mills driven by diesel engines. As in much of the rest of West Africa, a large proportion of the cereal grain was dehulled, winnowed, and ground by hand using the traditional wooden pestel and mortar.

The consumer study undertaken to determine the nature and size of demand and to indicate what types and volumes of flour the pilot mill should produce showed a growing demand both for improved custom-milling facilities and for commercially packaged flour from which local women could prepare traditional staple foods.

It was eventually decided that the pilot mill and its ancillary facilities should concentrate upon three main activities:

- Decortication and milling of sorghum, millet, cowpeas, and to a lesser extent maize;
- Production of bread and snack foods based upon the grains milled; and
- Development of modified traditional and relatively new food products as a basis for communally owned commercial food-processing and distributing industries.

Because of the wide range in shape, size, and physical condition of the local cereal and legume grains, break and reduction-roll milling was too inflexible and uneconomic. It was also found that the local typical plate grinder mills were variable in performance and generally both wasteful and uneconomic. It was, therefore, decided to rely upon a principle of decortication using either an attrition or abrasion process, followed by separation of the seed coats by aspiration or sieving, or both, with the separated endosperm and residual germ being ground in a hammer mill. Several methods of decortication were examined. Among them were pairs of counter-rotating horizontal carborundum rollers and an attrition-type dehuller composed of counter-rotating mosaic discs in which cutting blades were embedded in a stone or other continuous matrix. The former was unsuitable to process grains of widely different sizes because of the difficulty of maintaining uniform and effective spacing between the rollers. In the latter, the rotating discs produced a relatively low yield of decorticated endosperm.

Eventually, in cooperation with the Prairie Regional Laboratories (PRL) in Saskatoon, a machine known as the PRL dehuller was developed. This has subsequently undergone considerable modification and improvement. Basically, the original consisted of a series of carborundum discs mounted on a horizontal shaft and spaced at 1.5- to 3-cm intervals. The rotor so formed was mounted in a rubber-lined metal case with a clearance of about 2 cm at the sides and around the bottom of the rotating discs. A screened outlet near the top, with an air inlet at the opposite side, connected to an aspiration system automatically removed the fine bran particles as they were abraded from the cereal or legume grains. After dehulling, the grains were transferred to a hammer mill followed by a grain sifter in which the ground endosperm was separated into fine flour, middlings, and coarse semolina. The aspirated bran was collected and sold for animal feed.

A later development led to the replacement of the carborundum stones with lighter resinoid discs. The carborundum stones have to be formed into relatively thick sections to be rotated safely at speeds around 1000 rpm. Furthermore, rotation of the thick heavy stones calls for a relatively high power demand. Resinoid, made by bonding aluminum oxide into a plastic matrix, is formed into comparatively thin, light, strong sections that can be safely rotated at speeds up to 6000 rpm and provide more than twice the abrasive surface at only one-quarter the weight of carborundum stones. Consequently, a decorticator with resinoid discs consumes significantly less power than carborundum per weight of grain dehulled.

The Maiduguri mill eventually consisted of a precleaner, a PRL dehuller, two hammer mills, and a flour sifter, together with various packaging units. When running at full capacity, the mill achieved an extraction rate of slightly better than 75%, the bran separated being sold for animal feed. A secondary processing unit adjacent to the mill produced bread, from composite flours containing 20% of sorghum, noodles, and a variety of other packaged foods.

Other countries of Africa have benefited from the experience with the Maiduguri mill. During the 1960s and early 1970s in Botswana, there was a notable significant shift away from sorghum and toward maize that had been commerically processed and imported from South Africa as ground maize meal. This consumption of imported maize flour was to the detriment of local sorghum resulting in a serious decline in sorghum production by Botswana farmers.

With IDRC cooperation, the Botswana Agricultural Marketing Board established a sorghum-milling system similar to that in Maiduguri. However, in response to rural demand, the Rural Industrial Innovation Centre (RIIC) in Botswana modified the PRL dehuller significantly to permit it to function either in continuous flow or as a batch system. The PRL/RIIC dehuller is smaller than the original and can process 10-kg batches of grain. Because dehulling stones of smaller diameter have been combined with a novel system of unloading the batch model, individual batches of grain can be dehulled without stopping the machine. The project began with a consumer marketing study among 350 householders in different districts, including interviews with Botswanan women in their homes, in clinics, and at bus and railroad stations to determine what characters and qualities of milled flour the householders would be prepared to use and buy.

The acceptability of the system exceeded original expectations. In addition to the Marketing Board's continuous system, there are now some 15 small batch-milling units spread throughout the country, some owned privately, some cooperatively, and some communally.

After several years of experience, a wide ranging series of interviews among users by a young social scientist brought forth some interesting responses. Uniformly, the wide acceptance resulted from the convenience of having milled sorghum flour and from the time liberated for women who had previously hand-pounded the grain. Various women explained that liberation from hand-pounding gave them more time to attend to the farm, to raise vegetables and poultry, and to take care of their children. This time saving is extremely important in countries such as Botswana where many of the men work in the South African mines and the women are left to run the homestead farms. One dear lady informed the interviewer that having her grain custom milled gave her more time to read her Bible: an indication that appropriate technology can bring not only social and economic but also spiritual benefit.

These rural grain-milling systems, which began in cooperation among Nigerians, PRL scientists, and IDRC, have spread to several other countries including Ethiopia, Senegal, Sudan, Tanzania, and Zimbabwe.

POST-PRODUCTION RESEARCH IN ASIA

The early and difficult years of experience in semi-arid Africa, where the AFNS Division concentrated a high proportion of its resources, was immensely valuable as the program gradually spread through countries of South and Southeast Asia. It was in this region that Gordon Yaciuk concentrated his efforts during recent years.

In the mid-1970s, at the request of the Consultative Group on International Agricultural Research (CGIAR), IDRC undertook a study to determine needs and priorities for post-production research in Asia. The outcome was the formation of the Southeast Asian Cooperative Postharvest Research and Development Program, which is now jointly sponsored and financed by the Governments of the Netherlands and Australia, the United States Agency for International Development (USAID), the Canadian International Development Agency (CIDA), and IDRC.

Briefly, the program -- which concentrates principally upon rice and to a lesser extent upon other cereal and legume grains -- is carried out by a technical advisory team based in the Philippines. Its purpose is to identify constraints and difficulties in existing postharvest systems, and the opportunities for research and development, training, information, and demonstration by which to improve the existing sytems. The program serves to strengthen existing research capabilities and institutional facilities and to stimulate cooperation among scientists and technologists throughout Southeast Asia, many of whom were pursuing similar objectives in isolation from one another before the program started.

Through regular contacts with research and development workers by means of workshops, training sessions, and publications, the technical team seeks to inculcate a total systems approach to postharvest improvement throughout the region. The team has helped to knit together a wide variety of postharvest projects, close to 30 of which have been financed in different countries by IDRC, projects that have studied in systematic fashion the harvesting, threshing, drying, storage, and milling of rice by rural Asian communities.

Traditionally in rural Asia, rice is threshed by hand or by trampling under foot, the threshed grain being spread over any available flat surface to be dried in the sun. In some countries of Asia and Africa, the harvested stalks of wheat, rice, and other cereals are laid across public roads to be threshed by the vehicles that pass over them. Clearly, these traditional patterns of threshing and drying are both unhygienic and wasteful; hand threshing is very labour intensive and is often required at a time when the labour is needed for other on-farm operations -- particularly in communities where multiple-cropping systems call for planting of a second crop soon after the first is harvested. Improved threshers have been studied in projects supported in several Asian countries. A hand-fed drum thresher for rice developed in the Philippines led to an interesting development in the Middle East. The thresher, which worked technically and was economically satisfactory in the Philippines, was found to require considerable modification when translocated to Egypt. In Egypt, the thresher was subjected to a much heavier workload that led to metal fatigue and cracking of the frame. Furthermore, the Egyptian farmer feeds his animals with finely chopped cereal straw (a product known as tibn). The short fine-cut wheat or rice straw accumulated, choked the sieves and the grain blower, and was carried over unseparated from the seed.

Modifications to overcome these defects were undertaken by the Behera Corporation, a parastatal Egyptian engineering company. These included reducing the clearance between the fixed and moving knives; redesigning the sieves; the division of the fan housing into two sections, each with a separate air inlet to provide the higher air speed needed to prevent accumulation of the finely chopped straw; a lower eccentric speed to reduce the rate of metal fatigue; and other modifications to cut the cost of manufacture.

The Egyptians redesigned the thresher to be operated from a single multipurpose 10-hp diesel motor, which they subsequently adapted to provide power to various other farm machines, including seed drills, planters, sprayers, irrigation pumps, and a half-ton utility vehicle. Following its acceptance by the Egyptian farming community, the Behera design won an international competition for the production of 600 threshers manufactured with World Bank financing.

A CONTEMPORARY CROP OF POSTHARVEST DIFFICULTIES

Throughout Asia, the adoption of rapid-maturing rice varieties that make possible the production of two or three crops each year, has given rise to a new generation of postharvest difficulties. Rice crops harvested during rainy seasons have a significantly higher moisture content than traditional rice varieties harvested in the dry season. Furthermore, it is difficult to dry grain in the sun between frequent rain showers. High moisture content leads to rapid microbial growth and infestation. Consequently, without rapid drying soon after harvest much of the advantage of a second rice crop may be lost. Therefore, Gordon Yaciuk and his colleagues in the Post-Production Systems Group encouraged the development of inexpensive grain-drying systems and a variety of novel dryers are undergoing trials among rural communities in many countries of Asia, Africa, and the Near East.

A relatively simple flat-bed dryer, developed originally in the Philippines, has been modified and tested in a number of Asian countries. These flat-bed dryers are large rectangular structures in which 2 tonnes of threshed paddy are spread over a mesh screen located above a plenum containing heated air driven through a furnace by a fan. The rectangular box is constructed locally of plywood and the burner and fan are now manufactured in Thailand and some other Asian countries. The furnace that heats the air can burn rice hulls, rice straw, wood shavings, diesel fuel, or kerosene. The furnace will burn about 5 kg of gravity-fed rice hulls per hour and, at a drying temperature of about 40°C, the grain moisture content is reduced from 25% to 14% in about 6 hours. Research has determined the optimum air flow, the heat energy produced per kilogram of rice hulls, and the operating cost of different fuels. Using kerosene or diesel, the operating cost is roughly double that of a rice-hull burner.

At the Asian Institute of Technology (AIT), close to Bangkok, a different type of rice dryer is composed of an indirect solar heater that contains no moving parts, the wet paddy being dried by hot-air convection. The drying bed consists of a shallow rectangular box roughly 10 m x 1 m x 30 cm deep. The structural members are of bamboo, the bottom of the bed is woven bamboo and the sides are of hardboard. Removable panels permit the farmer to load and unload the paddy. The drying box is supported 1 m above the ground and the air heater consists of a layer of charred rice hulls spread in front of the paddy bed to absorb solar radiation. The heat absorbed by the blackened rice hulls during daytime insolation is gradually released in the form of air convection currents that pass through the paddy bed during the hours of darkness. The air-heating areas -- the air spaces above and below the paddy bed -- are enclosed in 0.15-mm clear-plastic film supported by a simple framework of bamboo poles and wire. The total cost of materials is about $50 and during the wet season the dryer will reduce 1 tonne of wet paddy to a satisfactory moisture content in about 24 hours. Although lower in capacity than the flat-bed dryer, the AIT solar dryer is cheaper to construct and operate and is being tested among a number of rural communities in Thailand and other Asian countries.

Various solar dryers have been developed and are being tested in several countries of Africa, Asia, and the Middle East: for drying of rice and cowpeas in Sierre Leone; for onion drying in Niger; and for dehydration of fish in Indonesia, Mali, the Philippines, and Thailand.

Egypt enjoys an annual average of 3600 hours of sunshine, solar intensity varying between 700 and 900 kcal/m^2/hour. Consequently, the drying of food crops by direct sunlight is a long-practiced tradition. At the solar energy laboratory of the National Research Council in Cairo, several prototype solar collectors and convection dryers have been designed and constructed, and their technical and economic efficiency is now being studied for the dehydration of fish and several vegetable crops. At different places in Egypt, the project has collected various data including intensity of solar radiation, seasonal average wind speeds, and ambient air temperatures and relative humidities, in addition to information relevant to production, harvesting times and conditions, and chemical composition and other properties of the agricultural and fisheries products potentially suitable for solar drying.

To satisfy different technological needs, the Egyptian research workers have developed large-capacity solar dryers capable of heating 800 m^3 of air/hour driven by a centrifugal fan, the product to be dried being spread on stainless-steel wire trays fixed to the walls of the drying chamber; and smaller capacity dryers that rely upon simple convection to be owned and operated by single farm families.

In Bangladesh, the estimated annual postharvest loss of food grains exceeds 1.3 million tonnes valued conservatively at more than $250 million. Annual losses of fruits, vegetables, roots, and tubers are valued at over $80 million at local market prices. In cooperation with the Bangladesh Agricultural University and volunteers of the Mennonite Central Committee, a solar dryer, constructed of panels of woven bamboo sheets and rice straw, housing food trays of woven split bamboo, is being used for systematic studies on the drying of pineapple, bananas, sweet potatoes, coconut, honey, ginger, garlic, and various legumes.

INDIAN POST-PRODUCTION GRAIN SYSTEMS

A large and complex post-production project has been supported in India for several years. In essence, it is studying postharvest systems relative to all of the principal cereal and food-legume grains grown on small farms throughout India. The program, which continues to expand, began with five institutions -- Tamil Nadu Agricultural University at Coimbatore, the University of Udaipur, Krishna Agricultural University at Akola in Maharashtra, and the Central Research Institutes for Rice at Cuttack and for Agricultural Engineering at Bhopal.

At Akola, scientists have developed an agricultural waste-fired dryer and a double-walled, polyethylene-lined bamboo bin (the PKV bin) and have determined optimum harvesting dates giving rise to a 16% increase in the quantity harvested and a significant reduction in shattering losses of threshed sorghum. At Bhopal, a 1-hp burr mill processes wheat flour, chickpea flour, and coriander powder at a much lower cost than larger commercial mills. At Coimbatore, significant progress has been made in developing groundnut strippers and decorticators and maize dehuskers and shellers. At Cuttack, scientists have pursued novel approaches to paddy drying, storage, and processing including a solar dryer, a Nanda bin, and a controlled system of parboiling. Traditional parboiling of brown rice retains many of the essential nutrients that are missing in polished rice, the parboiling process being essentially similar in principle to that used to produce bulgur from wheat.

RICE IN KOREA

A comprehensive study of post-production rice systems has been carried out by scientists at Seoul National University, close to the southern border of the demilitarized zone (the DMZ) that separates South from North Korea. Virtually all components of the system have been examined in relation to different rice varieties, including the longer grain Indica and the glutinous Japonica varieties harvested during both dry and rainy seasons.

Several different threshers were compared and the most suitable were modified to give highest yields of both paddy grain and straw, the latter being widely used as cattle feed, in floor mats, and for the packaging of eggs. To give it mobility, the best modified thresher was mounted on a tiller trailer using two universal joints to transmit power from the tiller to the thresher.

On-farm paddy drying and storage were improved by in-bin drying and storage using circulating air with and without supplementary heat from a flat-plate solar collector combined with a rock-pile heat-storage medium. Equipment and operational procedures were modified to increase head-rice recovery, machine capacity, and milling efficiency among different dehulling and polishing systems, the effect of all components in the system being related to milled-rice quality. A computer simulation model was used to analyze the relative costs of five different traditional and modified rice-production systems. The simulation model, among other intended benefits, will assess the cost and labour implications of changing components of the postharvest system among rice varieties during different seasons and regions of the country.

GROUNDNUTS IN THAILAND

Khon Kaen University is comparing the economic and technical efficiency of the flat-bed dryer and the AIT solar dryer, alongside a locally designed indirect solar dryer with a venturi-type opening on the collector to increase air flow in the drying of groundnuts. Khon Kaen scientists are also testing a rubber tire groundnut sheller on small farms in Northeast Thailand that grow about 0.5 ha of groundnuts.

The Thai Department of Engineering in the Ministry of Agriculture has developed and is testing a single pass, double abrasive roll, village rice mill. Abrasive rolls and rubber brakes are used both for dehulling and polishing. The mills can be transported among farms and communities on small trucks.

RURAL NUTRITION

A project of great social and nutritional significance has been in progress for some years at the College of Home Science of Andhra Pradesh Agricultural University in Hyderabad. The work is undertaken among and in cooperation with poor rural village communities, the purpose being to improve the quantity and quality of food grains processed by traditional home methods and to devise economically and socially acceptable methods of handling, processing, and utilization. More than 2000 households in three regions of the State have provided data on production, consumption, storage, home processing, and local preferences for different types of sorghum, millet, chickpea, pigeon pea, mung bean, and cowpea. The influence of traditional home processing on nutritional quality has been determined by analyses and biological assays. The research, carried out by graduate students, represents a remarkable and refreshing alternative to the normal pattern of thesis research in nutritional biochemistry, which seems more concerned with the nutritional behaviour of rodents than with human beings.

ROOT CROPS

Cassava and other roots and tubers provide the staple food for more than 300 million people in developing countries. Cassava, sweet potato, and other root crops deteriorate rapidly after harvest, particularly if bruised and damaged, under tropical conditions: compounds derived from the oxidation of polyphenols give rise to undesirable pigmentation in the tubers' vascular bundles and sweet potatoes shrivel at relative humidities below 90%. Roots and tubers display rates of respiration about 1000 times those of cereal grains causing a rapid breakdown of starch and high resultant weight losses. Postharvest losses may be reduced by storage at lower temperatures in atmospheres that are low in oxygen.

In West Africa, root crops are often left in the ground until used except where land is scarce and needed for subsequent crops.

In the Philippines, several collaborating research institutions are comparing the effectiveness of alternative postharvest storage systems for cassava, sweet potato, and other root crops. Comparisons are being made of storage in sawdust, in rice hulls, and in structures made of local materials that maintain temperatures considerably lower than ambient and relative humidities sufficient to prevent shriveling.

On farms and in many small factories in Thailand, Malaysia, Indonesia, and the Philippines, and in a modified fashion in South India, cassava is cut into chips and sun dried, some subsequently being ground before pelleting. In South India, the chips are parboiled before drying for human food. In some Asian countries, the chips and pellets are largely used for animal feed. Many of the technologies and systems employed are poorly controlled and the product quality is highly variable. At the Asian Institute of Technology, scientists have studied the influence on final quality of modified chippers to produce thinner and more uniform slices and operations research is being carried out to determine the influence of processing conditions on pelleting, cooling, bagging, and subsequent storage.

SHEA BUTTER IN AFRICA

Shea butter is the natural lipid of the nut of a tree species, *Butyrospermum parkii*, which grows wild in the semi-arid tropics of West Africa. Shea butter is one of the few natural lipids that is solid at normal temperatures. Consequently, it can be spread like margarine and is used in various food, pharmaceutical, and cosmetic preparations.

Traditionally, in Mali and other countries of the region, the shea butter is extracted from the nut after a period of fermentation followed by sun drying or mild roasting in a beehive oven. The kernel, removed from the shell by hand pounding, is ground to a paste and mixed with hot water that permits the oil to float to the top. The butter solidifies as it cools below its melting point of around 36°C. The traditional process produces a low yield of fat (only 30-40% of the total lipid present), that is high in free fatty acids and excessively oxidized during the long heating process.

Technologists in the Division du Mécanisme Agricole in Mali have developed and in the rural areas are testing a screw press with several modifications designed to increase yield and to improve the quality of the shea butter extracted.

FRUIT AND VEGETABLE PRESERVATION

In the northern triangle of Thailand, poppies are grown in large numbers for the illegal production and export of opium and its derivatives. The opium farmers destroy the forest, grow their poppy crop for 3 years, and then move on leaving the bare soil exposed to severe erosion. It has been estimated that more than 70% of the forest land in the three Northern provinces has been thus destroyed. How to provide a cash crop to replace opium that will provide even a remotely comparable income has taxed the ingenuity of governments and international agencies for many years. One hope lies in high-priced fruits, vegetable crops, and flowers but the difficulty has been to provide adequate cool storage to prevent rapid postharvest loss. There is no electricity in the remote locations and the high cost of transporting fuel militates against diesel-generated power.

Chiang Mai University is examining a novel system of passive cooling by which to extend the shelf life of fruit, vegetable, and floral crops that grow well in the region. In this passive cooling system, heat is conducted from the interior of the storage chamber into a reservoir of cool water located at the top of the structure. During the day, the water is shielded from solar radiation by a covering of 125-mm thick styrofoam and insulated from the surrounding warm air by sawdust enclosed in plastic bags surrounding a 75-mm thick gravel wall. The protective styrofoam is removed at night and the water reservoir temperature drops by evaporative cooling. In the morning, the styrofoam is replaced and the cycle repeats. The storage units have been constructed of local materials and built into hillsides, thus being further insulated by the soil. It has been calculated that the system will produce a selective radiator temperature 10°C below the local minimum ambient resulting in a cool-storage temperature of about 15°C during the summer and 10°C during the winter. If successful, this technique could lead to widespread application in many other developing countries.

THE POST-PRODUCTION SYSTEMS PHILOSOPHY

Much of IDRC's founding philosophy was inspired by the recommendations of the Pearson Commission on International Development in its report entitled "Partners in Development." The Pearson Commission recommended specifically greater support for research in developing countries with concentration upon food supply and tropical agriculture.

The foregoing brief narrative gives only a superficial overview of the many cooperative activities in which Gordon Yaciuk and his colleagues in the Post-Production Systems Group were engaged. From the time Gordon returned from Africa, the group was based in Edmonton, in or close to the Faculty of Agriculture of the University of Alberta. The IDRC Post-Production Systems Group derived immense intellectual and practical benefit from its close association with the scientists of Alberta and the other Western provinces.

During the last year and following Gordon's untimely death, the members of the Group have dispersed to various developing countries in Africa, Asia, and Latin America. As a team, they developed and propagated what, at the outset, was a relatively unfamiliar philosophy: the philosophy of a total systems approach. As Gordon

Yaciuk so elegantly demonstrated in West Africa, this requires first a comprehensive understanding of existing post-production systems and of the social, economic, physical, and technological environments by which these systems are conditioned.

The more traditional linear concept of research and development, which starts in a laboratory, proceeds through a pilot plant, and eventually in the scientists' own good time is demonstrated to potential users, is foreign to and often in conflict with a systems approach, which essentially begins by trying to understand and cooperate with those who are to use and benefit from new or modified systems and technologies. The philosophy is based upon the belief that technologies are best developed and adapted where and in close cooperation with those by whom they are to be applied.

THE HUMAN FACE OF DEVELOPMENT

Gordon Yaciuk's early work in West Africa demonstrated the fallacy of trying to transplant technologies from the laboratories of developed countries into rural communities in less privileged countries. Most important, he demonstrated the need for scientists first to understand what farmers and rural communities have learned over many generations before seeking to impose exotic and alien concepts of technological development.

Gordon would be the last to wish me to leave the impression that he was the sole architect or motivator of all that was attempted or accomplished. He was one member of what proved to be a very effective Post-Production Systems Group. He was, however, one of the first of the few; one whose imaginative intellect, analytical capability, enthusiasm, and dedication greatly inspired his other collegues in the AFNS Division of IDRC as well as many scientists in Africa, the Middle East, and Asia with whom he came into close and intellectually intimate contact.

More important, one should not leave the impression that Dr Yaciuk and his colleagues were purely technocrats, concerned only with systems, technologies, and machines. It was his sympathy with and concern for poor underprivileged people that set him apart from those whose interest in development issues is essentially intellectual or self-centred. It was Monnet who wrote: "It is more valuable to do something useful than to be someone important."

A roughly translated verse by one of the early Ukrainian settlers in Manitoba says: "We toiled and we suffered that better times should come that others might prosper."

The title given to this memorial lecture is a quotation from Anatole France: "Compassion is the very basis of genius." Compassion -- the willingness to toil that others might prosper, to do something useful rather than to seek importance in the eyes of others -- was the most exceptional of Gordon Yaciuk's many splendid attributes. He was, indeed, a noble example for all who engage themselves in international programs of development for those less privileged.

In paying tribute to many who gave their lives in what they believed to be a noble cause, a former President of the United States spoke words that seem singularly appropriate to this moment:

> The world will little note, nor long remember what we say here, but it can never forget what they did. It is for us the living, rather, to be dedicated to the unfinished work which they who fought here have thus far so nobly advanced. It is rather for us to be dedicated to the great task remaining before us -- that from these honored dead we take increased devotion to that cause for which they gave the last full measure of devotion.