Centre for Agricultural Strategy

International agricultural research: potential impact on world food markets and UK agricultural strategy

A F McCalla

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Preface

The United Kingdom (UK) is dependent for a substantial part of its food supply on trade with its European Community partners and with the rest of the world. In recent years much concern has been expressed about the possible shortage of food on the world market and the consequent effects on food prices and on agriculture in the UK. There is also some concern that purchase of food on the world market by a relatively rich country such as the UK may hinder procurement of food by less affluent nations.

For the past 30 years considerable international research, development and aid, funded by many agencies, have been devoted to improve food production, storage and distribution. In spite of considerable achievements by individual countries, such as India, the population of the developing countries continues to grow and the ratio of food supply to food demand has shown little improvement. Reports (such as that published by the International Food Policy Research Institute in Washington in 1976) have indicated that, particularly in developing countries, the situation may deteriorate during the rest of the century. Continued research and development effort will be needed to improve agricultural output in both the developed and the developing world.

Research is an international activity and findings in one centre may have substantial repercussions either by direct application of findings or by affecting trade in other commodities throughout the world. In considering UK food supply problems, the Centre for Agricultural Strategy wished to gain some insight into the effect of international agricultural research on the world food supply. A small but significant part of that research effort is the programme of the Consultative Group for International Agricultural Research (CGIAR) which has established a string of research institutes throughout the developing world. Some of these institutes have already won acclaim for developing new high yielding varieties of

wheat and rice. In 1976, the CGIAR requested Professor A F McCalla, Dr A T Mosher, Professor J McWilliam, and Professor E Åberg to review its programme. The Centre for Agricultural Strategy is grateful to Professor McCalla, of the University of California, Davis, for preparing this personal assessment of the potential implications of the CGIAR programme for UK food supply and agricultural strategy. It is recognised that the CGIAR programme is only one example of the effects of international and national research development programmes in tropical and temperate zones on the food supply and food production of a developed temperate country such as the UK. Nevertheless, it emphasises the need for the UK to trade and to interchange knowledge as well as technology with the rest of the world. UK agricultural strategy is by no means insular; it must take account of relationships with many other countries.

The views expressed in the paper are those of Professor McCalla. As with other papers in this series, the Centre staff and members of its Local and Advisory Committees do not necessarily agree with the author's views.

John C Bowman
Director

Contents

ABBREVIATIONS

CGIAR	Consultative Group on International Research (Abbreviations of individual Centres are given in Table 2)
IFPRI	International Food Policy Research Institute
UK	United Kingdom
USDA	United States Department of Agriculture

METRIC EQUIVALENTS

1 tonne = 0.984 tons

Summary and conclusions

This paper attempts to review the impact of the Consultative Group on International Research (CGIAR) research effort on world food supply/demand balances. It also attempts to outline the potential impact of that research for UK food strategy. It must be clearly recognised that a promising research finding does not immediately result in increased food production; there are many intermediate stages. However, the availability of new technology for increasing output is a necessary pre-condition to the complicated process of raising economic ceilings and achievement distributions. It is concluded that the research investments of the CGIAR are likely, over varying time horizons, to have positive effects on world food supplies in three ways:

(i) Through adoption of food output increasing technology by food-deficit developing countries thereby lessening their demands for world food supplies;
(ii) Through adoption by food exporters;
(iii) Through adoption by food importers such as the UK.

The cumulative effects should be to lessen the likelihood of extreme food shortages in the future and therefore increase the stability of international markets. It is unlikely, however, that CGIAR research will be so successful as to create food surpluses in the developing countries. Thus, for the UK and the Community, the CGIAR represents a positive element in the world scene which should stabilise world markets and lessen the call for 'self-sufficiency at all costs' in traditional importing countries.

1 Introduction

Increasing efforts, in terms of monetary resources and manpower, are being devoted to research to increase food production in developing countries. A growing component of this research is sponsored by the CGIAR (Consultative Group on International Agricultural Research, see CGIAR 1976 for full description); it is conducted at nine international research centres in nine countries of the developing world. The location of these centres is shown in Figure 4 (page 29). Some 'successes' have already been heralded and debated. There are, for example, the dwarf rices (eg IR-8) developed at the International Rice Research Institute (IRRI) and the dwarf wheats at the Centro Internacional de Mejoramiento de Maiz y Trigo (CIMMYT). Both 'successes' came early in the formal careers of these centres. Since then the number of commodities and the intensity of research have increased greatly. Thus the question arises 'What impact will CGIAR sponsored research have on world food production in relation to world food needs?'. A second question relevant to the UK is 'What impact will this research have on food supplies available to the UK either through increased international food availability or through direct adoption of new technology by UK agriculture?'. The latter question has particular relevance as the UK, long a major food importer, attempts to define future food strategy; however, its answer depends on the answer to the first question.

This paper presents some thoughts on both questions. Views are based on the author's involvement, over the past two years, in studying the world food problem and, in particular, the CGIAR 'system' of research centres (CGIAR 1977). Identifying the potential impact of agricultural research on world food availability is more complicated than would appear on the surface. This has two reasons. First, although research is one necessary requirement for increasing food output, it is not the only one nor is it sufficient in itself. Many other factors must interact

before food output increases. Second, global distribution of increased food output and, in particular, its availability to a country such as the UK is through a complex international network of trade, aid and investment. Increased potential food output resulting from a research breakthrough does not translate directly to increased food supplies. Any analysis of the food situation must begin by reviewing requirements for increasing food output and identifying the role of research in that process. The nature of international food movements must also be understood.

The paper begins with a brief discussion of the potential role of research in influencing world food supply and demand balances. It then turns to a detailed discussion of the role of research and identifies the limited role played by the CGIAR. Having identified the potential role, the paper briefly reviews the world food situation and the international movements of food products. Once the potential role of CGIAR financed research and its relationships to international food movements is understood it is then possible to ask what impact research improvement in the developing countries might have on international food availability. The paper then considers the potential for direct adoption of new technology by the developed countries, and in particular the UK, and its impact on food supplies.

The paper concludes with some tentative thoughts on the implications of the research for UK food strategy and the broader implications of the CGIAR for Europe and world food supplies.

2 Potential impact of research

Figure 1 attempts to outline the possible impacts of research on world food supply and demand balances. The research activities to increase food production potential (at the top of the figure) show clearly that the CGIAR supported activities are only one element of research. The potential impacts of CGIAR research can occur in three ways:

(i) By converting to usable technology and having that technology adopted by deficit developing countries;

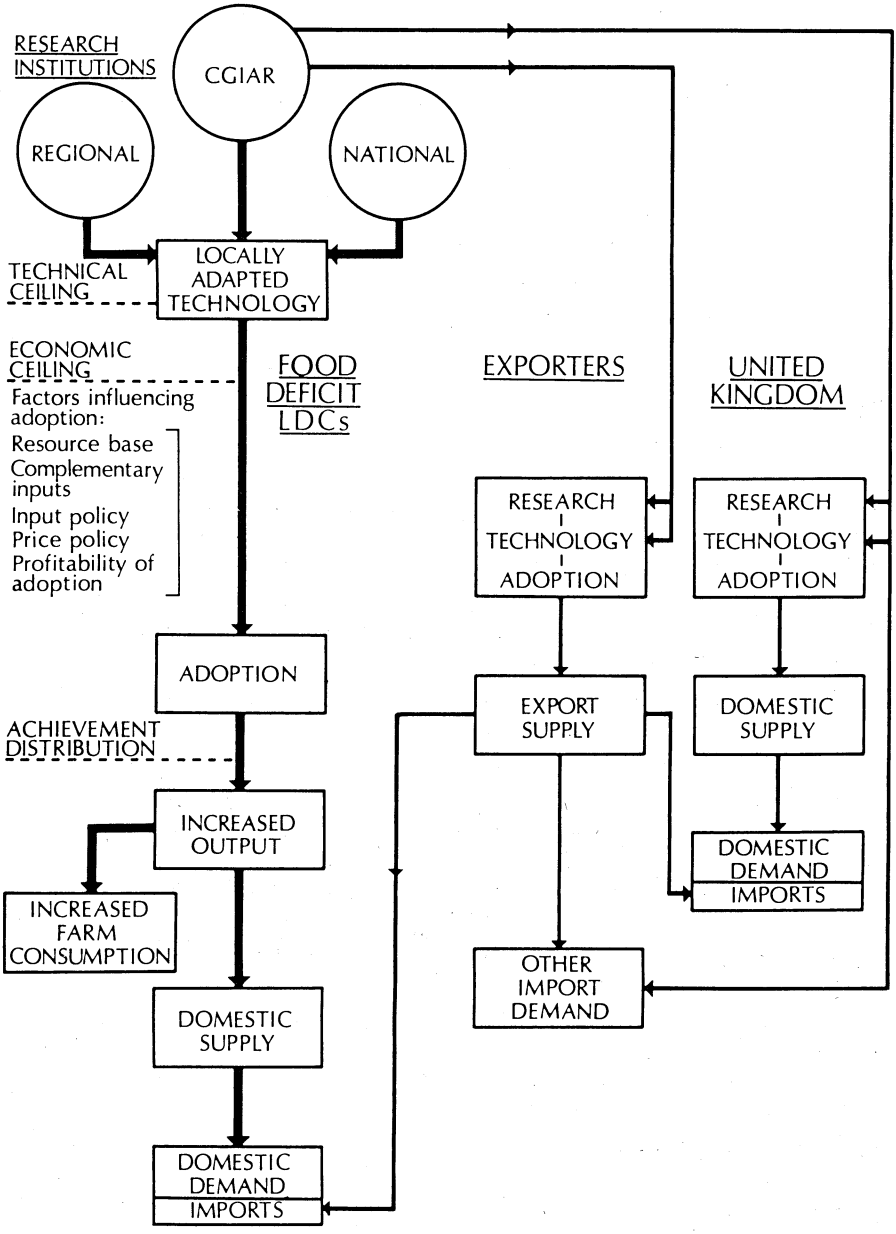
(ii) By the use of CGIAR research output in 'exporting' countries thereby increasing available export supplies;

(iii) By direct use of CGIAR research by an importing country such as the UK to increase domestic food supplies.

The first process is depicted as a sequence of events moving downward on the left of the figure. Research results must first be converted to locally adapted technology. This influences the level of technical possibilities for production. This is the so-called 'technical ceiling' which will be discussed in detail later. Many factors influence whether or not technology is adopted; these are schematically shown as precursors to adoption and are associated with raising the economic ceiling. Actual adoption potentially increases output. Some of the increase in output may be consumed on the farm on which it is produced. The remainder may enter the market and contribute to domestic supply. At this point, if the developing country is an importer, increasing supplies will reduce import demands. This outcome will tend to increase international supplies available to importers (such as the UK). Thus the first impact is through developing countries' supplies and is identified in Figure 1 by the heavy lines.

The second impact of CGIAR research is through the use of CGIAR research by developed (and developing country) exporters; the succession of events –

Figure 1
Potential impact of CGIAR research



research, usable technology, adoption and increased supply – could increase export supplies on the world market. The third possible impact is the direct use by the UK (or other importers) of CGIAR research to increase domestic food supplies. This is identified by the line from CGIAR research to the UK situation on the right. For the sake of completeness other importers are also shown as they too could use CGIAR research thereby increasing domestic supplies and reducing import demand.

Figure 1 serves as a quide to the remainder of the paper. First, the stages from research to increased supply are discussed in detail. Second, the nature of the world food supply/demand balances and the international movement of food are discussed. The paper then turns to a specific review of CGIAR research activities and discusses their potential impact via the three routes outlined above.

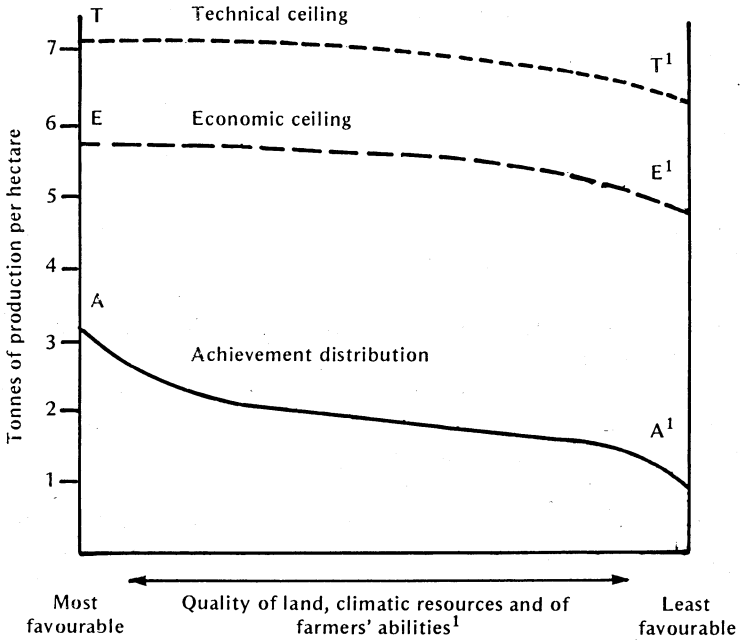
3 Research and the conditions for increasing food supplies

World food output can be increased in two ways, either by expanding the area under cultivation or by increasing production per unit area over a unit of time. Both approaches are constrained by resource availability, such as the physical resources and the climate-moisture-temperature conditions. Given these constraints, output can be increased by applying new technology.

To understand the requirements for increases in output it is useful to define three concepts, technical ceilings, economic ceilings and achievement distributions, developed by Arthur Mosher (CGIAR 1977). A technical ceiling is the maximum physical production that can be achieved per unit of land using the most productive set of technologies and services that are available given the physical conditions, eg land; this is shown as the line T-T^1 in Figure 2. The second factor is an economic ceiling which represents the most profitable outcome given the best technical inputs. It necessarily falls below technical ceilings because farmers maximise their returns where marginal cost equals marginal return which always yields an output less than the maximisation of physical production. The economic ceiling is shown as the line E-E^1 in Figure 2. Both the technical ceiling and the economic ceiling represent ideals. The third factor in the analysis is actual performance which is called the achievement distribution line A-A^1 in Figure 2. It a always lies below the economic ceiling because of imperfect information, aversion to risk and uncertainty, habit and imprecise economic decision-making. Increased agricultural output is achieved only when the distribution is raised. The economic and technical ceilings are important in two ways – either by removing barriers to raising achievement distributions or by providing an ever moving incentive to increased output.

Technical ceilings can be raised by research and technology development or by land improvement. Economic ceilings can be influenced by a series of factors

Figure 2
Technical ceiling, economic ceiling and achievement distribution



1 Only differences in land quality enter into the downward drift toward the right of a technical ceiling. However, two factors are responsible for the downward trend toward the right of achievement distribution. One is land quality. The other is differences in the abilities of farmers. Some of those differences can be removed by various types of education and training, but even with equal opportunities, significant differences in farmers' abilities always persist.

Source: Based on CGIAR (1977)

including raising technical ceilings and policy factors such as relative prices and markets. Achievement distributions can be raised by raising economic ceilings and can be accelerated by a series of extension activities. These possibilities summarised in Figure 3.

The purpose of the above discussion of well-known factors is to identify explicitly the role of research in the set of requirements for increasing agricultural output. Even the research element is more complicated. Research developed on experimental farms must be converted to locally adapted technology. Before technology can be adopted complementary inputs must be available. Only then can the other set of factors relating to economic ceilings and achievement distributions come into effect. In summary, research activities act directly only on technical ceilings. Output increases occur only when achievement distributions are raised and there is not a clear direct relationship between the two. It follows that increases in production potential through research and technology development do not necessarily translate into increased food output. On the other hand, of course, achievement distributions and economic ceilings could be constrained by the lack of movement in technical ceilings.

This paper does not deal with all research devoted to increasing food output, but discusses a limited set of activities supported by the CGIAR. There are three main types of research devoted to increasing world food output. These are:

(i) National research programmes in developing and developed countries;

(ii) Regional research programmes mainly among the developing countries and supported by the developed countries;

(iii) International research programmes such as, for example, the International Centres.

It has been estimated (Boyce & Everson 1975) that in 1974 approximately 3.8 billion dollars were spent on agricultural research globally. Of this, nearly 2.9 billion dollars were spent in the developed countries of Europe, the USSR, North America and Oceania. An additional 0.6 billion were spent in Asia where Japan was the most significant participant. Thus about 15%, 0.57 billion, were spent in the developing countries. The International Agricultural Research Centres in 1974 spent about 50 million or 10% of the developing countries' agricultural research expenditure. Thus, the CGIAR supported activities account for not more than 2% of total world expenditure on agricultural research.

In summary, research is only one element in the necessary conditions for increasing food output and the CGIAR system is only a small component of that research activity. This is not intended to suggest that the CGIAR is an unimportant element but rather to point out that attempting directly to translate CGIAR research success to increased food output is too simple an approach.

Figure 3

Agricultural development activities appropriate to raising technical and economic ceilings and achievement distributions

Raising the technical ceiling ($T-T^1$) is accomplished by:

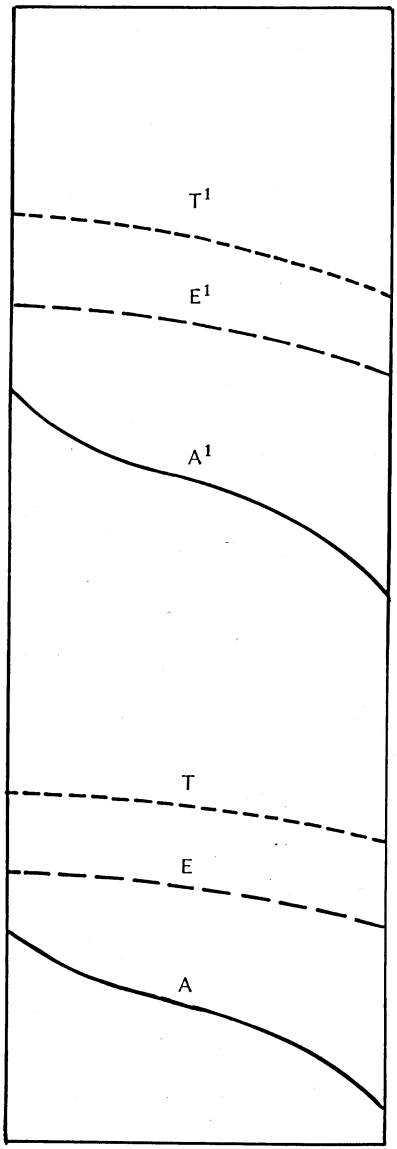
(i) Biological and engineering research,
(ii) Land improvement

Raising the economic ceiling ($E-E^1$) is accomplished by:

(i) Raising the technical ceiling
(ii) Increasing the number of localities served by, and the efficiency of:
    - Markets for farm products
    - Outlets for farm supplies and equipment
    - Production credit facilities
    - Farm to market roads
(iii) Favourable price relationships
(iv) Favourable tenure relationships

Raising the achievement distribution ($A-A^1$) is accomplished:

(i) Primarily by raising the economic ceiling.
(ii) It can be accelerated by an efficient extension service and other means of increasing farmers' abilities, skills and eagerness to increase production.



Source: Based on CGIAR (1977)

4 The world food situation

Many recent studies have sought to identify the scope and magnitude of the world food problems (eg: USDA 1974; University of California 1974; IFPRI 1976). Findings are summarised by Carter (1976) and reproduced in Table 1. The CGIAR Review Committee report for 1977 also includes a study by Koffsky. All these studies essentially project food demand by projecting population and income growth and use income elasticities of demand to project aggregate food needs. Some modify these projections by elements of nutritional needs. Similarly, most project supply by multiplying available land by some trend in yields to produce an estimate of aggregate food production. These two projections are then compared to arrive at a global food balance. The second stage is to analyse these figures on a regional basis, usually comparing developing and developed countries. All conclude that the developing countries will have food deficits and the developed countries will have food surpluses. Most, given the method of projection, yield a global balance. Presumably the surplus from the developed countries goes to the developing countries via trade or food aid.

However, these global approaches provide data of only limited use for more specific issues of regional or country deficits in terms of specific commodities. The IFPRI (1976) study and the Koffsky (1977) study do disaggregate by region and attempt to identify specific commodity issues. For example, Koffsky concludes that given continuance of trends in yields, population and income growth 'the deficit in cereal production in Asia, Africa and much of Latin America is likely to rise from about 17 million tonnes in 1969/70 to between 65 million and 88 million tonnes by 1985/86; and it might grow by another 30 to 35 million tonnes by 2000. Similar increases in deficits are likely in root and tuber crops, and grain legumes'. For comparison, the total volume of wheat trade by all countries has averaged approximately 70 million tonnes over recent

Table 1
Comparison of cereal projections to 1985 (million tonnes)

Item[a]	FAO Base 1969-71	FAO 1985	USDA Base 1969-71	USDA-I[f] 1985	USDA-II[g] 1985	USDA-III[h] 1985	USDA-IV[i] 1985	ISU 1985	UC 1985	IFPRI 1985-86
World										
Demand	1 207	1 725	1 062.6	1 548.5	1 618.7	1 501.8	1 643.9	1 145.5	1 777.2	
Production	1 239	NS	1 081.8	1 550.4	1 620.6	1 503.6	1 645.7	1 187.3(L)[j]	1 176.6	
								1 191.7(H)[j]	−0.6	
Balance[b]	+32	NS	+19.2	+1.9	+1.9	+1.9	+1.9	+41.8(L)[j]		
								+46.2(H)[j]		
Developing countries										
Demand	590	929	466.6	691.2	726.2	678.6	743.5		954.5	
Production	585	853	443.1	632.4	648.7	626.2	721.0		917.9	
Balance	−5	−76	−23.5	−58.8	−77.5	−52.4	−22.5		−36.6	
Developing market economies[c]										
Demand	386	629	299.7	479.4	512.6	466.7	529.1	524.7	210.2	534.2(H)[k]
										517.1(L)[k]
Production	370	544	279.2	424.7	441.0	418.7	513.3	411.0(H)[j]	206.5	451.6
								406.6(L)[j]	−3.7	
Balance	−16	−85	−20.5	−54.7	−71.6	−48.0	−15.8	−113.7(H)[j]		−82.6(H)[k]
								−118.1(L)[j]		−65.5(L)[k]
Asian centrally planned countries[d]										
Demand	204	300	166.9	211.8	213.6	211.9	214.4		744.3	
Production	215	309	163.9	207.7	207.7	207.7	207.7		711.4	233.4
Balance	+11	+9	−3.0	−4.1	−5.9	−4.2	−6.7		−32.9	
Developed countries[e]										
Demand	617	796	596.0	857.3	892.5	823.2	900.4	403.4	822.7	
Production	654	NS	638.7	918.0	971.9	877.4	924.7	574.0	858.8	
Balance	+37	NS	+42.7	+60.7	+79.4	+54.2	+24.3	+170.6	+36.1	

Note:

FAO = Food and Agriculture Organisation; USDA = US Department of Agriculture; ISU = Iowa State University; UC = University of California; IFPRI = International Food Policy Research Institute.

a The data for FAO and USDA are not comparable because FAO carries rice as paddy, USDA carries rice as milled.

b Imbalances for USDA between demand and production in base are due to stock build up, timing of shipments, and missing data on a number of small importers. Projected equilibrium does not allow for building or reducing stocks.

c UC developing market economies include Africa and Latin America. IFPRI includes Asia, North Africa, Middle East, Sub-Sahara, Africa, and Latin America.

d UC, FAO, and IFPRI Asian centrally planned includes the People's Republic of China and other Asian centrally planned countries (North Korea, North Vietnam, etc). UC also includes Japan.

e Includes the USSR and Eastern Europe.

f USDA-I. Assumes economic growth temporarily slowed, but resumes strong expansion in late 1970s. Limited expansion of world trade.

g USDA-II. High world import demand situation. Larger income growth rate than USDA-I in both developing and developed countries.

h USDA-III. Low demand situation that assumes economic stagnation would continue in the late 1970s and recovery does not occur until the 1980s.

i USDA-IV. Developing countries' import needs are reduced. Have assumed that they have increased their investment in food production by increasing the inputs used.

j Projection designated (L) are made under a low variant upper bound on cropland expansion. Those designated (H) are made under a high variant bound on cropland expansion.

k Projections designated (L) are made under a low variant upper bound on income growth. Those designated (H) are made under a high variant bound on income growth.

Source: Carter 1976 (Based on USDA 1974; University of California 1974; IFPRI 1976).

years, two-thirds of which was trade between developed countries. The Koffsky analysis also points out that plant materials are the dominant source of food in developing countries (according to the University of California (1974) plants provide 90% of food energy consumed, animals 9% and fish 1%) and within the plant groups cereals (wheat, rice, sorghum and millets) and starchy products (such as potatoes, cassava, yams) are the dominant sources, with cereals alone contributing between 50 and 70% of dietary sources of energy (CGIAR 1977).

All the reports conclude that the world food problem is concentrated in the developing world which is experiencing rapid population growth rates and not very spectacular increases in food production capacity. Furthermore, the food problem is essentially one dealing with cereal and plant production. Thus, in terms of the world problem, these food deficits can be offset either by increased food production in the developing countries or by increased international movements of foodstuffs from the developed to the developing countries. Both solutions could have impact on international food supplies available to developed countries. On the one hand food balances would improve if developing countries increased food production sufficiently to become net exporters or, alternatively, the food balance might deteriorate if the developing countries continued to depend on world markets and became increasingly important competitors for internationally available food supplies. Before turning to these possibilities it seems appropriate to examine international food movements.

5 International food movements

The major part of world food output is consumed in the countries in which it is produced. It has been estimated that world output of plant products in 1970 was 3146 million tonnes of which 1208 million tonnes was cereals. About 9% of this output, in terms of energy, was fed to livestock. Cereals accounted for 60% of total food energy and 73.5% of the world crop area (University of California 1974). Although figures are difficult to obtain, it is likely that trade in agricultural products in 1970 totalled less than 200 million tonnes, ie less than 7% of global production. The distribution of this trade is also skewed. Cereals account for more than 50% of trade in weight terms, with wheat and coarse grains the dominant items. Between 15 and 20% of world wheat production enters international trade. Coarse grain trade makes up somewhat less than 10% of total production; less than 3% of rice production is traded. International trade for other products (such as roots and tubers, pulses and lentils) is very limited. In summary, cereals are the dominant element in international trade and movement of food products (University of California 1974).

Analysis of the origin and destination of trade shows that more than 75% of the volume of exports originate in developed countries and more than 80% of agricultural trade goes to the developed countries (University of California 1974; Sorenson 1975). Analysis by the country of origin of traded products, particularly of cereals, shows they originate in six major countries: the USA, Canada, Australia, Argentina, France and the USSR (McCalla 1977). Until 1972, the major involvement of developing countries as importers was under concessional trade terms (US PL 480 and EC concessional food shipments). However, with price rises in the international market from 1972 on, concessional food shipments dropped considerably except those proceeding under the World Food Programme.

In summary, international movements of food products in recent years have been mostly through commercial trade and this has been dominantly between the developed countries. Particularly in cereals, the number of exporters has deceased and the number of importers increased as more and more developing countries enter the world market as commercial importers (not always by choice – many previously depended on PL 480 local currency sales).

6 Impacts of CGIAR research on world food supplies

The preceding sections of the paper have attempted to put the subject in perspective by outlining the role of research in increasing food output; the world food situation and its future dimensions; and international movements of agricultural products. As the discussion proceeds to the actual CGIAR research activities these perspectives should be kept in mind.

Analysis of the potential impact of CGIAR research begins by reviewing the character of the research activities. It then considers the possible impact of adoption of potential technology by the developing countries on world food balances, and the implications for the UK; it concludes with some thoughts on the broader implications for Europe and the world food situation.

CHARACTER OF CGIAR RESEARCH AND ITS POTENTIAL OUTCOMES

The centres supported by the CGIAR conduct research on many commodities of relevance to the world food problem. These are listed in Table 2, and their location shown in Figure 4.

The programmes of the centres can be grouped into three classes. First, there are centres which have a strong or total concentration on specific commodities on a world wide basis; these are CIMMYT, IRRI and CIP. A second group have regional or ecological zone responsibility in addition to commodity responsibility; these are ICRISAT, ILCA, CIAT, IITA and ICARDA. (Most of these centres also have farming systems or general systems programmes – ICRISAT, ILCA, IITA and ICARDA.) The third class work on specific regional problems, eg ILRAD which is concerned with specific livestock diseases in Africa.

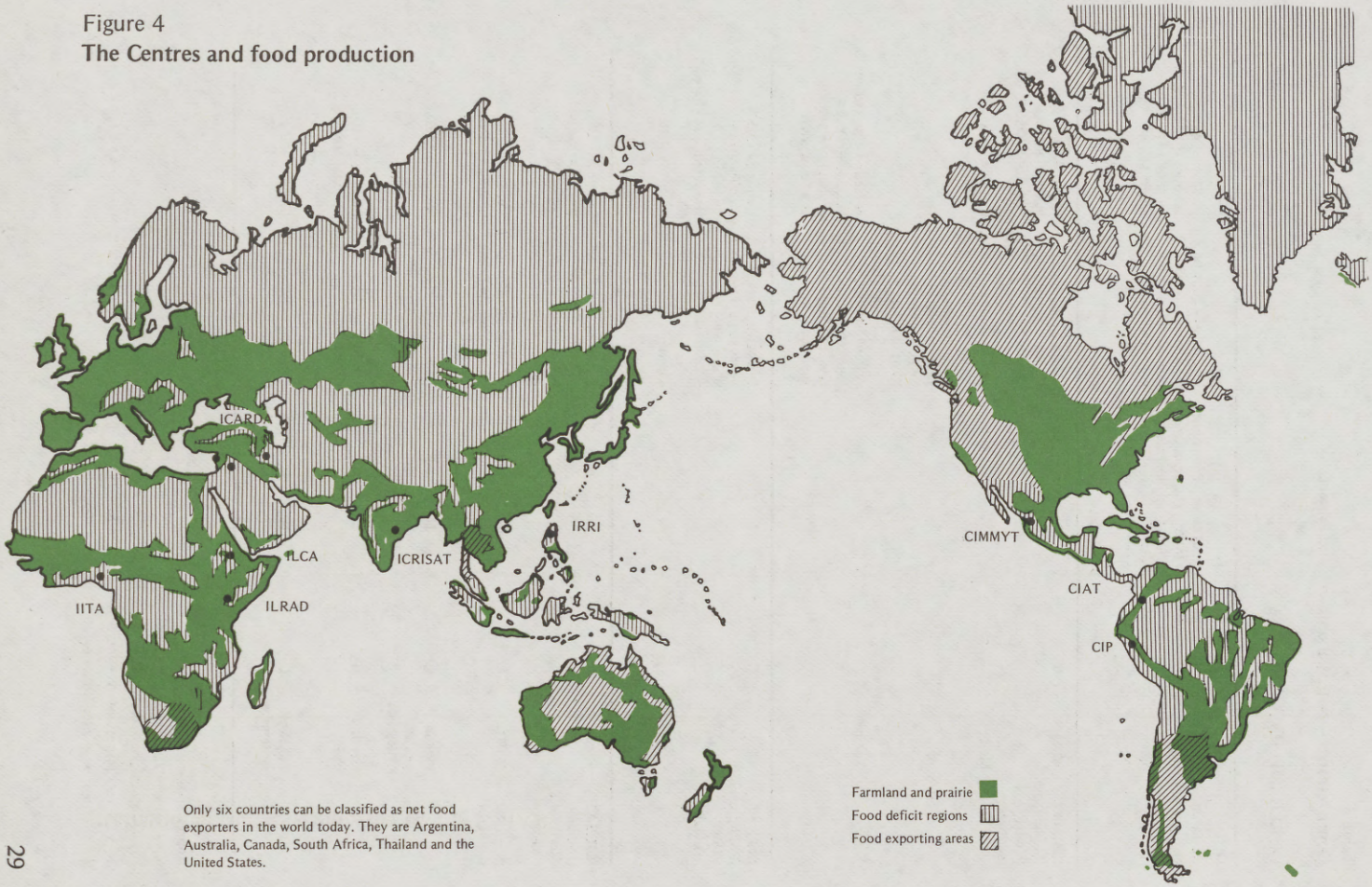
Table 3 lists the centres (column 1), their research programmes (column 2), and suggests the potential outcome and impact of their research programmes. For each research programme (commodity or otherwise) a judgement is made as

Table 2
International centres supported by the CGIAR

Centre		Location	Date of establishment	Commodities
CIAT	Centro Internacional de Agricultura Tropical	Cali, Colombia	1967	Cassava, field beans, livestock forage
CIMMYT	Centro Internacional de Mejoramiento de Maiz y Trigo	Los Banos, Mexico	1966	Wheat, maize, triticale, durum
CIP	Centro Internacional de la Papa	Lima, Peru	1971	Potatoes
ICARDA	International Centre for Agricultural Research in the Dry Areas	Syria, Lebanon, Iran	1976	Barley, lentils, broad beans and farming systems
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics	Hyderabad, India	1972	Cropping systems, sorghum, millet, chick pea, pigeon pea, ground nuts
IITA	International Institue of Tropical Agriculture	Ibadan, Nigeria	1968	Cropping systems, root and tuber and grain legumes
ILCA	International Livestock Center for Africa	Addis Ababa, Ethiopia	1974	Livestock production systems
ILRAD	International Laboratory for Research on Animal Diseases	Nairobi, Kenya	1973	African livestock diseases - theileriosis and trypanosomiasis
IRRI	International Rice Research Institute	Los Banos, Philippines	1960	Rice, rice cropping systems

Source: CGIAR (1976)

Figure 4
The Centres and food production



Only six countries can be classified as net food exporters in the world today. They are Argentina, Australia, Canada, South Africa, Thailand and the United States.

IMPLICATIONS FOR UK

(8) Net impact on food supplies available to importers, such as UK	(9) Product used in UK? As food	(9) Product used in UK? As feed	(10) Product grown in UK?	(11) Percent imported UK, 1974	(12) Probability of UK adopting Centre results	(13) Potential impact on UK supplies and import demand	(14) Total effect on UK s-s and food strategy
Likely to increase available supplies	Yes	Yes	Yes	32	Moderate to high	Moderate to high	Could increase s-s and lower costs of wheat supplies
Marginal because not a traded food crop	No	Yes	Yes	100	Moderate to high	Significant	Depends on live-stock numbers. Could lower costs
Unlikely to have major impact in next 10-15 years. After?	No	No	No (could be)	0	Could be very important in UK if adopted	If adopted significance on feed imports	Uncertain; could reduce feed import needs and costs
Limited — most rice is not traded	Yes	No	No	100	None	None	Potential increase in available supplies
Limited	Yes	No	No	na	None	None	No impact
Limited — if any	No	Yes	No	100	Moderate to good	Limited — sorghum not an important crop	Little impact
None	No	No	No	na	None	None	None
None	Yes	No	No	100	None	None	Little impact
Limited	Yes	No	No	100	None	None	Little impact
Limited — if any	na	na	na	na	Very low	None	None

Table 3 (continued)

WORLD IMPLICATIONS

(1) Research centre	(2) Research programme	(3) Geographic importance[1]	(4) Importance in international trade[2]		(5) Probability of output increasing research[3]		(6) Impact of adoption on developing countries' food supplies and import demand	(7) Impact on export supplies if adopted by food exporting countries
			As food	As feed	0-5 years	5-10 years		
ICARDA (Syria, Lebanon, Iran) Ecological zone arid areas	Barley	G	M	M	l-m	m	Limited — is not a preferred cereal	Limited as food — moderate as feed
	Lentils	L	N	N	l	l-m	Limited in the near-term	None
	Broad beans	L	L	N	l	l-m	Limited in the near-term	Limited
	Farming systems	L	na	na	l	l	Limited in the near-term	Limited — if any
CIAT (Colombia) Regional and ecological Latin American tropics	Cassava	L	N	L	m-h	h	Could be locally significant. Overall, limited — not a preferred food	Limited — except as pelleted livestock feed
	Field beans	L	L	N	m-h	h	Locally significant. Overall, limited impact	Limited — if any
	Livestock (forage)	L	M	N	l-m	m	Impact on meat supplies only in Savannahs of Latin America and Africa	None — major livestock exporters more advanced
IITA (Nigeria) Regional — tropical low altitude tropics	Farming systems	L	na	na	m-h	h	Limited — major importance to subsistence home use	Limited if any
	Roots and tubers — cassava, yams, sweet potato	L	VL	L	m	m-h	Limited in terms of cereal demand — subsistence crops	Not traded except as cassava pellets
	Grain legumes	L	VL	L	m	m-h	Main impact would be to upgrade quality of diet	Limited — if any
CIP (Peru) Global	Potatoes	G	VL	N	m-h	h	Local impact — not traded or a cereal substitute	Limited — not traded
ILCA (Ethiopia) Regional	Livestock (systems)	L	M	N	l	l-m	Meat is not imported to Africa — no effect	Limited — unless Africa became an exporter
ILRAD (Kenya) Regional	Livestock (animal disease control)	L	M	N	l-m	m-h	Meat is not imported to Africa — no effect	Limited — unless success allowed Africa to be an exporter

Abbreviations:

na — not available; s-s — self-sufficiency

1 G — global; L — local and/or regional

2 Vi — very important; I — important; M — moderate; L — limited; VL — very limited; N — none

3 h — high; m — medium; l — low; l-m — low to medium; m-h — medium to high

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(8) Net impact on food supplies available to importers, such as UK	(9) Product used in UK? As food	(9) Product used in UK? As feed	(10) Product grown in UK?	(11) Percent imported UK, 1974	(12) Probability of UK adopting Centre results	(13) Potential impact on UK supplies and import demand	(14) Total effect on UK s-s and food strategy
Moderate – as feed grain	Yes	Yes	Yes	7	Moderate to high	Could reduce feed imports	Depends on live-stock number
None	Yes	Yes	Yes	0	Moderate if available	Little if any	Little impact
Limited	Yes	No	Yes	100	Moderate	Little if any	Little impact
Limited	na	na	na	na	None	None	None
Limited – as feed supplement only	No	Yes	No	100	None	None	Little impact
Limited	Yes	No	Yes	100	Moderate	Little	Little impact
Limited – could possibly increase meat supplies	Yes	Yes	Yes	Meat – 25 Forage – 0	None	None	Little impact
Limited	na	na	na	na	None	None	None
Limited – if any	Yes	Yes	No	100	Low	Little – if any	Little impact
Limited – if any	Yes	No	Yes	?	Moderate	Little	Little impact
Limited – if any	Yes	Yes	Yes	1	High	Limited	Limited – already self-sufficient
Limited – if any	Yes	No	Yes	25	Little or none	Little – if any	Little impact
Limited in near-term, longer-term effect possible	Yes	No	Yes	25	None	None	Little impact in near future

to whether the programme has local and/or regional significance as opposed to global significance (column 3). This differentiation is important in two regards. First, a commodity of world wide dispersion is more likely to enter international trade and through this mechanism increases in productivity will have a direct impact on world food availability. Second, commodities of regional or local importance are less likely to be traded widely and therefore have a lesser direct effect. On the other hand, they could have indirect effects because improvement would increase local supply availability thereby lessening the supplementary imports of widely traded products by developing countries. Column 4 identifies whether the commodity is traded as a food product or as a feed input. This distinction is important in assessing effects both on the UK and on the world.

Column 5 presents the author's best judgements regarding the probability of obtaining, within the next five to ten years, research findings which will increase output. These judgements are necessarily hazardous; they are based on the following:

(i) The length of time the centre has been open and fully staffed. One would generally expect more immediate outputs from the older established centres such as IRRI, CIMMYT, IITA, CIAT and CIP;

(ii) The amount of detailed biological research done on the commodity prior to the establishment of the centre. One would expect faster results in well-studied crops such as wheat, rice, maize and barley;

(iii) The complexity of the research mandate of the centre. Clearly one would expect faster results from a specific commodity improvement programme than from a programme devoted to broad systems problems. For example, one would expect faster results from CIP than from ILCA;

(iv) The imminence of research results. The author's judgement is based on extensive discussions with centre directors and personnel.

Column 6 estimates, for developing countries now in deficit, the impact on food supplies and therefore import needs if the research findings were adopted. Similarly, column 7 attempts to assess the likelihood of adoption of centre technology by food exporting countries, both developed and developing, and the potential impact of adoption on available export supplies. The sum of columns 6 and 7 provides a rough estimate of the impact of centre research on overall food supplies.

The remainder of the table attempts to focus on the potential impact of centre research on the UK situation. Column 8 summarises the potential impact of adoption by the developing countries and exporters on import availability. Columns 9, 10 and 11 indicate the importance of the crop to the UK, whether it is grown in the UK and what percentage of consumption is imported. Recognising that centre technology could be directly adopted by UK agriculture

and therefore increase domestic supplies, columns 12 and 13 attempt to attach a probability to adoption in the UK and potential impact on UK supplies and import demand. The final column attempts an overall assessment of these three impacts (adoption by developing countries, by exporting countries and by the UK) for UK self-sufficiency and food strategy.

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Column 14 suggests that the major potential impacts for UK food supplies result from a limited number of CGIAR research programmes including wheat, maize, barley, triticale and rice. In the case of wheat and barley, the impact is likely to come both from the adoption of CGIAR technology by exporting countries and from direct adoption by UK agriculture. In the case of rice and maize, the impacts will come from the adoption of technology by exporters and food-deficit developing countries, which will thereby decrease their import demand and increase world supply. In the case of triticale the outcome is highly uncertain; if the potential (as currently demonstrated in experimental field trials at CIMMYT) materialises and this new crop is adopted, the impact could be substantial by all three routes. However, major supply impacts are unlikely to be felt for five years or even ten years.

It is concluded that the other crops in the CGIAR system will have little direct impact on UK food supplies. This is because they are not grown and/or used extensively in the UK or because the research outcome is likely to be specific to tropical locations. Nevertheless, it should not be concluded that certain commodities which are not traded in large quantities do not influence the world food balance. Some non-traded commodities (such as rice) influence the market for other products (such as wheat) which are traded. Some crops, such as groundnuts, enter trade as oil and meal and compete with other products which are important in trade. Also, production increases in developing countries, even through improvements in farming systems or expansion of non-traded crops such as pulses, will alter the balance for the major traded products such as grain.

However, for all crops studied by the CGIAR the overall effect on UK food supplies appears to be positive. There is no doubt that CGIAR research will result in increased productivity over the next ten to twenty years for most, if not all, the commodities being investigated. Thus, the impact of the CGIAR will be to increase food supplies. The crucial question for the UK is whether supply will increase more rapidly than world demand which is being stimulated primarily by population increases; studies on world food supply and demand balances (see Chapter 4) suggest continued strong pressure of world needs. Any programme that tends to alleviate that pressure will tend to improve world market prospects for countries wishing to purchase a portion of their supplies in international markets.

CGIAR research impinges on UK strategy by influencing the fundamental decisions of the government as to how far to stimulate investment in agriculture (or in certain sectors of farming) through public financial assistance or through policy attitudes taken in Brussels negotiations. In this sense it influences the approach taken by the government to the question of self-sufficiency, along with all the other variables relating to future food availability. The output – increasing potential of this research seems to imply that technological changes may be under way, and these may reduce the need for importing countries to stimulate high-cost food production. It also has more direct implications for publicly financed research programmes in the UK, and for the UK attitude towards contributions made to the CGIAR under technical assistance programmes.

IMPLICATIONS FOR EUROPE AND THE WORLD FOOD SITUATION

Implications of CGIAR research for the UK have been discussed. It also seems appropriate to comment briefly on the broader implications for Europe and the world.

Many of the implications drawn for the UK also apply to Europe. For wheat, adoption of new technology would be likely to increase the Community's existing surplus of soft wheat. Adoption of feed grain technology would presumably lessen external demand for feed grain imports. Both would have positive effects on European food balances in the Community. Similarly, success in the African programmes (particularly ILCA and ILRAD) could have the effect of increasing potential meat supplies nearer to Europe than Australia or Argentina. In sum then, the impact of CGIAR research on the Community would seem to be complementary to the Community's policy of self-sufficiency. In a parallel sense, adoption of CGIAR technology by developing countries in relation to commodities that the Community imports would expand available export supplies, presumably at more favourable prices.

The discussion relating to the UK also applies in world terms. In the foreseeable future, population and income growth will continue to put demand pressure on world food production. Any activity that helps to increase food production will lessen the likelihood of catastrophic food shortages and will also increase the stability of international markets. Both outcomes should be in the interests of all participants in the world food situation.

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