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THE POTATO AS A FOOD CROP FOR  
THE DEVELOPING WORLD

by

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## THE POTATO AS A FOOD CROP FOR THE DEVELOPING WORLD

Douglas Horton\*

### ABSTRACT

The potential role of the potato as a food crop in developing countries has been greatly underestimated. Prejudices against the potato, which go back several centuries in Europe, still bias agricultural policy against this crop. In the Andes (South America), where the potato was first cultivated, as well as in Europe and some parts of Africa and Asia, the potato is a major staple food. Where potatoes have been recently introduced, they may be consumed occasionally as a high-cost vegetable. Across all developing countries growth of potato consumption is faster than that of any other major foodstuff.

The potato is one of the world's most efficient crops in converting land, water, labor and capital into a highly nutritious food. The major barriers to expansion of the potato crop in the developing world are problems of marketing, non-adapted varieties and costly and poor quality seed. CIP is conducting research and backstopping national and regional programs in each of these key problem areas. Once policy makers in the developing world appraise the role the potato can, and should, play in their countries, a wealth of knowledge about the potato can be mobilized in resolving the constraints to its production and use.

### RESUMEN

El papel potencial de la papa como cultivo alimenticio en los países en desarrollo ha sido tremendamente subestimado. Los prejuicios contra la papa, que se originaron hace varios siglos en Europa, todavía sesgan las políticas agrícolas en contra de este cultivo. La papa es un alimento principal en los Andes--en donde se cultivó por primera vez--y también en Europa y partes de Africa y Asia. En otras partes del mundo, a donde la papa ha llegado más recientemente, puede ser consumida de vez en cuando como una hortaliza de lujo. En todos los países en desarrollo el consumo de papa crece más rápidamente que el de cualquier otro cultivo alimentario.

La papa es uno de los cultivos más eficientes del mundo para utilizar tierra, agua, trabajo y capital en la producción de un alimento altamente nutritivo. Las barreras principales para la expansión del cultivo de la papa en el mundo en desarrollo son problemas de mercados, falta de variedades adaptadas y semilla costosa y de mala calidad. El CIP está apoyando a los programas nacionales y regionales y haciendo investigación en cada uno de estos problemas principales. Cuando los forjadores de la política en el mundo en desarrollo reconozcan el papel que la papa puede y debe jugar en sus países, se podrá movilizar una gran riqueza de conocimientos acerca de la papa para ayudar a resolver los factores que restringen el cultivo y la utilización de este alimento humano.

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## I. MAN DOES NOT LIVE BY CEREALS ALONE

Most discussions of food production and security in developing countries focus on the adequacy of cereal supplies. In its widely cited projections of food needs to 1990, for example, the International Food Policy Research Institute (IFPRI) expresses all foodcrop production and consumption in millions of metric tons of cereal, or wheat equivalents.<sup>\*</sup> Expressing diverse crops in terms of wheat equivalents may be useful for analyzing energy or caloric supplies and needs. But it underrates the economic and nutritional importance of other crops, and helps perpetuate the mistaken view that the world's food problems can best, or perhaps only, be resolved by improving cereal grain production and distribution.

Root and tuber crops are of great importance in many areas.<sup>\*\*</sup> At present, in the developing countries of Africa, Asia and Latin America root and tuber crop production is around 190 million tons, which is more than 40% of the volume of total cereal production in the same regions.<sup>\*\*\*</sup>

Among the root and tuber bearing plants, the white, or "Irish," (sic) potato (Solanum tuberosum) can play the greatest role in intensifying agriculture and improving diets in the developing world. In these areas potato prices are generally not far below cereal prices, reflecting the fact that consumers are buying something more than just calories. Hence, converting potatoes to cereal equivalents, by dividing their production by an energy-equivalent factor of five grossly underestimates their economic and nutritional importance. The potato is one of the most efficient crops in converting natural resources, labor and capital into a high quality food with wide consumer acceptance. Production of potatoes is expanding more rapidly than any other major foodcrop in the developing countries, and in some areas where potatoes were virtually unknown a few generations ago they are now a dietary staple.

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\* Food Needs of Developing Countries: Projections of Production and Consumption to 1990. IFPRI Research Report No. 3 (December 1977).

\*\* The importance of root and tuber crops is highlighted in T. James Goering. "Tropical Root Crops and Rural Development." World Bank Staff Working Paper No. 324 (1979).

\*\*\* Unless otherwise indicated, all statistical estimates on production and use of potatoes and other crops are drawn from FAO publications.

## II. BIASES AGAINST THE POTATO

Why has the importance of potatoes been overlooked in agricultural development circles? Ancient prejudices, misinterpreted economic principles and political interests have conspired against this crop.\*

### A. Prejudices

Western society tends to view wheat as "the king of crops," while roots and tubers are considered "inferior foods." Prejudices against the potato, the only root and tuber cultivated as a major staple crop in Europe, go back several centuries.

The potato was first cultivated by the indigenous highland people of Peru. It has long been a staple foodcrop in the Andes of South America. Potatoes brought to Europe by the 16th century Spanish conquistadores remained a botanical curiosity for more than a century. The potato was at times denounced as being unhealthy (causing among other maladies rickets, scrofula, flatulence and leprosy!), narcotic, and encouraging lust. (Why else would Irish peasant families be so large?). Prejudices were so strong in Prussia that when Frederic the Great sent a wagon-load of potatoes to Kolberg in 1774 after a famine, the peasants responded, "the things neither smell nor taste, not even the dogs will eat them, so what use are they to us?"\*\*

During the eighteenth century the potato became a major foodcrop in Ireland, allowing Irish agriculture to support a rapidly growing population. Dependence upon the potato became so complete that crop failures in the 1840's resulted in widespread famine. As potatoes became an important food for the peasantry and laboring class, earlier prejudices against the crop were transferred onto those who cultivated and consumed it. Whole societies were damned for eating potatoes! Ludwig Feuerbach, who coined the phrase "Der Mensch ist was er isst" (Man is what he eats) had Ireland and England in mind: "You (Irish) cannot conquer, for your sustenance can only arouse a paralyzing despair not a fiery enthusiasm. And only enthusiasm will be able to fight off the giant (the English) in whose veins flows the rich, powerful, deed-producing blood (roast beef)."\*\*\*

Gradually, as the more absurd prejudices gave way, potatoes became a major crop in Europe. As a cheap source of food, the potato made a major contribution to urbanization and industrialization. And since potatoes were difficult to destroy, either in the field (horses could eat and trample the foliage but not the underground tubers) or in the store (they didn't burn) potatoes played an important survival role in European wars.

\* Historical accounts of potato production and use are in Redcliffe Salaman. The History and Social Influence of the Potato. (Cambridge University Press: London, 1949 (reprint 1970), and W.G. Burton. The Potato (H.Veenman & Zonen N.V.: Wageningen, Holland, 1966). The following section on prejudices draws heavily on Salaman, Chapter 7.

\*\* Salaman, op. cit., p. 115.

\*\*\* Ibid., p.338.

### B. Misinterpreted Economic Principles

Prejudices persist to this day. People still think, mistakenly, that potatoes are fattening and that they have little or no body-building protein. And economists still project, mistakenly, that potato consumption will fall, or at best increase very slowly in developing countries, because potatoes are an "inferior" staple food.

Modern economics has its roots in the industrial revolution, and textbooks borrow many examples and illustrations from this period. The potato is still the classic example of the "inferior food," for which demand is inelastic. This example is based on the experience of nineteenth-century England, where potatoes were a low-cost staple food and consumption levels were higher among peasants and laborers than among wealthier groups.

Income elasticities are the basis for conventional demand projections. In the absence of data on household potato consumption patterns in developing countries, and on the assumption that potatoes are an inferior food -- learned in the highly respected European and North American texts-- economists "plug into" their demand projections low income elasticities for potatoes. This procedure biases demand projections downward, since in most developing countries potatoes do not play the role of an inferior food or a basic staple but of a luxury vegetable.

Many people also doubt that potato consumption would increase if prices were lower. The economic principle behind this argument is that price elasticities of demand for staple food are low. While this textbook rule holds true for potatoes in Europe, it is not valid in poor countries where potatoes are a luxury.

As a result of misuse of economic principles, the projections for potato consumption are falling far behind actual growth rate. Consumption levels are increasing especially fast in such diverse countries as Afghanistan, Burundi, Colombia, India, Indonesia, Iraq, Rwanda, Tanzania, Sri Lanka, and Viet Nam.\*

### C. Political Interests

Much agricultural research and extension in developing countries is financed by private groups, who appropriate the direct benefit; organized private interests also lobby for public programs.\*\* Research on traditional export commodities, including sugar cane, bananas, cotton, coffee and tea,

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\* It is interesting to note that during the same period per capita consumption of other roots and tubers has fallen.

\*\* Few studies of the political economy of agricultural commodity research have been made. A useful contribution is Kym Anderson. "Public Agricultural Research Investment in Developing Countries: A Politic-Economic Theory." Contributed Paper: Seventh International Conference of Agricultural Economists, Sept. 3-12, 1979, Banff, Canada.

was initiated by plantation owners, often colonial interests. And much research on crops for which hybrid seeds are patented (e.g., maize) and on those which are processed or exported (e.g., wheat, rice and soybeans) is supported by private industrial groups. In contrast, research on commodities which are produced by small farmers and consumed domestically without processing has received little attention. This is because the main beneficiaries are too small and numerous to conduct their own research, or to present a strong effective demand for publically funded programs. For example, in the Andes, where the potato crop is the single most important source of food and agricultural employment and income, the research budget for potatoes is far below that for export crops and cereals.

The bias in research funding toward export commodities has recently been recognized and partially corrected. In the 1960's and 1970's a network of 13 International Agricultural Research Centers was established to carry out research on foodcrops for domestic consumption, to promote and strengthen national research efforts, and, ultimately, to increase the quantity of food production in the developing world. Three of these centers conduct research on root and tuber crops.\*

### III. THE POTATO AS A WORLD FOODCROP

Most people have the mistaken impression that potatoes are mostly carbohydrates (starch) with negligible or poor quality protein. In fact, the potato is one of the world's most nutritious plant sources of food for human consumption. The ratio of protein to carbohydrates is higher in potatoes than in many cereals and other roots and tubers. In addition, the value of potato protein is higher than that of other major foodcrops (Table 1). So, contrary to popular wisdom, potatoes are an extremely well balanced food source. The favorable protein/carbohydrate balance and the extremely high quality of potato protein are potential assets for improving the nutritional status of malnourished populations whose diets are based on cereals and other roots and tubers.

Table 1. Nutritive Value of Selected Crops and Egg

Item	Biological Value <sup>1</sup>
Egg	96
Potato	73
Soybean	72
Maize	54
Wheat Flour	53
Peas	48
Beans	46

<sup>1</sup> Biological value is an index of the portion of absorbed nitrogen retained in the body for growth or maintenance, or both.

Source: M.S. Kaldy. "Protein Yield of Various Crops as Related to Protein Value." *Economic Botany* 26 (1972).

\* The philosophy and research mandate of the IARCs are outlined in Consultative Group on International Agricultural Research (CGIAR Executive Secretariat, World Bank: Washington D.C., 1979)

The growing population of the developing world must be fed largely from land already under cultivation. Since cultivated plants are more efficient than livestock in producing calories and protein for human consumption, crop production must be intensified. The potato is superior to almost every other crop in food production per hectare per day. In developing countries, potatoes and sweet potatoes rank first in energy production per hectare per day, and are significantly above cassava, the cereals and pulses. Among crops consumed in fresh form, the potato ranks first in protein production per hectare and per day (Table 2). The potato crop has a shorter growing cycle than most other foodcrops in the tropics, and for this reason it can be more easily incorporated into some cropping systems than other longer-cycle crops. The ability of potatoes to generate large amounts of calories and protein per unit of land and time augers well for the potential of this crop in intensifying agriculture in the tropics.

Table 2. Comparison of Average Energy and Protein Production per Hectare and per Day of Selected Foodcrops in Developing Countries

	Yield 1978 (kg/ha)	Period of Vegetation (days)	Energy Production per ha per Day (10 <sup>3</sup> kcal)	Protein Production per ha per Day (kg)
Potato	10,372	125	53	1.4
Cassava	8,979	330	35	0.2
Sweet Potato	7,405	135	53	0.7
Yam	9,540	280	30	0.6
Dry Bean	447	150	10	0.7
Chickpea	657	150	16	0.9
Maize	1,339	135	36	1.0
Wheat	1,394	120	40	1.3
Rice	2,106	150	35	0.8

Sources: Yield is FAO estimate of average yield for all developing market economies. Period of vegetation, edible portion and energy and protein coefficients are from B.S. Platt. Tables of Representative Values of Food Commonly Used in Tropical Countries. Med. Res. Count., Lond. Spec. Ser. 302 (1962); D.E. van der Zaag "Potato Production and Utilization in the World," Potato Research 19 (1976); and C.A. de Vries *et.al.* "Choice of Foodcrops in Relation to Actual and Potential Production in the Tropics." Net. J. Agri. Sci. 15 (1967).

Potatoes are an excellent small-farm crop, grown with labor-intensive methods in rotation or association with other crops. In developing countries most producers grow less than one hectare of potatoes. But with this small amount of land a family can satisfy its potato consumption needs and generate a market surplus.\*

\* At the average LDC yield of around 10 t/ha, and considering 1.5 t/ha for seed and 25% for wastage, one-half hectare of potatoes supplies 600 kilograms for each member of a family of five --far in excess of average annual per capita consumption.

The fact that potatoes are ideally suited for the intensive small farm cropping systems has important implications for both equity and growth. Expansion of potato production allows agriculture to productively employ a growing labor force and provide a nutritious food at declining prices.

#### IV. RECENT TRENDS IN POTATO PRODUCTION AND USE

After rapid nineteenth century expansion of potato production and use in Europe, North America and Oceania, potato production has tended to stagnate or decline in these same regions. It is often assumed that this trend reflects a negative income elasticity of demand for potatoes, and consumer preferences for other foodstuffs, such as bread wheats, meat, fruit and vegetables. However, most of the European decline in total potato production results not from shrinking human consumption but from a shift away from potatoes to cereal grains in starch production and to cereals and high-protein supplements in livestock feeds. This shift, in turn, reflects greater technological gains and declining relative prices for cereals, coupled with the increasing availability of soybeans and fish meal as protein supplements for livestock.

In Europe, the potential demand for processed potatoes for human consumption has not been exploited; less than 10% of the potatoes now consumed are processed.

In the USA, in contrast, more than half of the potatoes consumed are processed. The demand for processed potatoes (primarily frozen and dehydrated) has expanded rapidly, and as a consequence, while fresh potato consumption has fallen, total potato consumption has risen in recent years.\*

While potatoes originated in the Andean highlands of South America, they have been introduced only recently to other parts of Latin America and to Asia and Africa. In these areas the expansion of potato production and utilization has been rapid. By 1979, two of the world's five largest potato producing countries --China and India-- were Asian.

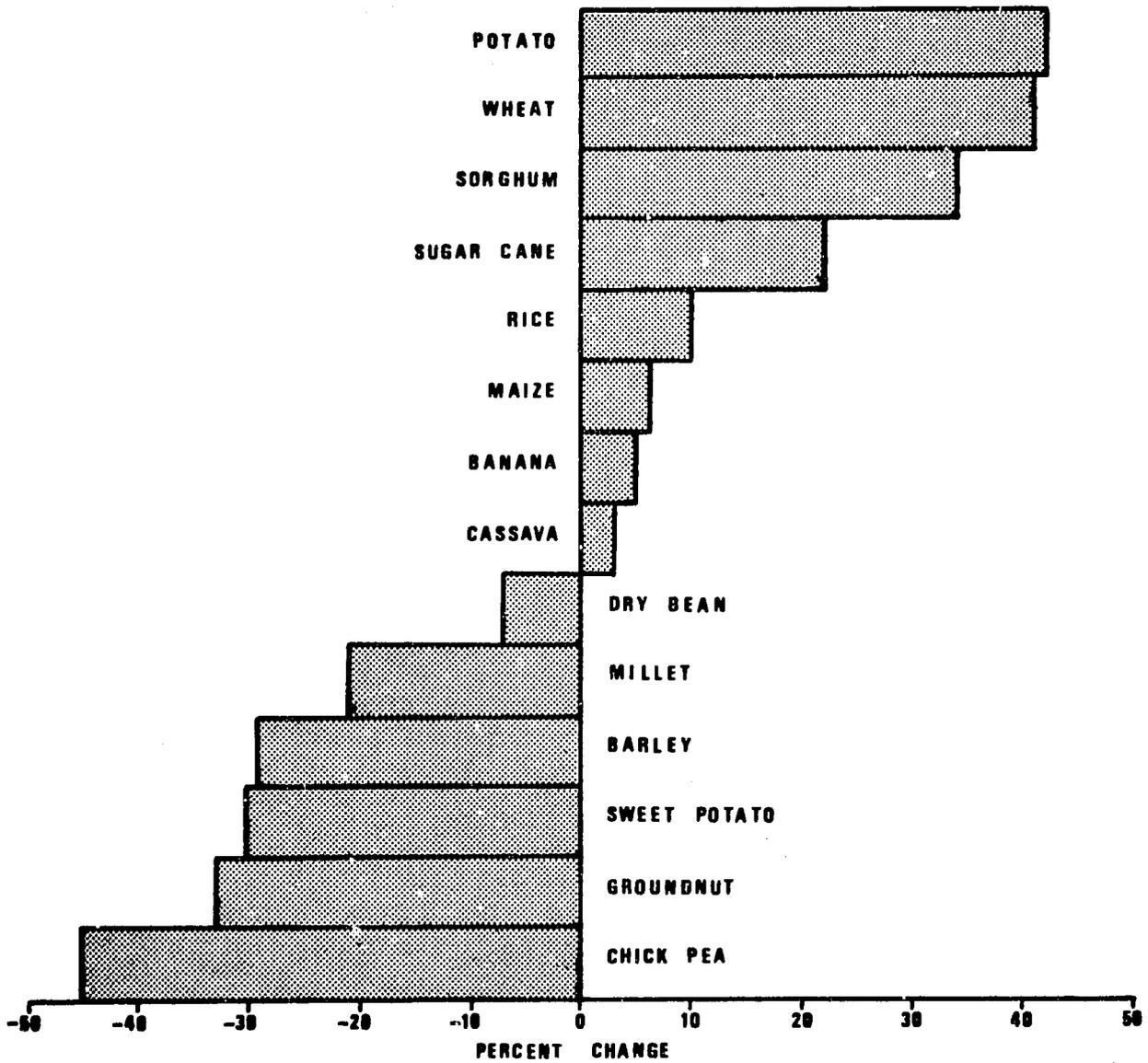
Taking the developing market economies as a whole, potato production has increased more rapidly than production of any other major foodcrop over the last 15 years.(Figure 1). In Asian countries, such as Egypt and India, potato production is now over five times greater than in 1950. In Eastern Africa the area seeded to potatoes has expanded by more than ten times and production has increased even more. In the Andes, where potatoes have long been a staple food, production has increased less rapidly, but growth still surpasses that of other root and tuber crops and pulses. In non-Andean areas of Latin America, such as Mexico and Venezuela, potato production has expanded more rapidly --around five times since 1950 (Figure 2 and Maps).

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\* USDA. Vegetable Situation (JVS-215, Feb. 1980).

Figure 1

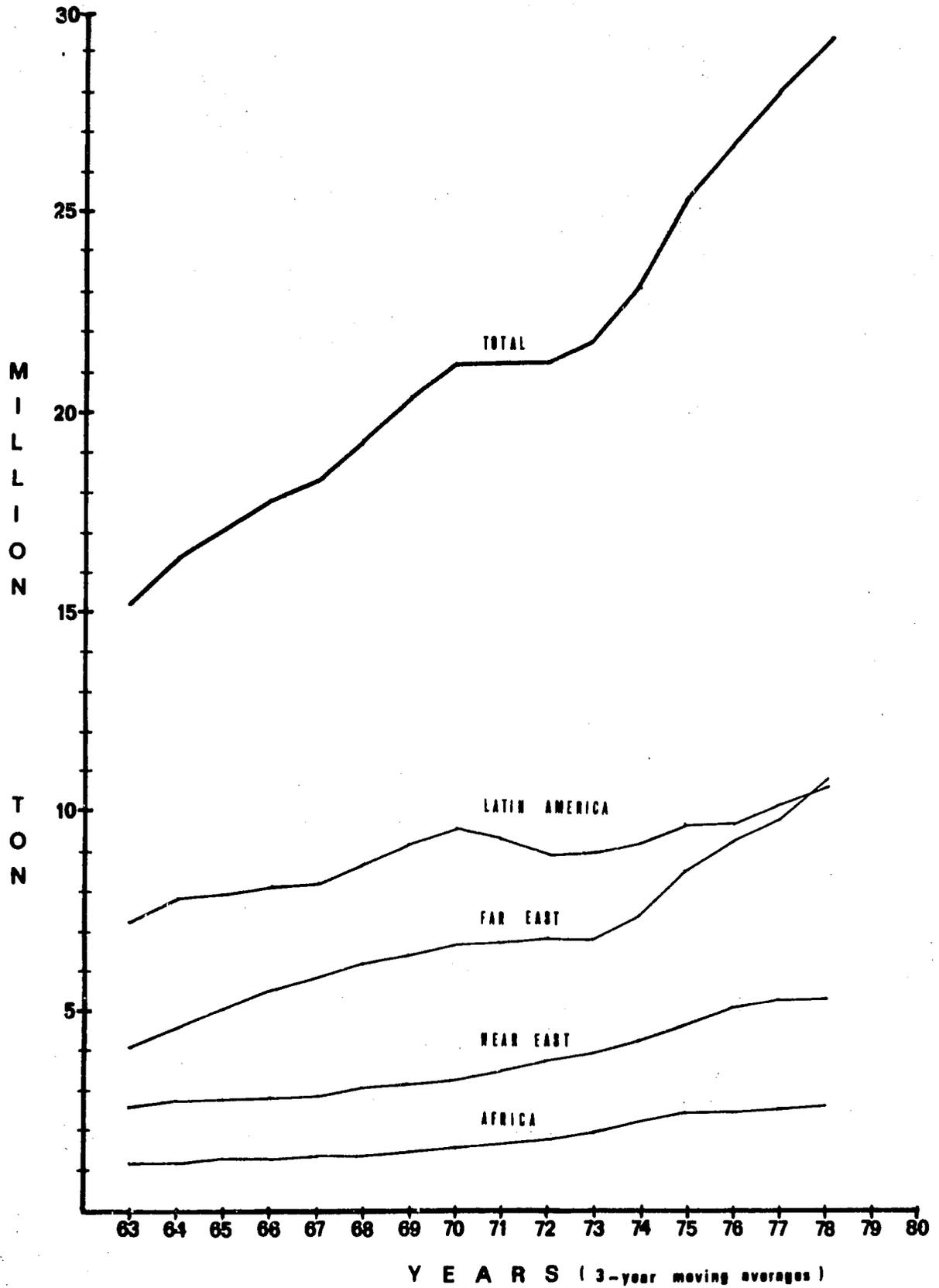
CHANGE IN PER CAPITA PRODUCTION OF SELECTED FOODCROPS  
IN DEVELOPING COUNTRIES 1963-78



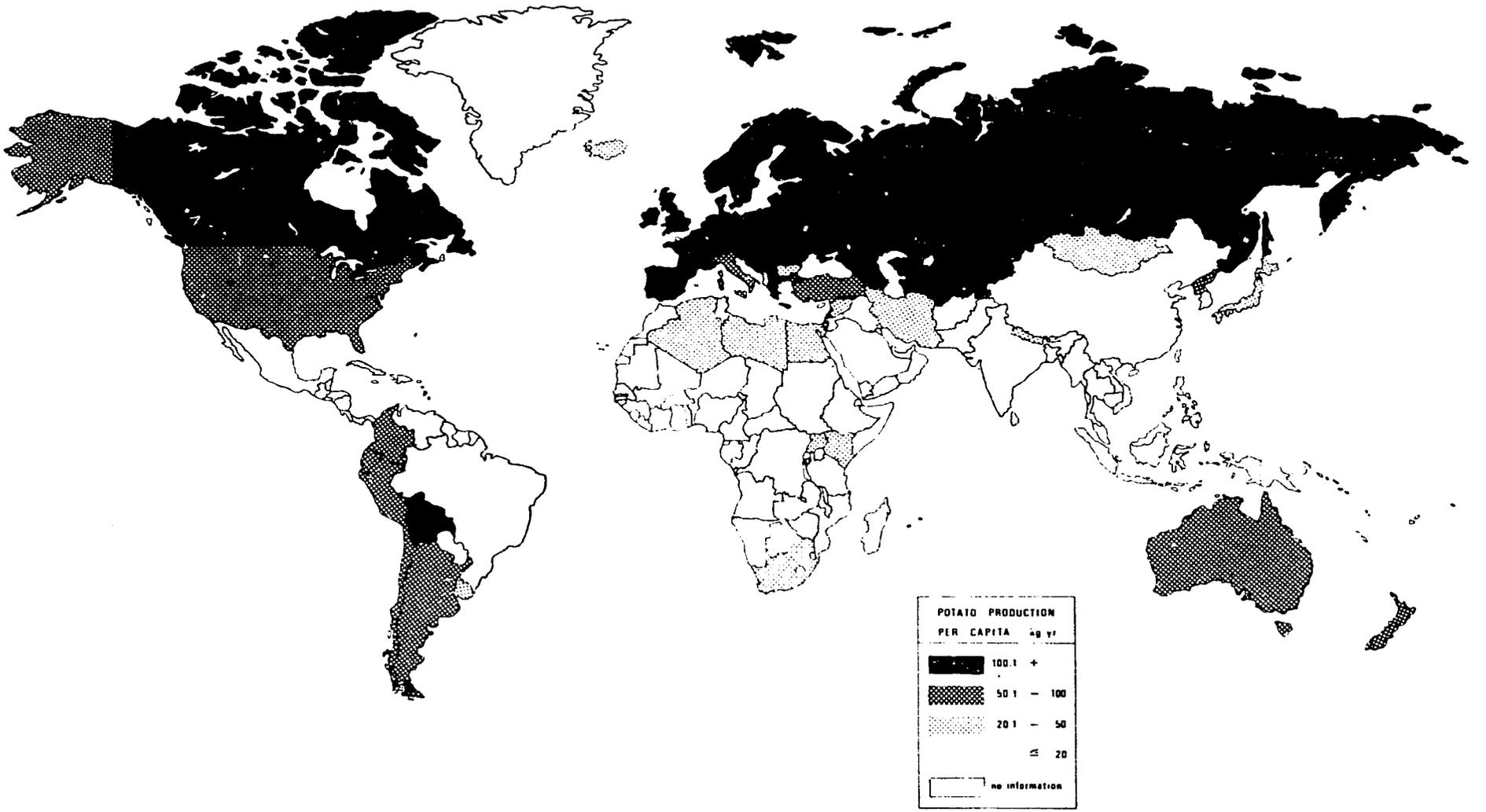
Source: FAO Production Yearbooks.

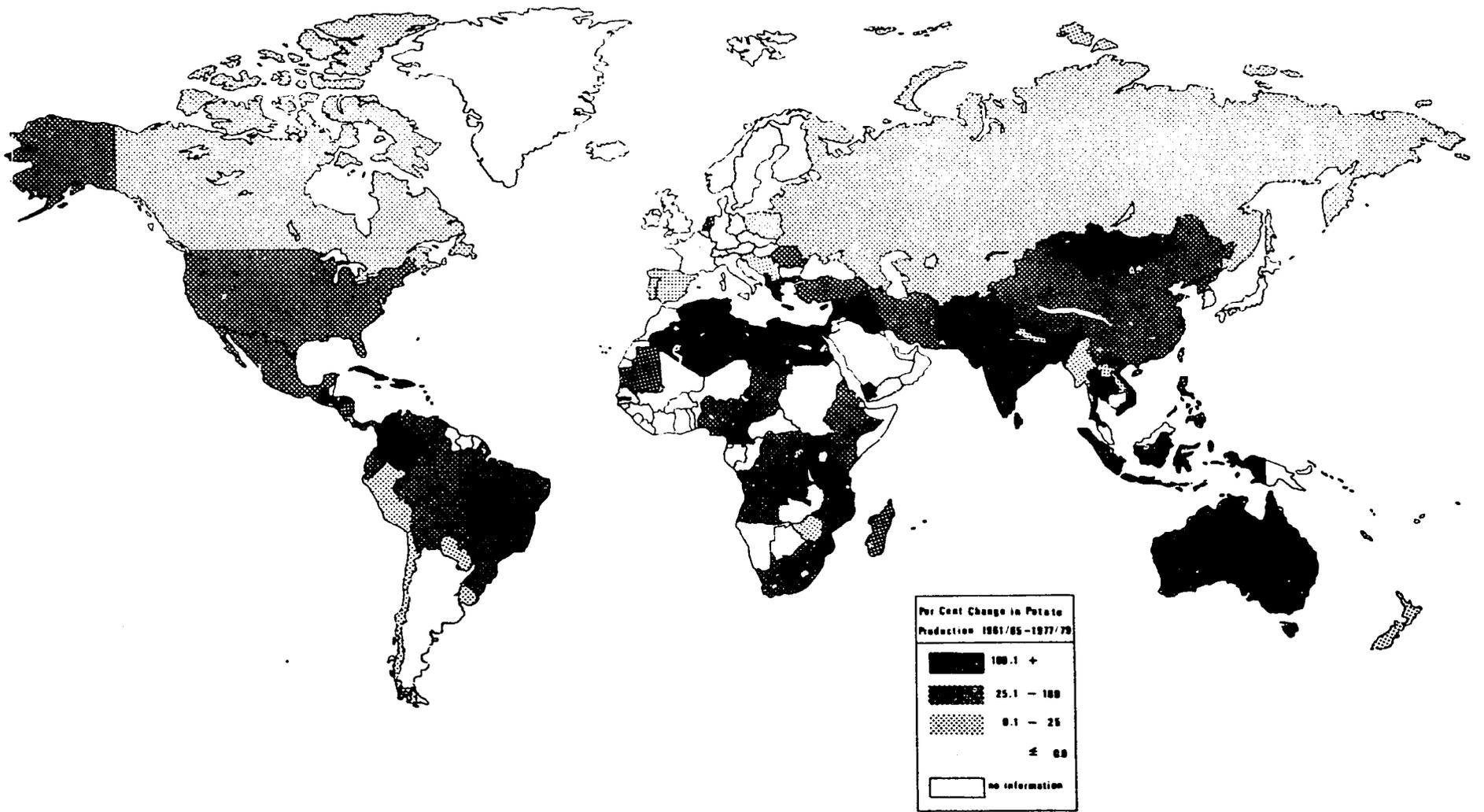
Figure 2

GROWTH OF POTATO  
PRODUCTION IN  
DEVELOPING REGIONS



Source: FAO Production Yearbooks.





## V. BARRIERS TO POTATO PRODUCTION AND USE

Although potato production is expanding rapidly, in the developing world the potato still is a minor vegetable crop in many areas. Developing countries account for only 15% of the 18 million hectares of potatoes cultivated in the world, and their average per capita production is only a fraction of the level of the developed market economies or the centrally planned economies (Table 3).

Table 3. Regional Potato Production and Yield, 1977/79

	Thousand Hectares	Yield (t/ha)	Per Capita Production (kg/yr)
World	18,436	15	66
Developed Countries	3,254	24	99
North America	654	29	77
West Europe	2,370	22	143
Oceania	44	24	60
Other	186	23	30
Developing Countries	2,853	10	14
Africa	399	7	8
Latin America	1,094	10	31
Near East	395	14	27
Far East	963	11	9
Other	1	7	1
Centrally Planned Economies	12,329	14	128
Asian CPE	1,648	9	16
Europe USSR	10,681	14	414

Source: FAO Production Yearbook.

The major barriers to increased use of the potato as a foodcrop in developing countries are problems of production, post-harvest losses and marketing, which make potatoes too expensive to compete as a staple with other foodstuffs.

### A. Marketing Problems

Due to the bulkiness and perishability of potatoes, post-harvest technology and marketing are critical to the entire production/use system. Post-harvest losses are high throughout the developing world. And in areas with seasonal peaks in production and inadequate storage, potatoes are

available for consumption only part of the year. The International Potato Center (CIP) places high priority on development and introduction of low-cost storage and processing systems, appropriate for existing ecological and socio-economic conditions. These help reduce marketing bottlenecks and make potatoes available at reasonable prices the entire year.

### B. Non-Adapted Varieties

Most potato varieties from Europe and North America are low-yielding under developing country conditions. Prior to founding CIP little effort was put into identifying or developing varieties for the tropics and subtropics. Exploiting the potential value of native Andean clones in developing cultivars which are better adapted to tropical conditions is one of CIP's priority research areas.\*

### C. Costly, Poor Quality Seed

The potato crop is conventionally grown from tuber seed, which is a major source of disease transmission from one season to the next. Tuber seed is also the single most costly input in potato production often accounting for more than 50% of the total production cost, or over US\$1,000 per hectare sown. Planting tubers wastes both money and food. At present levels of developing country consumption the seed tubers sown on one hectare could feed a family for more than 40 years!

Many experts feel that European-style seed potato certification programs should be set up in the developing countries, and many attempts have been made at a heavy cost in terms of both financial and technical resources. But these programs seldom prosper in developing countries. After a few years they tend to collapse, due to lack of trained personnel and a host of "institutional problems," including lack of research facilities, adequate seed certification legislation, a certification agency, a seed producers' organization, credit, extension, marketing and coordination of all of the above!

Gradually we are recognizing that promoting seed potato certification programs may do more harm than good, by channeling scarce resources to a costly venture with little or no possibility of success. Instead, why not build on the existing, informal seed production and distribution systems which have proven their viability for years, without support of either local governments or foreign experts? One way to harness the strength of existing seed networks would be to feed into them healthy stock of virus-resistant varieties (including traditional varieties!)

An entirely new approach --the use of true, or botanical seed-- offers even greater promise for the future. Planting true seed, instead of tubers would drastically reduce the cost and energy expended in producing, storing, transporting and handling tuber seed, and it would increase net food production per hectare. In addition it would help bring potato cultivation

\* CIP's research agenda is outlined in Richard L. Sawyer. "Profile of the International Potato Center (CIP 1970-1995)" (CIP: Lima, Peru)

"down the hill," to subsistence farmers in warm, humid areas where it is not feasible to use perishable tuber seed.

Scientists have long used true seed for breeding. But, once obtained, varieties are multiplied vegetatively to maintain their "varietal purity." This concept is basic to seed certification programs which in Europe, for example, may reject an entire seed field if it has a few atypical plants. As far as plant uniformity goes, potato consumers are far less demanding than seed certification agents. In many countries the uniformity of potatoes consumed is not much greater than that of a crop produced from true seed.

The People's Republic of China is pioneering the use of true potato seed in a large-scale multiplication program. Research at CIP aims at developing true seed technology for direct production of ware potatoes at the farm level. In the near future use of true potato seed may revolutionize potato agriculture in the developing world.

#### D. Technology Transfer

Even before true seed and varieties adapted to the lowland tropics become available, potato yields and marketable production could be substantially raised with existing technology. But, for a variety of reasons, farmers do not adopt many recommendations based on experimental station results. More effective transfer of technology requires an understanding of farmer's production problems and tailoring existing technologies to their needs and resources.

CIP social scientists collaborate with biological scientists and with regional and national programs in carrying out farm-level research projects that point to farmers' production problems (such as overuse or mis-management of fertilizer and pesticides), test and evaluate proposed technical solutions to these problems, and reveal reasoning behind timely adoption or non-adoption of new technologies. This interdisciplinary work contributes ultimately, to improving the effectiveness of the overall research-transfer system.

#### VI. POLICY IMPLICATIONS

The potential role of the potato as a foodcrop in developing countries has been grossly underestimated. Potatoes are one of the world's major foodcrops, grown and consumed in nearly every country. They are rapidly becoming an important small farm crop and a familiar dietary component in developing countries. For potatoes to realize the potential of a world-wide foodcrop, national, regional and international coordination is needed so each contributing institution specializes in its area of greatest comparative advantage and complements the work of others. Because many developing countries cannot afford a comprehensive potato research program CIP's priority role is highlighted: to backstop national program research and facilitate the communication of potato knowledge among all countries.

The major barriers to expanded utilization of the potato are at national levels. Needed is a better appreciation of the potential role of the potato as a foodcrop in different ecological and socio-economic environments and a definition of national priorities for potatoes, vis a vis other crops. Policy makers in the developing world must appraise the role the potato can, and should, play in their countries. Once national priorities are determined, a wealth of knowledge about the potato is available and can be mobilized in resolving the constraints of its greater production and use.