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STRUCTURAL SHIFTS IN THE WORLD GRAIN ECONOMY: 1962-1982

PRODUCTION, TRADE, CONSUMPTION

by

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1 Introduction

Cereals represent the main staple food of mankind. More than half of all the food energy directly consumed by man is derived from cereals and 50% of all arable land is devoted to the cultivation of grain.

During the last two decades several structural shifts in the world grain economy have occurred. They are better identifiable when they are studied for each kind of grain at country, regional and at global levels. Several world maps have been drawn to make the reader familiar with the geography of the phenomena studied. The data were taken from FAO. The production of grain in all countries during the period 1962-1982 has been subject of the analysis. Five-year-averages have been formed, centering on 1962, respectively 1982. Further, the structure of the international trade in cereals for the three-year-average 1982 to 1984 has been investigated.

In the beginning of this contribution the dramatic effects in the delay between the increasing growth rates in the human population and the difficulties of accelerating agricultural progress in many developing countries are discussed. Then follows an analysis of the relative contribution yield or area increases have to grain production in the world's regions. The large structural shifts which had occurred in the cultivation of the various cereals and in consumption are discussed. Finally, perspectives of the future international grain trade will be evaluated. ^{1/}

2 Medical progress and agricultural progress

Technical progress has many dimensions. In the framework of this contribution two types are distinguished: medical progress and agricultural progress. It is well known that

the spatial diffusion of medical knowledge has accelerated the population growth, specifically in developing countries. It takes still there several decades before the birth rate is gradually adjusted to a fast declining death rate. Unfortunately, the agricultural progress which has to be transformed

into rising yields does not follow fast enough the acceleration in population growth. This is still the situation in most of the developing countries. The transfer of advanced agricultural methods proves more time-consuming than the transfer of medical progress has been. Man is in its existence obviously more ubiquitous than his cultivated plants.

3 Structure of the world grain economy

3.1 Technical progress, population growth and grain production

In 1982 the world counted 4.6 billion people, thereof 58.2 % lived in Asia. They produced 41.7 % of the world's grain. Africa and South America were the other two world regions where the share in the world's grain production did not reach the one in population (Table 1). On the other hand, North and Central America, Europe and the USSR are the world's regions where the grain production share is larger than the population living there.

A comparison of the annual growth rates in population and in total cereal production shows that at world scale and in all continents - with the exception of Africa - cereal production grows faster than population. The differing growth rates between grain production and population increases are in Europe nearly three times higher than in Asia and South America or reach almost the double of North/Central America. However, the large positive difference between the two growth rates occurs mainly because Europe has a much lower population increase than other continents. This decline in demand is transferred to the international markets and influences increasingly the structure of the whole grain economy.

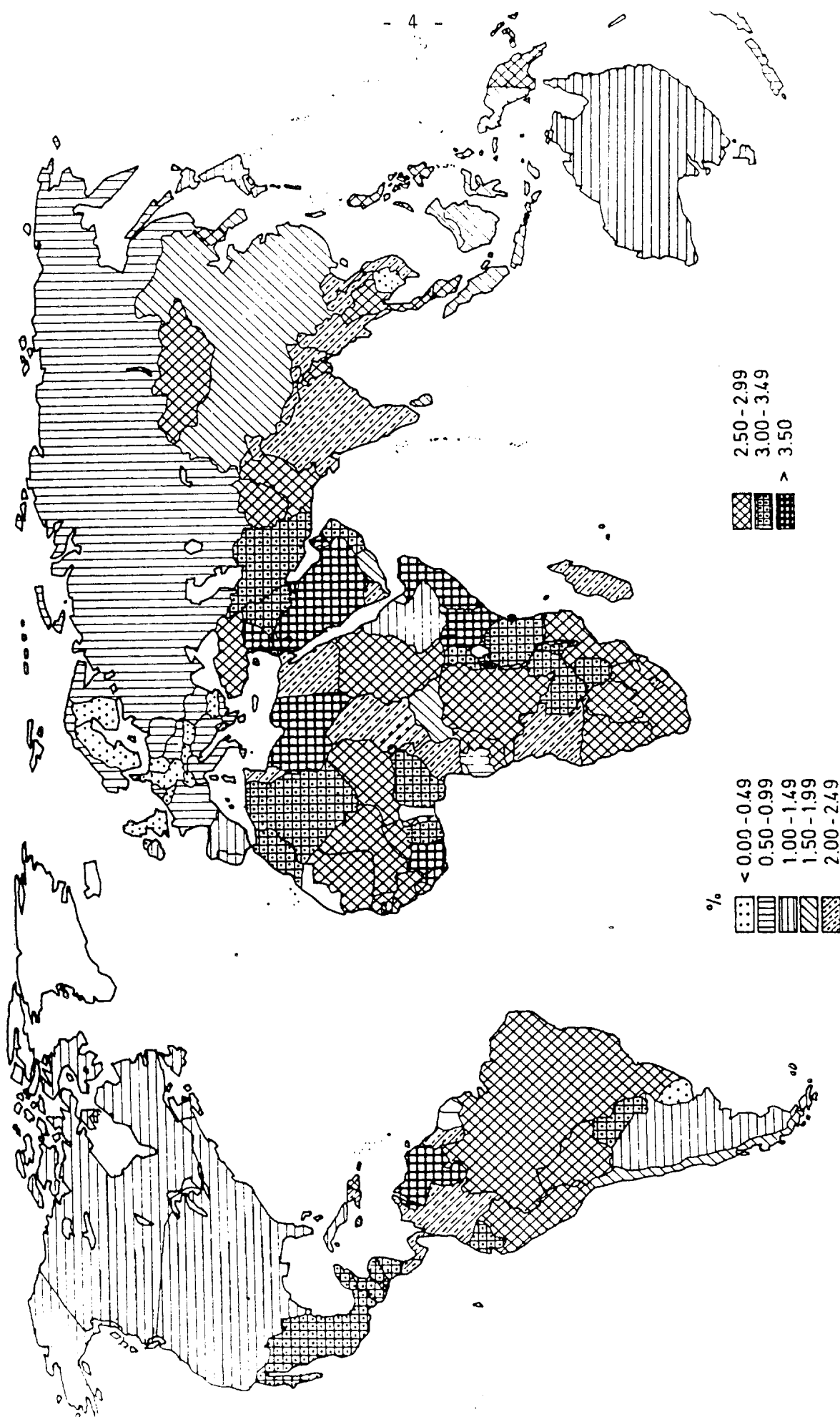
Figure 1 reminds at the high population growth rates in developing countries. The level and the annual changes in grain yields are reported in Figure 2. The difference in the distribution of the above mentioned two types of progress: medical progress transformed in population growth and agricultural progress transformed in yield increases can be derived for each country from Figure 1 and 2. A comparison of the two growth rates country by country shows that most African countries have low and

Table 1: Increase of cereal production and population
World, 1982, 1962^{a)} - 1982^{b)}

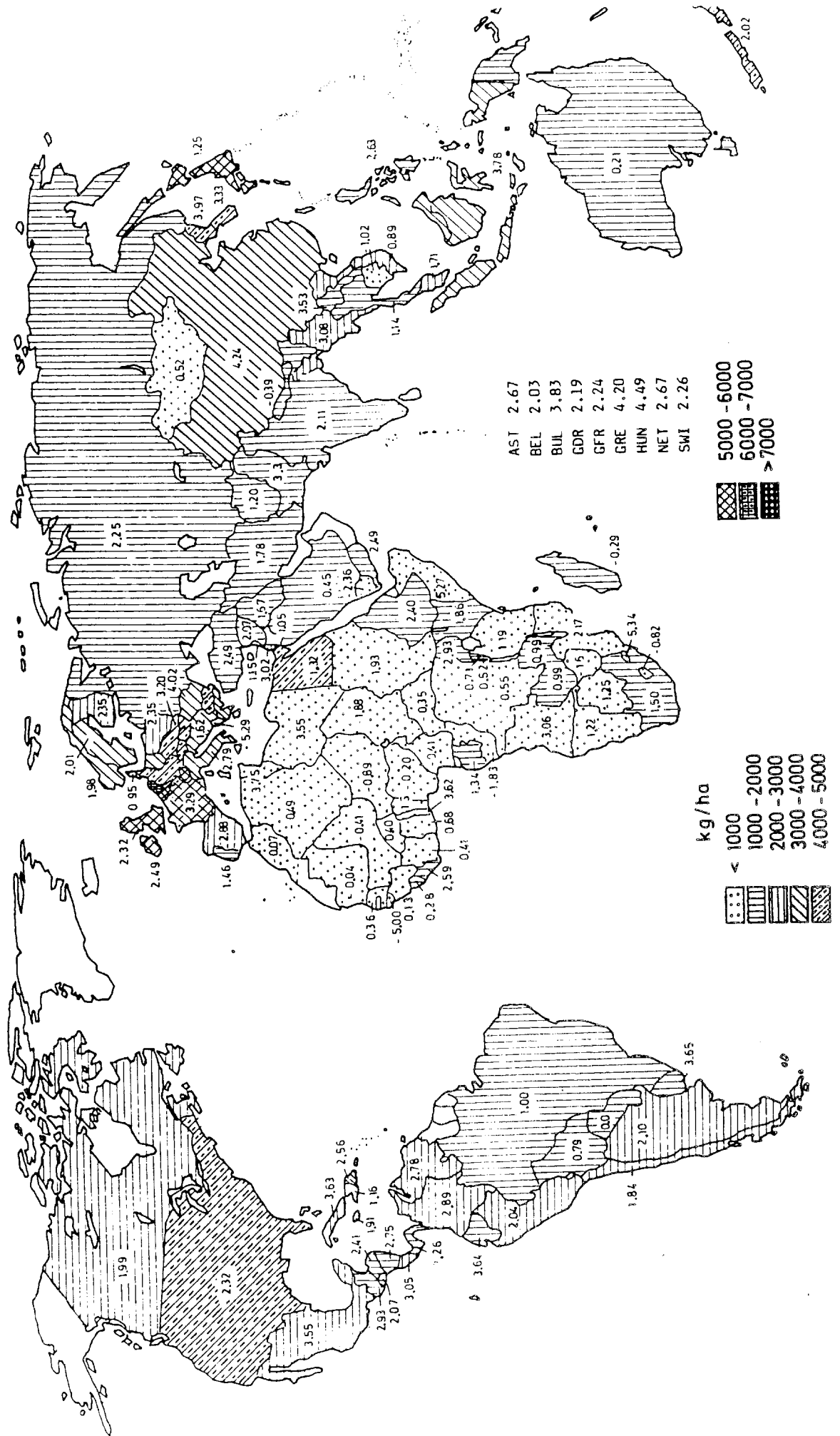
Category Region	Population		Cereal Production		Difference between the growth rates
	million 1982	Increase p.a. (%) 1962- 1982	million t 1982	Increase p.a. (%) 1962 - 1982	
	1		3	4	5
Africa	503.0	2.93	69.7	1.59	- 1.34
N C America	385.6	1.65	366.9	2.94	+ 1.29 Prod ↑
South America	251.7	2.52	73.2	3.35	+ 0.83 Prod ↑
Asia	2678.1	2.25	699.0	3.04	+ 0.79 Prod ↑
Europe	487.7	0.60	269.9	2.89	+ 2.29 Prod ↑
USSR	270.2	1.00	174.3	1.90	+ 0.90 Prod ↑
World	4599.9	1.99	1674.8	2.81	+ 0.82 Prod ↑

a) Three-Year-Average. - b) Five-Year-Average
Source: FAO Production Yearbook, Rome 1972/1981/1984.

Figure 1: Annual growth rate of the human population, World, 1960 - 1980



Level of grain yields (kg/ha): World 1982
Annual growth rates of grain yields (%), Period 1962 - 1982
Five - Year - Average



even negative growth rates in cereal yields but at the same time they show the highest population growth rates. This lack in agricultural progress observable for Africa has many undesirable consequences in the production and consumption of grain.

Since 1968 the term "Green Revolution" has been frequently used in the pertinent literature. It describes the "take-off" of grain yields in developing countries which were the consequence of newly introduced high yielding varieties. In this view the sharp increase of cereal yields in developed countries remains disregarded. To delineate better the world's growth areas the term "Green Revolution" is reserved in this contribution to those 23 countries where the grain yields have increased during the last two decades more than 3 % per annum. Such a favourable situation prevailed in the following continents and countries:

- a) Africa (5): Benin, Libya, Somalia, Swaziland, Tunisia;
- b) America (5): Costa Rica, Cuba, Equator, Mexico, Uruguay;
- c) Asia (9) : China, Indonesia, ^{Israel} Korea (North and South), Laos, Pakistan;
- d) Europe (6): Albania, Bulgaria, Czechoslovakia, France, Hungary, Romania.

A first inspection of Figure 2 shows that the yield levels and the observed growth rates of cereals are quite dispersed.

"Green Revolution" type of yields were not related exclusively to specific political, social, economic systems or to the degree of economic development. The most Northern countries of the globe have had obviously less possibilities to increase grain yields above the stipulated 3 % rate.

However, many countries are with respect to the economically cultivable arable land area not as densely populated as Europe, the USSR, or Asia. They have still the chance to increase grain production by an increase of the area. In Oceania (mainly Australia) the grain production increase was caused during the period 1962 - 1982 to 84 % by an enlargement of the grain area, in Africa by 62 %, in South America by 48 % and even in North/Central America the area increase counted for 26 % of total grain production.

In Europe and the USSR the increase of grain production came exclusively from higher yields. The need to increase yields is obviously quite different between the continents (Table 2).

The agroclimatic and the economic conditions of a country determine the kind and the share devoted to the various grains cultivated. The grain production of countries differs tremendously in size. To obtain better world and regional perspectives a summarizing table of the basic trends for all cereals has been constructed (Table 3). The following growth rates of grain yields at world scale could be observed in descending order for wheat (3.0 %), maize (2.3 %), barley (2.1 %), rice (2.0 %), rye (1.9 %), sorghum (1.4 %), millet (1.3 %) and oats (1.0 %). The above defined yield growth rate of 3 % qualifying for the term "Green Revolution" applies only for Europe for total cereals (3.2 %), for wheat (3.7 %), for maize (4.5 %) and in Asia for wheat (4.2 %) and for sorghum (3.6 %). No other continent and grain surpasses this level of grain yield increases. Africa has not only the lowest increase of yields for all cereals (0.5 %), they are only relatively high for wheat (1.7 %), moderate for barley (1.1 %), unsatisfactory for rice (0.2 %), but negative for rye, oats, sorghum and millet. The conclusion one can draw is that the agricultural progress measured by the grain yield increases is not yet there where the progress in medicine has recently led to^{the} high population growth rates (Figure 1). The situation seems to be aggravated in countries where grain yields are at present the lowest.

3.2 Wheat

Wheat as a grain of temperate and subtropical zones has become the most important cereal for human consumption. Wheat is the most important grain in Oceania, the USSR and Europe (Table 4). The highest wheat yields can be observed in the humid parts of Western Europe where more than four tons per hectare are the rule. The Netherlands attain more than seven tons per hectare, Belgium, the United Kingdom, Ireland, Denmark and West Germany more than six tons. One observes comparatively high wheat yields further in New Zealand and in Zimbabwe, where the white settler community has a long tradition of wheat growing. Wheat yields in Europe are gradually approaching the half of the theoretical maximum of grain yields calculated by Dutch agronomists (Figure 3).

Table 2: Relative contribution of yield and area to increases in cereal output

World 1962^a) - 1982^b)

Region	Increase of total cereal production		
	Total increase (%)	caused by area increase (%)	caused by yield increase (%)
	1	2	3
Africa	38.1	61.5	38.5
N C America	75.2	26.4	72.1
South America	82.2	47.8	52.0
Asia	79.6	6.5	91.3
Europe	68.9	- 8.0	108.0
USSR	35.6	- 5.6	105.9
Oceania	107.9	83.9	14.7
World	69.5	13.6	86.4

a) Three-Year-Average.- b) Five-Year-Average.

Source: Calculated according to FAO Production Yearbook, Rome 1972/1981/1984.

Table 3: Annual growth rate of cereal yields
1962^a) - 1982^b)

Region \ Grain	Cereals total	Wheat	Rice	Maize	Barley	Rye	Oats	Sorghum	Millet
	1	2	3	4	5	6	7	8	9
Africa	0.51	1.72	0.15	0.62	1.10	- 2.80	- 0.98	- 1.08	- 0.27
N C America	2.28	2.09	2.06	2.44	2.24	2.54	1.12	1.11	-
South America	1.70	1.01	0.56	1.98	0.59	0.75	0.87	2.79	- 0.36
Asia	2.93	4.15	2.16	2.28	1.29	1.91	2.82	3.56	2.06
Europe	3.23	3.73	0.25	4.51	1.92	2.15	1.91	2.87	2.85
USSR	2.09	2.48	2.77	1.97	1.67	1.56	2.68	0.65	0.78
World	2.51	3.03	2.04	2.26	2.06	1.91	0.98	1.41	1.26

a) Three-Year-Average.- b) Five-Year-Average.

Source: FAO Production Yearbook, Rome 1972/1981/1984.

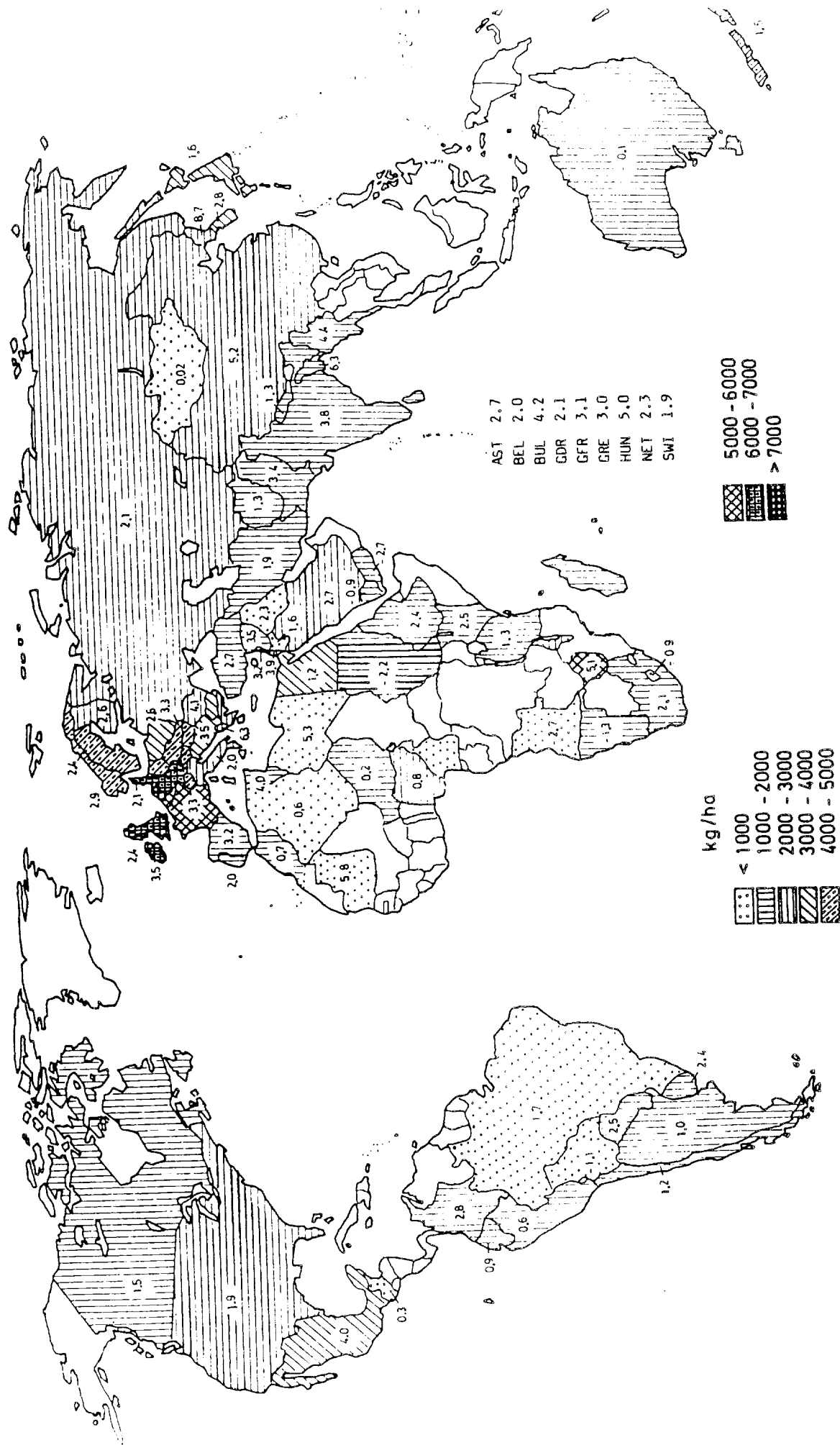
Table 4: Cereals as percentage of total cereals
World 1963 - 1982
Five - Year - Average

Grain Region	Wheat		Rice		Maize		Barley		Oats		Rye		Sorghum		Millet	
	1963	1982	1963	1982	1963	1982	1963	1982	1963	1982	1963	1982	1963	1982	1963	1982
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Africa	12.7	13.2	10.9	12.4	31.6	37.9	7.0	5.7	0.4	0.4	0.3	0.1	17.9	14.3	17.6	14.9
N C America	23.8	26.6	1.9	2.4	50.3	54.1	6.0	6.3	9.5	2.9	0.6	0.4	0.9	-	7.0	7.0
South America	25.0	20.4	20.0	19.1	44.4	46.5	3.1	1.0	2.1	1.1	1.1	0.2	0.5	0.3	3.5	12.6
Asia	14.2	21.5	59.3	55.7	9.5	12.8	6.9	2.4	0.6	0.2	0.2	0.3	6.6	2.5	2.6	2.9
Europe	37.4	39.3	1.0	0.7	16.2	21.2	21.3	26.4	10.8	5.3	10.3	5.4	0.7	-	1.4	0.2
USSR	51.8	49.9	0.3	1.5	12.2	6.4	15.1	26.2	6.1	9.0	11.9	6.8	2.2	1.2	0.5	0.1
Oceania	74.4	66.3	1.4	3.0	1.7	1.5	9.5	17.1	10.6	6.4	0.1	-	0.3	0.1	2.0	5.7
World	25.8	28.7	25.6	25.7	21.9	25.0	10.1	9.8	4.8	2.6	3.4	1.8	3.9	1.8	3.6	4.1

Source: Calculated according to FAO Production Yearbook, Rome various issues.

Figure 3:

Level of wheat yields (kg/ha): World 1982
Annual growth rates of wheat yields (%), Period 1962 - 1982
Five - Year - Average



1: Countries with more than 10 000 ha of wheat

The economic environment, the efforts and the possibility to increase wheat yields have been favourable in most countries of Europe. An annual growth rate of wheat yields above 3 % occurred outside Europe mainly in China, on the Indian Subcontinent (Bangladesh, Burma, India, Pakistan), some countries in the Near East (Israel, Lebanon, Syria), in Mexico and in Zimbabwe. Using the above definition, a "Green Revolution" in wheat yields has with the exception of the two countries mentioned not reached the continents of Africa, America, Oceania to the same extent as Europe or the large countries of Asia.

Wheat dominates the international bread grain trade. The surplus situation permits that wheat, in the case of an arising demand, can be supplied everywhere in any quantity. Wheat has from all grains the highest possibility of becoming the main grain for city dwellers even in those countries where wheat traditionally was neither grown nor consumed in substantial quantities.

3.3 Rice

Rice has been and still is the staple food of many people in Asia (Figure 4). It has some importance as food in parts of South America and Africa. The highest yields are obtained outside Asia in those countries which combine irrigation and high levels of rice technology like Australia, Egypt, Italy, Spain, and the U.S.A. An increase of yields of more than 3 % occurred only in five Asian, six African and five Central American and Caribbean countries. Neither in Europe nor in Oceania had rice attracted breeders and rice growers to increase the yields faster. Presumably, the economic demand for rice has not been inducive for such efforts.

3.4 Maize

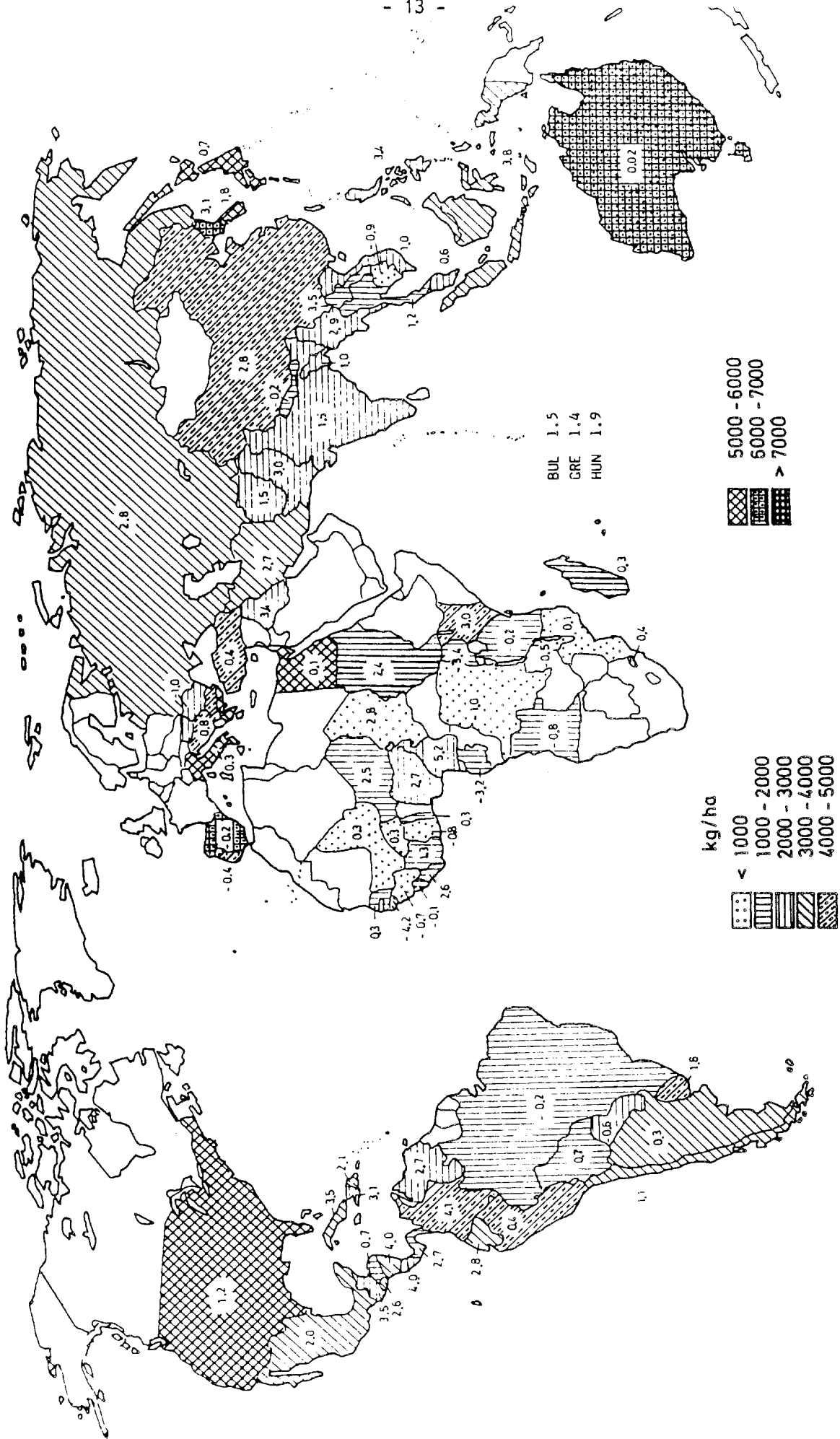
Maize has its origin and its importance still in the Americas, but is also the preferred cereal in Sub-Saharan Africa (Table 4). In the affluent parts of the world maize is exclusively used as a feed grain. Yellow maize is prevalent among the maize eaters of Latin America. African people prefer to eat the white maize type which is not grown in substantial amounts for exports outside Africa. This facilitates that in times of maize shortage wheat penetrates further the urban consumption structures.

Figure 4:

Level of rice yields (kg/ha): world¹ 1982

Annual growth rates of rice yields (%), Period 1962 - 1982

Five - Year - Average



y: Countries with more than 10 000 ha of rice

United States agriculture pioneered in the development of hybrid maize. Southern Europe benefitted most of these advances in the cultivation of maize. Maize yields above five tons per hectare can now be observed besides North America in Europe, North Korea and New Zealand. In the most parts of the tropics maize yields are still below two tons per hectare (Figure 5).

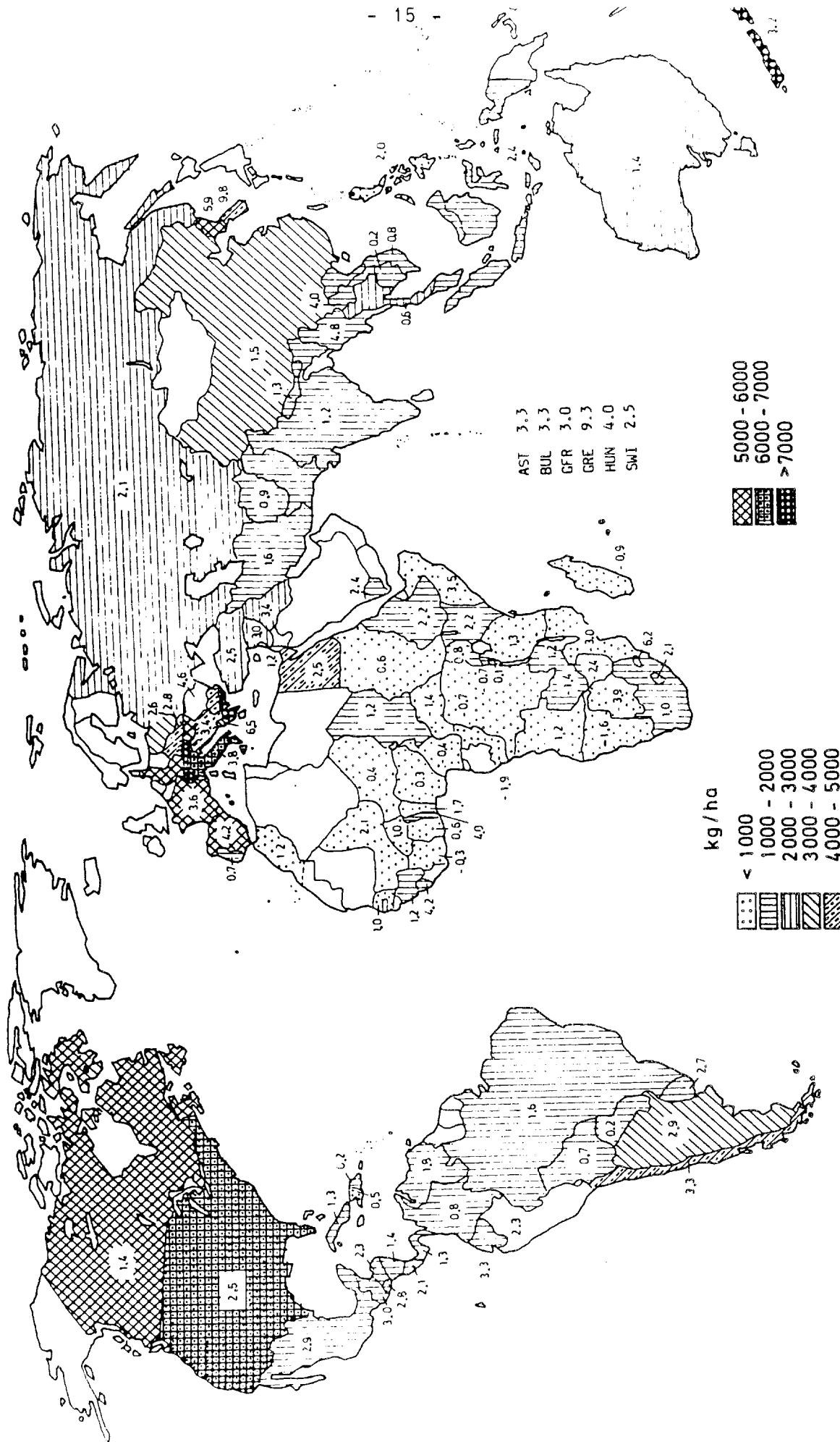
Hybrid maize seed has to be purchased anew each year because the sowing of non-hybrid seed leads to lower yields. The possibility to introduce hybrid maize at large scale requires the establishment of a comparatively sophisticated hybrid maize seed industry. Such a network which covers the relevant agroecological zones for maize growing is still beyond the organizing capacity of most of the tropical countries. This is the main reason that outside Europe only eleven countries achieved growth rates above 3 %. However, the North American and European experience indicates how large the yield increases could become when the hybrid biology is applied at large scale.

3.5 Barley

Barley is a cereal of the moderate zones in the Northern hemisphere. A further concentration can be observed in the semi-arid areas of the Near East and North Africa, where the yields remain extremely low. The bulk of the world's barley is produced in Europe and the USSR. Besides of barley used in breweries, barley is the main feed grain cultivated in the cooler areas of Europe where maize can not be grown. Western Europe has the highest barley yields, however, the annual growth rates are lower than for wheat. Only nine countries in the whole world achieved annual growth rates of barley yields of more than 3 %, thereof four in Europe (Albania, Italy, Poland, Romania) (Figure 6).

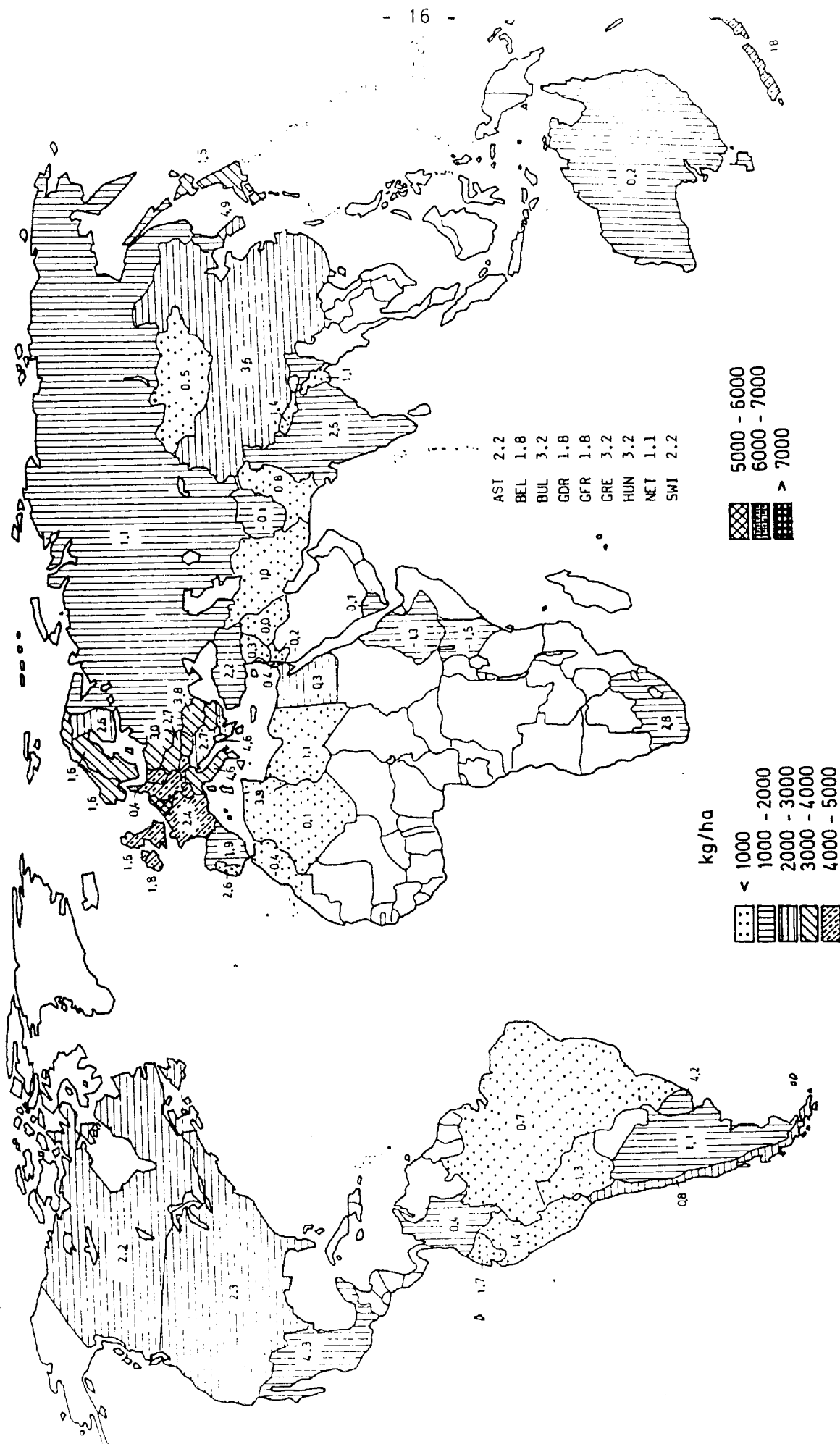
The expansion of barley in area and in production in Northern Europe and the USSR is a consequence that rye and oats have lost much of their competitive force. Moreover, the European and the USSR grain economy becomes increasingly oriented to grow more feed grain instead of bread grain.

Figure 5:
 Level of maize yields (kg/ha): world¹ 1982
 Annual growth rates of maize yields (%), Period 1962 - 1982
 Five - Year - Average



1: Countries with more than 10 000 ha of maize

Figure 6:
 Level of barley yields (kg/ha): world 1982
 Annual growth rates of barley yields (%), Period 1962 - 1982
 Five - Year - Average



1: Countries with more than 10 000 ha of barley

3.6 Rye

Rye has been for centuries the principal bread grain of germanic and slavic people in Europe. Rye could be grown on the poorer soils. However, despite the still reasonable yields they are lower than those of wheat and barley and the consumers have developed a preference for wheat bread during the last decades. The existing traditions do not eliminate the consumption of rye bread, but the reported change from rye to wheat bread has contributed to the relative decline of rye in Europe's grain economy (Figure 7).

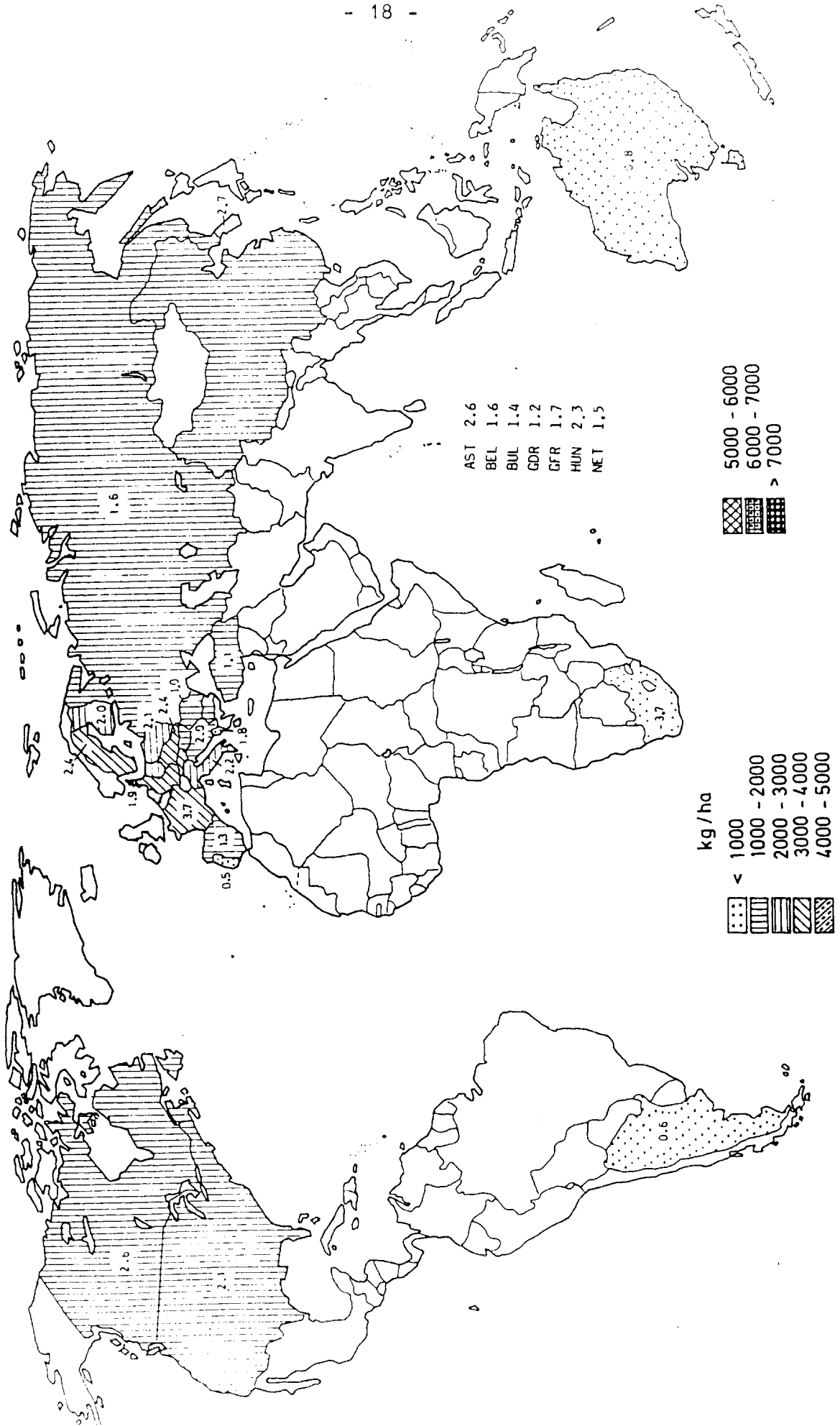
3.7 Oats

Oats share the destiny of rye. The tractor mechanization has almost abolished the horses which were fed with oats. The cultivation of oats is still of regional importance in Northern cereal areas where other cereals can not be grown (Figure 8).

3.8 Sorghum and millet

Sorghum and millet are the staple food of people in the Sahel zone and other dry parts of the world. They are grown in areas where soils are poor in nutrients and the rainfall is low and erratic. Sorghum needs more water than millet, the latter is the grain of the drier semi-arid areas. Hybrid sorghum has a large yield potential, but it can only be exhausted if sufficient water during the vegetation period is available. This reveals the following example: during the period 1980-1984 the sorghum yields attained in France 4.6 tons per hectare, but reached only 0.2 tons per hectare in Botswana (Figure 9). In those countries where hybrid sorghum has been introduced tremendous annual growth rates of yields have been possible: Czechoslovakia (8.6 %), Uruguay (7.8 %), Guatemala (7.1 %), Spain (6.5 %), Algeria (6.4 %) and China (5.4 %). Sorghum is used in these countries as a feed grain. On the other hand it is frightening to observe that most African countries and mainly those of the Sahel zone which depend to a large extent upon sorghum for their daily food intake have besides extremely low yields even continuously declining yields.

Figure 7 :
 Level of rye yields (kg/ha): World¹ 1982
 Annual growth rates of rye yields (%), Period 1962 - 1982
 Five - Year - Average



1: Countries with more than 10 000 ha of rye

Figure 8:
Level of oats yields (kg/ha): World¹ 1982
Annual growth rates of oats yields (%), Period 1962 - 1982
Five - Year - Average

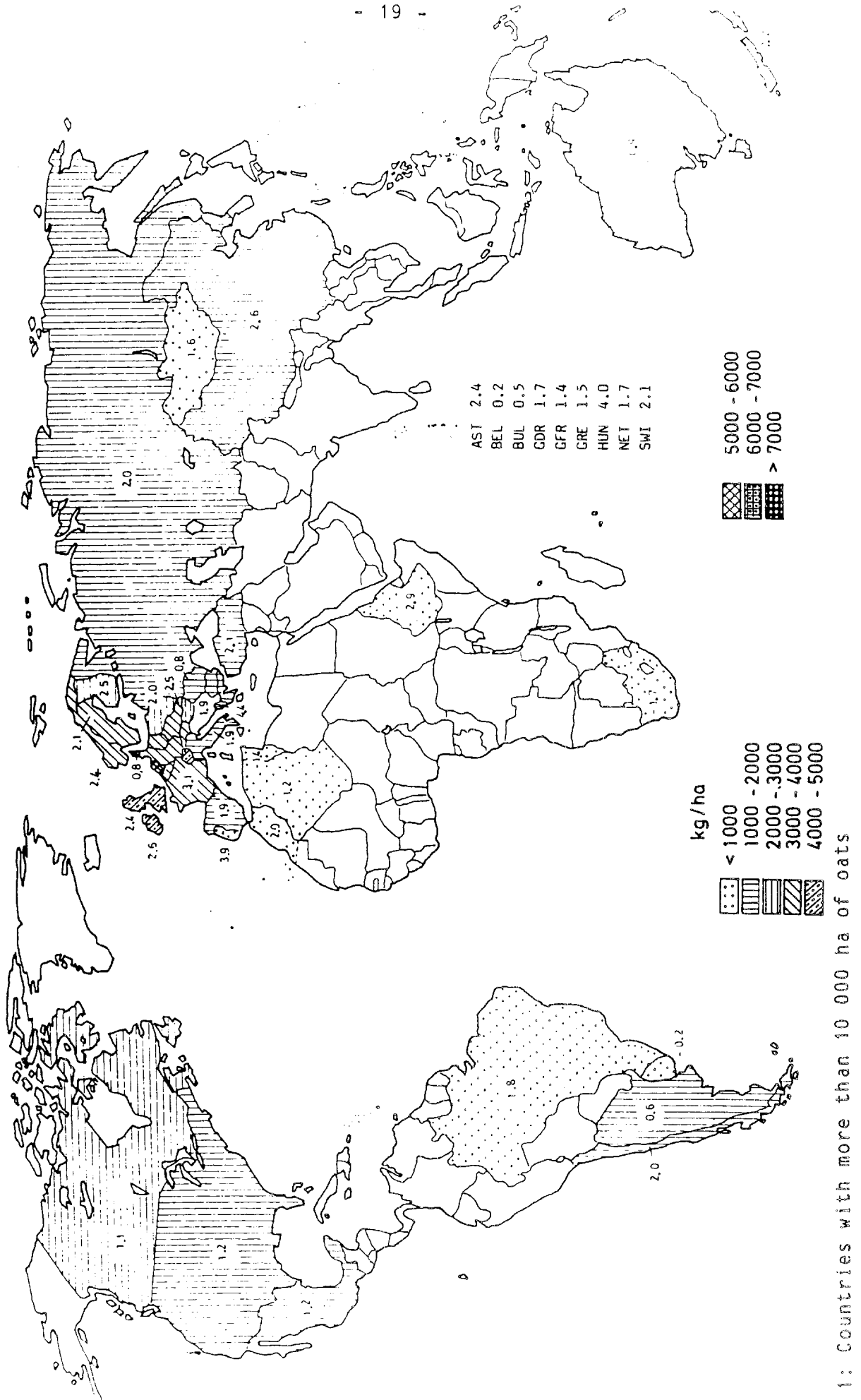
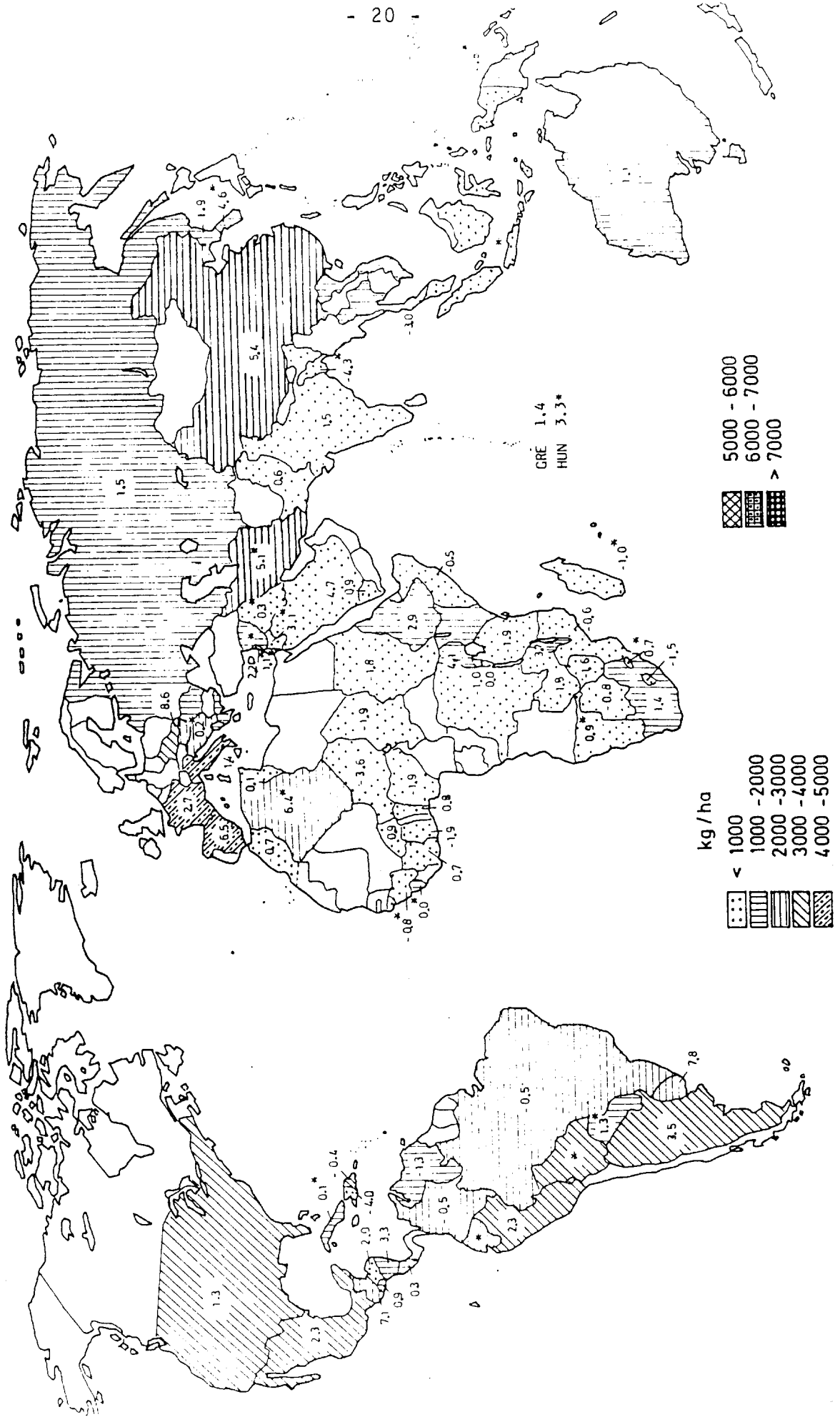


Figure 9:



1: Tree-Year-Average. *: less than 10 000 ha.

Compared to sorghum the situation for millet is even worse. The yields specifically in Africa are extremely low (Figure 10). Due to irrigation Egypt with 3.8 tons per hectare^{has} millet yields twenty-seven times higher than in Botswana which achieved only 140 kilogram per hectare in the period 1980-1984. Without large investments and comprehensive^{enduring} research programmes the trend of declining yields will certainly not be soon reversed.

4 Structure and tendencies of the international grain trade

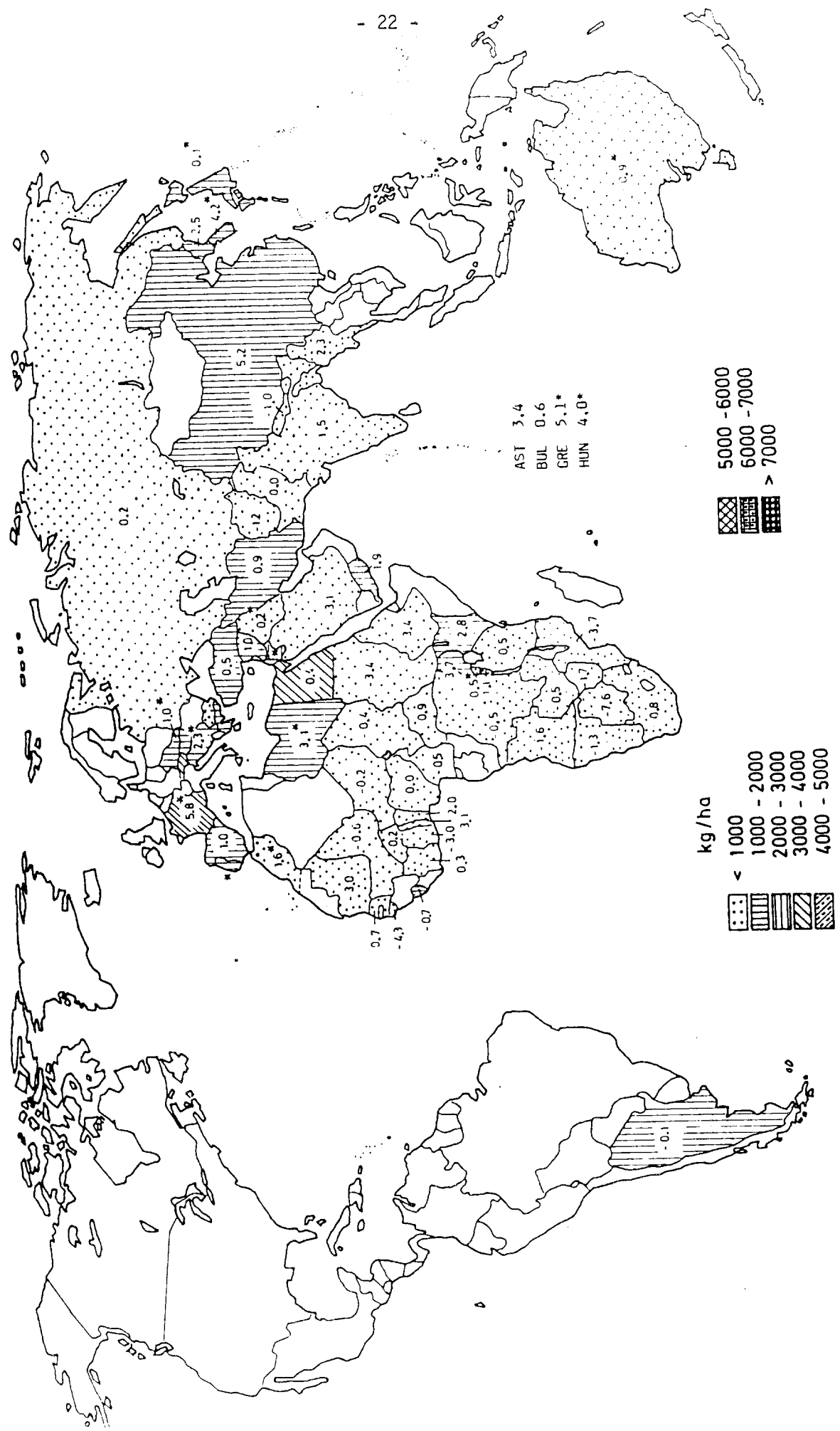
4.1 Classification of importers and exporters of grain

The minimum food requirement of the average man is satisfied if a country produces between 250 kg and 300 kg grain equivalents^(net) per year or between 2260 and 2700 kcal per capita and day. Under such low productivity conditions food is mostly consumed in the form of vegetable products. Higher levels of agricultural productivity or a higher purchasing power permits that more grain per capita can be converted into livestock products and alcohol. The large differences which exist between countries in the per capita production of grain are indicated in Figure 11. As soon as countries do not produce enough cereals commensurate to their per capita income level they will improve their consumption pattern by importing cereals. These reflections on the various countries' capacity to produce grain permit to formulate a hypothesis concerning whether a country will be an exporter (net) or an importer (net) of cereals.

Disregarding the annual, partly accidentally occurring trade variations two groups of countries can be distinguished:

a) Countries which will with a high probability continue to be importers of cereals for more than one decade to come. This group contains nearly 100 countries (Figure 12). The following seven countries imported during the years 1981-1983 more than five million tons of cereals: Soviet Union (36.3), Japan (18.2), Egypt (7.3), Korea-South (6.5), Mexico (6.3), Spain (5.7) and Poland (5.0). The demand of these great importers determines to a large extent the world market. However, the majority of countries imports less than one million ton of cereals.

Figure 10:
Level of millet yields (kg/ha): World 1982
Annual growth rates of millet yields (%), period 1963¹- 1982
Five - Year - Average



1: Three-Year-Average. *: less than 10 000 ha.

Figure 11: Level of grain production per capita (kg): World 1981
Five - Year - Average

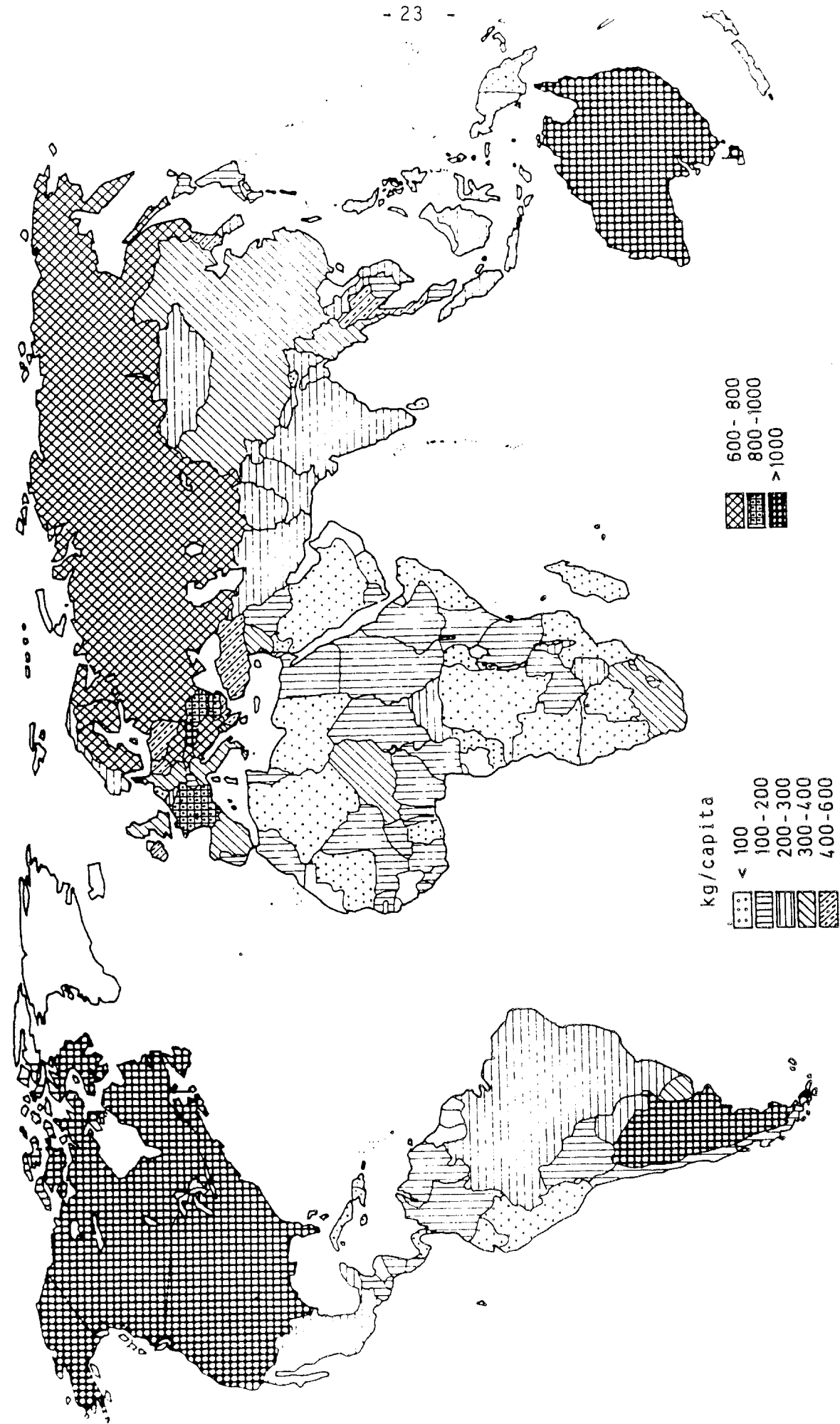
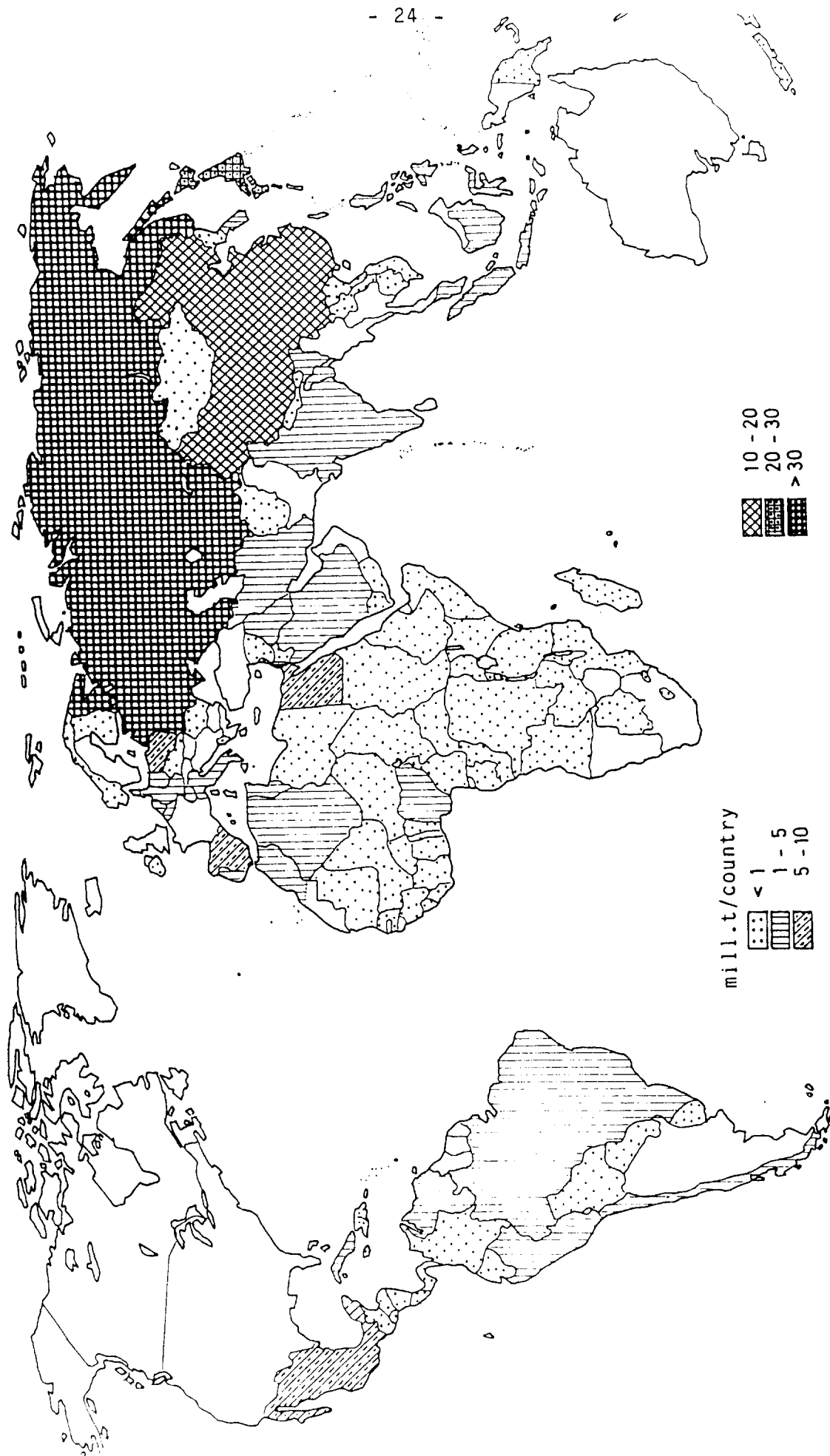


Figure 12: Foreign trade in cereals (mill. t): World 1982 (Tree-Year-Average)
Importing countries



Among the importers there are two groups of countries: those importing cereals mainly for direct human consumption and those converting cereals mainly in livestock products. The latter group has the higher purchasing power and comprises the countries of Europe, Japan, some oil and mineral exporters and most of the small island and city states which have to exchange their specialized products against foreign produced grain.

One can derive from figure 13 that besides the large importers mentioned above many other countries depend substantially on a regular provision with foreign grain. They import more than 100 kg of cereals per capita: there are three countries in America (Cuba, Chile, Venezuela), six in North Africa (Algeria, Egypt, Libya, Mali, Morocco, Tunisia), six in Asia (Israel, Jordania, Saudi-Arabia, Syria, Yemen (-South), Malaysia) and ten in Europe. The imports of feed grain played traditionally a large role in Europe, but the richer oil and mineral exporting countries of Africa, America, Asia are already following this trading pattern. They start to build up their own livestock economy.

b) The world has out of about 120 countries only 19 net grain exporters. They differ tremendously in the size of their exports. Thereof only eight countries export more than one million tons of grain (USA (103.6), Canada (25.3), France (19.5), Argentina (18.5), Australia (12.7), Thailand (6.2), South Africa (2.6) and Hungary (1.4)). Disregarding South Africa and Thailand, the large exporters produce more than 800 kg of grain per capita (Figure 11). They^{are} forced to export their surplus of grain because their high food consumption levels practically prohibit that the surplus grain can be absorbed by the domestic market.

Any observer will certainly be surprised to find now the United Kingdom, Sweden, Austria, Hungary among the net grain exporters. Generally, the capacity to increase yields has grown in Europe everywhere faster than the economic demand for grain. There are at present no signs that these tendencies will come to a halt.

Figure 13: Foreign trade in cereals per capita (kg): World 1982 (Three-Year-Average)
Importing countries

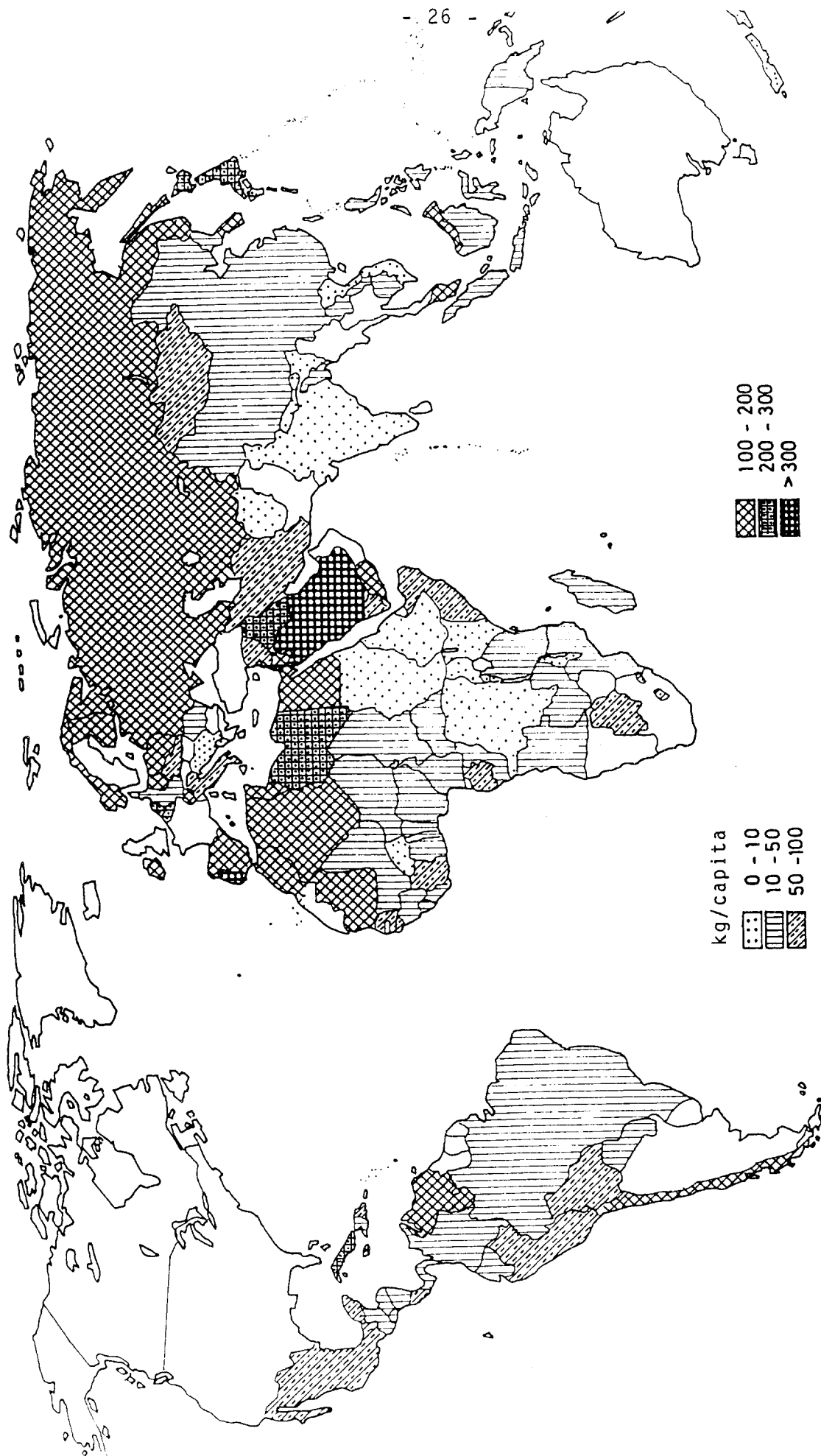
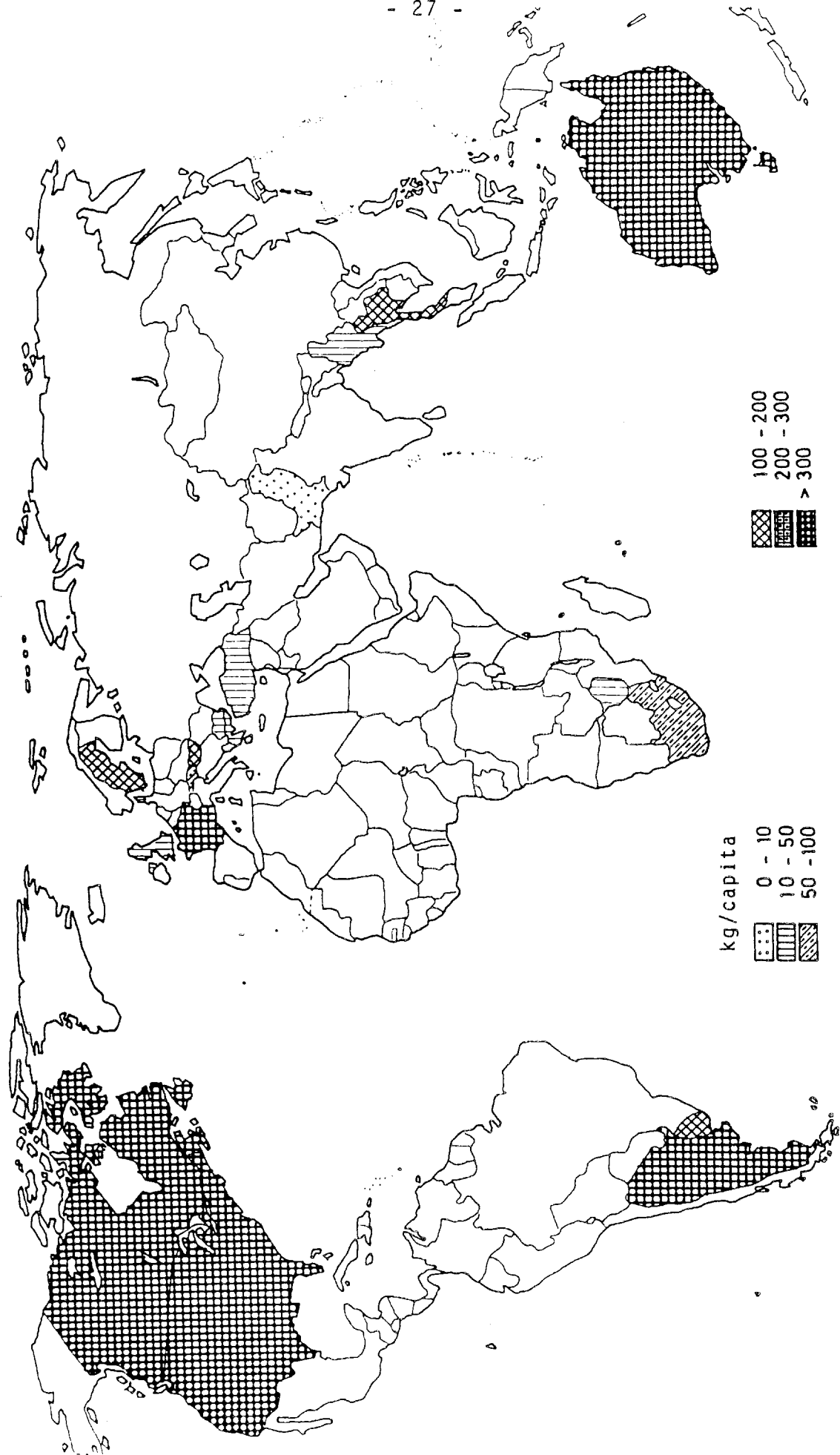


Figure 14: Foreign trade in cereals per capita (kg): World 1982 (Three-Year-Average)
Exporting countries



4.2 Assessment of present trends in international grain trade

The international grain trade has during the last ^{two} decades changed its image. Before World War II the industrialized countries of Europe were the main importers of grain. Europe imported both: bread grain and increasingly feed grain. After World War II additional countries emerged as grain importers (Eastern Europe, the URSS, Japan). They were followed by the big oil exporters and the more wealthy countries of North Africa, the Near East and the small island and city states.

During the last decades several countries of Europe changed their trading position from being a net importer to a net exporter of grain. Other importers of grain emerged: many countries of Africa, some in Asia and a few in Latin America had increasingly to import grain. This tendency is fortified that exporting countries offer favourable export credits to importing countries or pay subsidies in various forms to their exporters. Another, but smaller stream of grain flows in countries of need as part of development aid, or even as grant or gift in cases of urgency.

It is difficult to forecast precisely what will be the future directions of the international grain trade. Too many variables are involved. There are the uncertainties which specific grain policies the larger grain producing areas like the USA and the EG will adopt. The unpredictable changes in the value of the US-dollar against other and among other currencies aggravate additionally a firm evaluation of the competitive position of grain producers. However, the fact that an increasing number of the richer countries already have become and others still will becoming net exporters of grain undoubtedly increases the competition in the years to come. These countries have not unlimited, but reasonably large budgetary means to promote their grain exports by many ways. Besides of offering export credits and subsidies, they accept "soft" currencies, they strive for barter trade arrangements or they promise new technical and capital assistance projects.

Many times in the past economists have argued that the consumers should be provided with cheaper food. Cheaper food is in many countries of Europe hardly anymore a topic which is very sensible in the public debate. Paying subsidies to agriculture and to exporters is strongly regretted only by economists. The general political debate mostly considers the financial support of agriculture as an unavoidable fact of having agriculture in an industrialized country. Thus, it seems reasonable to assume that the international grain economy will be faced in the future rather with more than with less competition.

5 Some conclusions

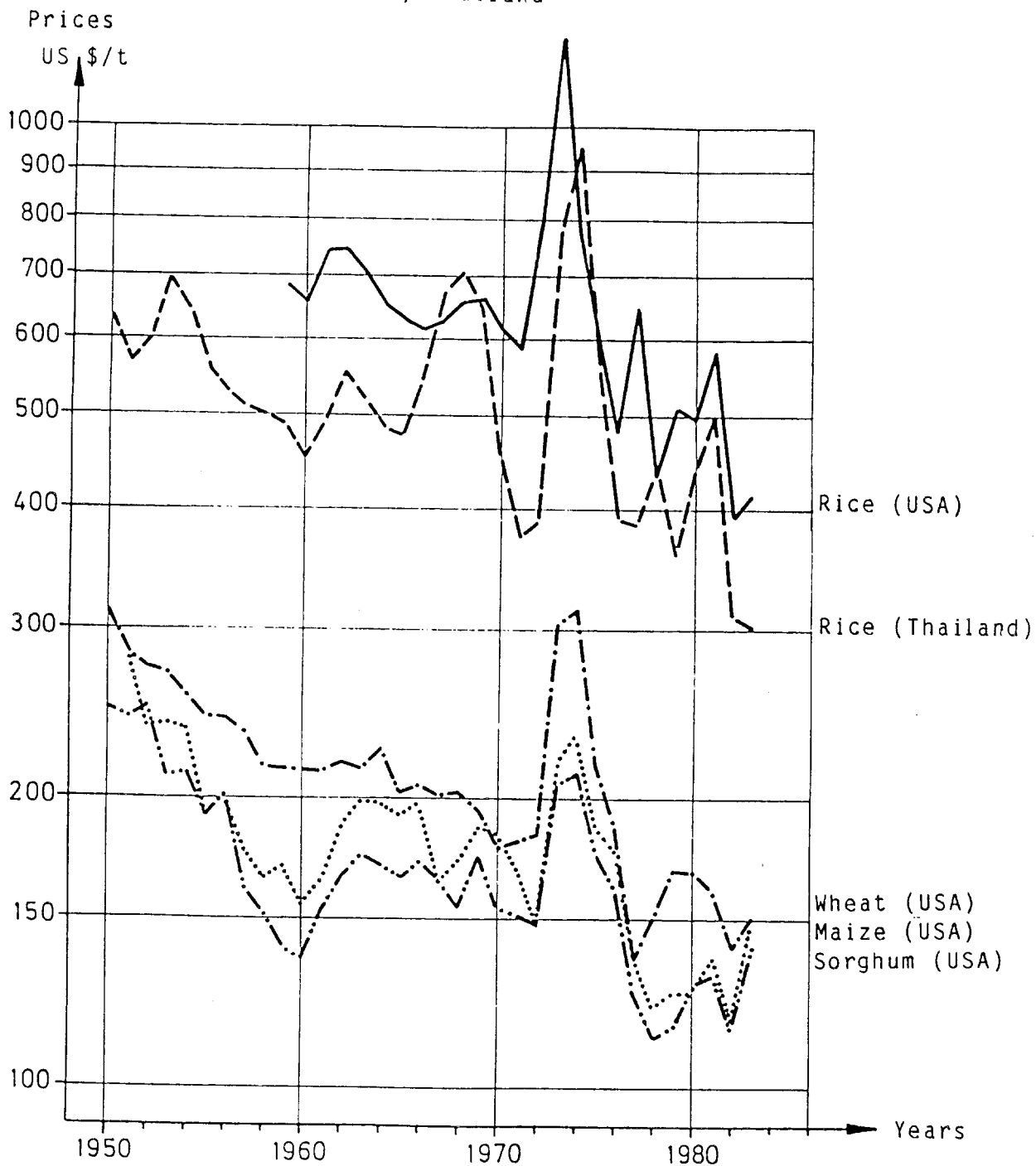
The emphasis in the discussion of "Green Revolution" was directed on the changes grain yields had experienced in developing countries. Rice and wheat were the grains of success. In a more global analysis it becomes clear that the "Green Revolution" is not occurring everywhere in developing countries. On the other hand, the tremendous increase of wheat and maize yields in Europe meets a weak demand which fortifies the competition among all countries and the various cereals.

Among all grains wheat has become the dominant grain. Its importance will grow further. It has had in the last two decades the highest growth of yields in Europe, the Near East and on the Indian Subcontinent. The consumption of wheat per capita has reached the saturation level in North America and Europe. Wheat penetrates gradually the consumption structure of urban dwellers in countries where wheat was not a staple food. The increasing wheat production in a growing number of exporting countries with various forms of export supports will lead to declining wheat prices (Figure 15). This promotes at world scale the use of wheat as the main bread grain. Neither rice nor rye as the traditional bread grain or staple food has a similar chance to make inroads on the consumption habits outside their traditional areas of cultivation.

Sorghum and millet are the grains of the semi-arid areas. Their growth potential can probably not be tapped as needed because neither the national agricultural research systems nor the international agricultural research institutes have given these two cereals the same priority as rice or wheat. However, it may

Development of grain prices (constant prices of 1980)

USA, Thailand



Source: Commodity Trade and Price Trends 1985, World Bank (Editor), Baltimore 1985, pp. 50,52,54,56.

even be much more difficult to increase sorghum and millet yields in the areas where an erratic and low rainfall prevails.

Besides the consumption of maize by Latin Americans and Africans it is the main feed grain grown in North America and Southern Europe. In the cooler climates of North America, Europe and Asia barley (and partly oats) has become the feed grain of the livestock economy. Hybrid biology can be transformed and applied everywhere as soon as the hybrid maize research and distribution system has reached a higher state of maturity by establishing a hybrid seed industry. Among the cereals maize has still a tremendous untapped growth potential in the poorer regions of the world. As a feed grain maize will enter increasingly the world markets.

Footnotes

1/ The reported changes are caused in each country by various demand and supply factors. On the demand side one observes that the income elasticity for bread grain in almost all developed countries is negative or near zero. Only in the poorest countries of the developing world are the income elasticities for bread or grain still positive. However, even the income elasticity for feed grain will approach the value of zero in most Western European countries because saturation levels in the consumption of livestock products have been obtained. The reported change of the size of income elasticities have had the consequence of a smooth restructuration of the types of grain grown. An indication for these shifts can be derived from the share the feed grain has in total grain: more than 70% in the USA, 55% in West Germany, 40% in the USSR, but less than 20% in most developing countries.

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