Staff Papers Series

P86-43 September 1986

A REVIEW WITH REFLECTIONS AND REMARKS ON HAYAMI-RUTTAN'S AGRICULTURAL DEVELOPMENT

Adolf Weber

Department of Agricultural and Applied Economics

University of Minnesota
Institute of Agriculture, Forestry and Home Economics
St. Paul, Minnesota 55108

A REVIEW WITH REFLECTIONS AND REMARKS ON HAYAMI-RUTTAN'S AGRICULTURAL DEVELOPMENT*

by

Adolf Weber**

*At the occasion of the appearance of Yujiro Hayami and Vernon W. Ruttan, Agricultural Development. An International Perspective. Revised and expanded edition. The Johns Hopkins University Press. Baltimore and London 1985. 506 pp. ISBN 0-8018-2348-X, hardcover US $43.45, ISBN 0-8018-2376-5, paperback US $20.85.

**I am indebted to Ford Runge, Department of Agricultural and Applied Economics, University of Minnesota, for many valuable comments and suggestions on an earlier version of this article.

I. Reviews of the first edition.

The first edition was reviewed in the leading economic journals, at which time Hallett (8) stressed: "...it should be of value for students of both development economics in general and their agricultural aspects in particular." Schultz (21) wrote "The central contribution of Hayami and Ruttan is their extension of economic theory to explain the behavior of organized research activities as an endogenous sector in modern economic growth." Porter (18) observed "...this book might have been subtitled as 'encyclopedia of agricultural development theory'." Also Johnston (13) welcomed the book's appearance, but he raised the question: "The rather mechanical view of the role of relative prices in the Hayami-Ruttan 'induced development model' seems to encourage a somewhat naive view of the political process." Sahota (19) who analyzed in detail the methodology and the results of the empirical tests anticipated early the success of the Hayami-Ruttan approach "Conceptually, therefore, the authors of Agricultural Development are independently in line with the current vogue in other economic disciplines." Schuh (20) in another lengthy review, stated "The book represents an unusual combination of theory, historical and cross-country analysis, and an extraordinary grasp of an enormous body of literature. Its scholarship is vast, and the analysis is insightful, relevant, and provocative...". Among several assessments he remarked "one of the puzzles in the Hayami-Ruttan framework is the asymmetric treatment of land, labour, and capital

in their model. They are concerned with land and labour as barriers to agricultural development. Their analysis focuses on these two primary factors of production and rather leaves capital to the side."

In the German language agricultural economists also praised the Hayami-Ruttan (H-R) approach and the empirical results (Pevetz, Weber [17, 24]). Weber was concerned with the aggregation procedure of calculating the various countries' agricultural output by using only Indian, Japanese, and U.S.A. prices as numéraire. Generally, for the German language area the H-R approach revived the traditional view of the state in strengthening agriculture through the public support of agricultural research, education and extension. Another element of the early acceptance was the similarity between the classification of land-saving or labour-saving technologies with Brinkmann's (1922) technical progress as biological, mechanical or organizational (3). Areboe (2) and his school had in 1909 considered different development paths according to initial population densities and agroclimatic conditions, although in loose terms. However, there was one difference in perspective. The early emphasis in agricultural economics was on the management of large estates. Technical change meant how to adjust farms and farming systems to a conceived equilibrium shaped by internal and external price ratios. The whole agricultural sector of countries was less a subject of theoretical interest. The paucity of agricultural sector data

supported this view.

In the tradition of this German school Herlemann and Herlemann/Stamer presented in 1954 and 1958 an international development model based on three factors of production (land, labour, capital). To examine their development hypothesis by differing initial factor endowments of land, labour, and capital they convincingly combined data from farm records, selected farming systems and some agricultural sector data. Their work was not internationally recognized, because they wrote early, only in German and were somewhat isolated from the mainstream of agricultural development literature. Development economics literature really began to expand in the 1960's, when development aid agencies requested the expertise of agricultural economists. The accruing literature broadened and deepened the theoretical and empirical foundation of the Hayami-Ruttan approach. Reviewers emphasized differing aspects of the first edition of the book, which became a standard in graduate courses on agricultural development, world food economy, the history of international agricultural research and related areas. It has served the research community in numerous studies as a starting framework. Its enduring quality was recognized in 1985 by an award of the American Association of Agricultural Economists.

II. Organization and contents of the second edition.

The organization of the second edition remains basically the same. It is divided in five parts, with 13 instead of 12

chapters. However, it has grown from 367 to 506 pages. Sahota (19) counted 800 citations from over 460 authors in the first edition. This time the reviewer counted about 1,100 citations from 795 authors contained in 542 footnotes. Forty-five instructive illustrations and 69 tables with masses of elaborated data suggests how much work and cooperation must have been required. The cross-sections data or factor endowments, agricultural output, labour and land productivity now contain the five-year-averages of 1960, 1970, and 1980. The historical time series from 1880 to 1980 again cover Japan and the U.S.A., Denmark, France, and England. The mixture of historical with cross-sectional data help to trace clearly the possible development paths of a great diversity of countries. In their introduction the authors express their methodological belief that "international comparisons also offer an opportunity to test the induced innovation hypothesis over a much broader range of variation in variables, especially factor proportions, than would be possible within any single economy."

The first part of the book examines the assigned role of agriculture in economic development (Chapter 2) and agricultural development theories (Chapter 3). Besides additions and amendments to the text the views of Ricardo's scarcity hypothesis and the Latin American dependency school have now been integrated. New in the chapter on agricultural development theories is the resource exploitation model (frontier model) where sudden production growth occurs mainly through settlements

in new areas--by cutting down forests to sell timber or satisfying a foreign demand for tropical products (coffee, cocoa, rubber, spices, etc.). It is surprising that in this context the tremendous expansion in the world's fish catch during the last 100 years is not mentioned. Many countries--like Japan--relied on and improved its diet by increased fish consumption and saved through fishing agricultural land or expanded their available food resources.[1] Chapters 2 and 3 prepare the reader well for the book's central Chapter 4: Toward a Theory of Technical and Institutional Change. The essence of the technical and institutional change in the theory of induced innovation presented can be summarized in the following two concepts: (1) long-term change of price ratios and (2) the appropriate design of institutions.

(1) The price ratio between various factors of production determines in each country the economics of the agricultural sector. For example, population growth and increasing food demand lead to an increasing scarcity of land, which can be overcome by the application of biochemical inputs. In the rare cases where land is abundant, a shortage of agricultural labour can be substituted by mechanical inputs. The engine behind this secular substitution process is basic and applied agricultural research. The first is determined by the size of the governments' science budget, the second is "induced" by changing price

ratios. It is the task of political and administrative processes to perceive that the existing scarcity can be lessened by research. Factor and product prices are the appropriate signals to gear agricultural research to the most needed problem areas.

(2) The outlined substitution process can only work if five institutional prerequisites are available: (a) growth and modernization oriented policy processes, (b) public sector innovation (e.g. agricultural experiment stations), (c) private sector innovations (technical input industries), (d) an innovative agriculture supported by education, extension, profitable products, progressive agrarian structure, and (e) complementary innovations (e.g. fertilizer-responsive varieties and pertinent plant protection means).

Capital is not explicitly included in the agricultural development model, in contrast to traditional economic growth theories. To set and keep all the innovation processes in motion capital has to become cheaper than labour and land during the process of economic development. However, such saving takes place outside of the agricultural sector, thus justifying its exclusion.

Both authors felt that in the first edition their modelling efforts of the agricultural sector, including resource endowments, technology, institutions and their mutual interactions, were not complete. They have now added cultural

endowments, categorized as property rights, ideologies, and tastes, with the expressed hope that other social scientists will elaborate and enrich the term "cultural endowment".

Part II, International Comparisons, is dominated by the concept of agricultural productivity and its growth (p. 119). It focuses again on partial productivity measures like labour and land productivity. Data on the whole capital stock in agriculture were not available, therefore capital productivity and total factor productivity could not be measured. The authors compare the size and the direction of growth rates in labour and land productivity for 43 countries in sequence of cross-sectional data from 1960 through 1970 to 1980. Impressive stylized development paths (Asian, European, New Continental Path) of labour and land productivity for densely and less densely populated countries can be derived from these intercountry comparisons. The same insight can be gained if one considers the respective growth of the land and labour substitutes: fertilizer or mechanical power.

The authors observe a sharp difference in productivity growth between developed (middle stage countries included) and developing countries. In the former groups, labour productivity grows two or three times faster than land productivity. In developing countres, land productivity grows faster than labour productivity (p. 123, 418). These differences are due to two main factors. In most developing countries the labour force still grows in numbers but declines in developed countries. The

increasing scarcity of agricultural labour in developed countries requires consequently large investments in machinery and equipment. Considering the two differing growth rates in labour productivity one has to be aware that the capital input needed to replace the outmigrating agricultural labour in developed countries is not accounted for by a partial productivity measure. On the other hand, an increasing agricultural labour force in developing countries makes the labour input cheaper and land more expensive which facilitates the application of yield increasing technologies. This explains why the growth of land productivities between the two parts of the world is not really different. In conclusion, a measurement of total factor productivities would probably show a tendency for more equalized growth rates between both country groups. The message for developing countries (LDCs) is, however, very clear: as long as the agricultural labour force increases, growth in land productivity must precede growth of labour productivity.

Part II contains another analytical instrument to test the induced innovation hypotheses to explain productivity differences among countries: production functions. The authors start with the concept of a metaproduction function which is "the envelope of the most efficient production points in the world.... such an envelope approximates the innovation possibility curve for the LDCs." Several econometric tests are made with two versions of intercountry agricultural production functions: the Cobb-Douglas and the CES-function (the latter only to justify the Cobb-Douglas

functions' use). Two sets of inputs are distinguished: conventional (land, labour, livestock, machinery, fertilizer) and non-conventional (general and technical education). The authors divide the countries investigated into several groups: Developed countries (DCs) and developing countries (LDCs) and estimate production elasticities. They observe that the production elasticities of conventional inputs are much larger in DCs. The authors conclude "that LDC agriculture was characterized by constant returns, and DC agriculture was subject to increasing returns" (p. 146). Hayami and Ruttan mention, however, that increasing returns in DC agriculture occur only when introduced as a scale factor (national output divided by the number of farms).

The variable general education yielded negative production elasticities in DC agriculture, but technical education (number of agricultural graduates per 1,000 agricultural workers) had everywhere positive production elasticities. The estimated production elasticities with respect to the mentioned conventional and non-conventional inputs were compared with those of other authors, in general, the elasticities showed stability over time and were considered as plausible. The main conclusion drawn is that there is strong evidence that the agricultural production can be increased by a higher use of inputs.

This reviewer thinks that two other elements restrict a too intensive interpretation of the estimated international production elasticities. First, considering the recent work of

agronomists it can not be assumed (7, 14) that a world-wide agricultural production function, valid for all regions, exists. Distinguishable productivity classes have different initial yield levels and different theoretical maxima. According to the degree of economic development and environment, countries may produce at similar points but belong to different agroclimatic production functions. In these cases, the input per unit of ouput will differ. However, these are at present negligible, minor points, because the chosen countries are generally in similar productivity classes.

Second, the estimated production elasticities are derived from an input-output ratio, where only the output was valued with a common price numéraire but the input was accounted in physical units. Experience shows that practically all technical inputs (fertilizer [16], pesticides, machinery, energy) and scientific inputs (6, p. 24) which substitute for land and labour are cheaper to obtain in DC agriculture. The estimated production elasticities in DCs would therefore be lower if the inputs had been valued by their prices. One may hypothesize under the assumption of equal input prices that the returns in DC agriculture are likely to be constant rather than increasing.

Part III deals with agricultural growth in the United States of America and Japan as cases of differing factor endowments. Land abundance in the U.S. in 1880 can be contrasted and compared to the land scarcity of Japan at that time. Both countries have developed institutions promoting technical change. This is a

fascinating story, narrated with knowledge and skill. The authors stressed the dramatic change which occurred during the last 100 years in agriculture's factor shares and factor productivity for Japan and the U.S.A. (pp. 167, 204). Because they did not dispose over the total stock of capital employed in agriculture, the authors used a price valued flow of fertilizer and machinery as proxies for the various forms of capital utilized in agriculture. The accompanying graphs and econometric tests illustrate and confirm the change of land-labour and power-labour ratios triggered by respective factor price ratio movements.

The choice of Japan and the United States allows the authors to apply knowledge about their native countries, stimulating readers to think about their own nation's initial factor endowments. Whether Japan in 1880 was like a developing country of today is questionable. This seems less probable when one compares historical Japan of 1880 with the Sub-Saharan Africa of 1960, at the high time of decolonization. As Maddison (15, p. 3) reported, Japan had many other favourable assets for entering the period of economic growth well prepared. The Meiji-period was characterized by a strong central government and a relatively urbanized and sophisticated society. Tokyo (Edo) in 1780 was already the largest city in the world. Between 40-50 percent of boys and 15 percent of girls had obtained formal schooling outside their homes in the beginning of the Meiji-period. This superior cultural endowment is insufficiently captured by the

measures of agricultural factors used by the authors.

The uniqueness of the United States' favourable factor endowment is also difficult to compare with contemporary examples in developing countries. The year 1880 is well taken for European agriculture, but is far removed from current LDC agriculture. Agriculture in a developing country today required labourers to perform many functions (social work activities, cultural ceremonies, building shelter, and providing clothes) which cannot be captured by agricultural labour inputs alone.

The fourth part is titled: Can Growth Be Transferred? The emphasis is on the theory and practice of rice technology generation and its diffusion on Asian's irrigated fields. The different stages in the transfer of agricultural technologies are treated and the functions of the newly established International Research institutes described. It includes a very useful discussion of the virtues and effects of the "Green Revolution." The success of the whole package of rice technology may, unfortunately, give the student an overly optimistic picture of other food crops, the problem of semi-arid agriculture, livestock diseases, and other areas where despite large investments no scientific breakthough is in sight.

Part V contains a Retrospect and Prospect. The authors observe in Chapter 11 various disequilibria: (a) at the farm and village level, (b) on national markets, and (c) on international markets. The first two examples are related to the "Green Revolution" literature, where social scientists have expressed

concern on the inequity resulting from modern technologies (mainly rice). The following chapter examines the disequilibrium on world markets caused by protectionist policies in industrial countries. Although written from the liberal perspective of economists, it recognizes that the often quoted repeal of the Corn Laws (1846) represents an idealized case. In the reviewer's perspective the British case was singular for many reasons. England at this time was not the medium-sized country of today, but the centre of an Empire, where the mass migration of British people to the colonies guaranteed the return flow of moderate zone products.

In LDC's, the authors identify disequilibrium with negligence of agriculture, depressed agricultural prices and overvalued exchange rates. While policies and/or distorted prices are reasons for disequilibria, uncontrollable natural and social factors probably play a large role. The farmer, the village, as well as national and international markets will continue to learn to respond economically, technically and/or institutionally to various disequilibria (Schultz [22]).

The last chapter deals with agricultural transformation and economic growth. Besides the British, Danish, and Japanese experience, the French case has been added. Between 1871 and 1944, low French population growth led to low agricultural output growth compared with other European countries, retarding agricultural research and infrastructure. The authors also note that the Méline tariffs retarded French agriculture, because they

prevented imports of cheap feed grain and concentrates for livestock. In contrast, Denmark's livestock became an important export to England and later Germany. Of course, we do not know whether Germany or England would have accepted agricultural imports from France, and grain tariffs alone have not prevented Germany from feeding millions of pigs with imported grain given strong domestic demand. While it is in the liberal tradition of economists to complain about tariffs, the effect of tariffs on production and consumption may be less pronounced than the literature seems to suggest. Tracy has clarified this point for Germany (23, p. 32).

Overall, the H-R approach is successful in identifying the economic forces and institutions which foster production growth in agriculture. While an excellent account of the supply side, internal and external demand slowdowns, as in France before World War II or in the U.S.A., the EC and other European countries today, require stronger consideration. The H-R approach contains a message of hope for an agriculture struggling for higher production: "The capacity to move from a natural-resource-based to a science-based agriculture--to generate a continuous stream of technical innovations that are responsive to the supply of factors and product demand--depends in most developing countries on substantial investment in education and research." (p. 442)

III. Remarks and observations on data interpretations.

International agricultural productivity comparisons are a most revealing, enlightening and rewarding research topic. Such

studies require great effort, a mastery of the data, as well as conceptual and definitional issues. The Hayami-Ruttan book, while it advances all of these issues, draws attention to several remaining problems.

1. Problems of obtaining "true" international agricultural prices.

Agricultural output depends on the quantities produced and the prices chosen for aggregation. Such a procedure is relatively straightforward for a single country. However, international comparisons of agricultural productivity face problems of finding a "representative" price. Otherwise countries with higher agricultural prices will have high apparent productivities and vice versa. Hayami-Ruttan deal with 43 countries, but use only the three price structures of India, Japan, and the U.S.A. from 1958 to 1962 to aggregate the various agricultural products in a weighted measure of agricultural output. This methodology, reminiscent of Colin Clark's (4, p. 242), was commented on by Weber (24, p. 28*) in a review of the first edition. The more complex FAO-Geary model of relative wheat prices, in contrast to the H-R approach, would permit a world-wide measure of agricultural output for each product and each country. This would be a cumbersome task. IIASA researchers have (12) devised a price numéraire for their global food and agricultural model based on three-year averages of export prices for agricultural products. Exchange rate instability during the seventies and eighties suggests that even

if world export prices are expressed in U.S.-Dollars, problems arise in aggregating agricultural output over countries and products. As soon as currencies in relation to the U.S.-Dollar rise or fall, the respective country's agricultural output changes and thus the country's productivity measure.[2] Antle (1) argues that simply treating the exchange rate as a price would yield agricultural output results similar to the H-R approach. Considering these efforts, one can conclude that measuring productivity differences between countries does not call for an exact price numéraire. As H-R argue, over time development paths are more important than exact productivity differences.

2. Problems of calculating land productivity in feed importing countries.

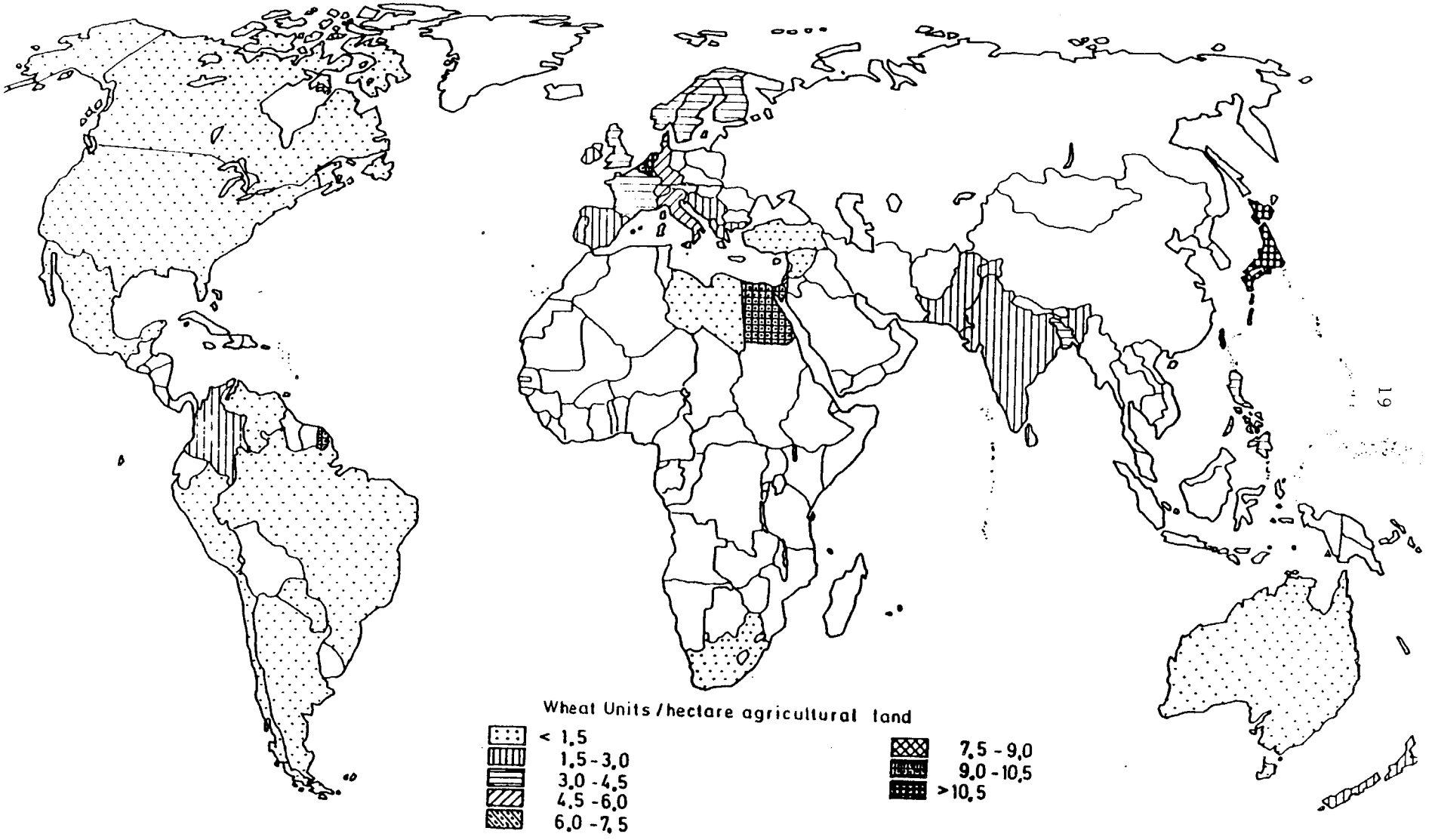
To obtain land and labour productivities for each country, agricultural output must be divided by labour and agricultural land inputs. H-R deduct seed and feed (including imported feed) from agricultural output (p. 448). However, they do not deduct the livestock products generated by the imported feed (9). This tends to increase the apparent land productivity of feed importing countries. Consider a small island without agricultural land which imports all feed for its livestock. No land productivity exists. Agricultural output is exclusively a function of labour productivity. However, assuming that land is a factor inevitably leads to the conclusion that it is very productive. In 1980, the Netherlands land productivity is measured as 14.1 wheat units by H-R. The Netherlands, compared

to neighbouring Western European countries, have 20 percent higher crop and livestock yields. However, even assuming higher feed conversion ratios, it is improbable that the absolute difference in land productivity--measured in wheat units--is as large as the H-R figures suggest: Belgium-Luxembourg (10.08), Denmark (5.58), France (4.09) or Germany (5.99). Similar reflections apply to the high land productivities reported for net feed grain importers such as Taiwan (18.65), Japan (12.23), and Egypt (9.18).

3. Problems of assessing land productivities.

The 43 countries covered by H-R account for more than 50% of the world's arable land. Figure 1 shows that they are concentrated in the Americas, Western Europe and Oceania. The spatial distribution of land productivity is divided into eight productivity classes. The width of each class is 1.5 wheat units. The Americas, Western Europe, and Oceania dominate the figure. Asia--besides the Indian Subcontinent, the Philippines, Taiwan and Japan--and most of Africa have not been presented due to lack of data. To obtain a measure of land productivity, H-R divided a country's aggregated agricultural output by its agricultural land. This understates the achievements of agricultural technology in those countries which have large and in many cases less productive pastures and meadows or grazing land (e.g. Australia, Peru, Mexico, U.S.A.). It overstates the achievement of agricultural technology in countries which have a high percentage of arable land, like Taiwan and Japan. Land

Figure 1. Geography and Levels of Land Productivity 1980 – 44 Countries
(Hayami - Ruttan Country Group)



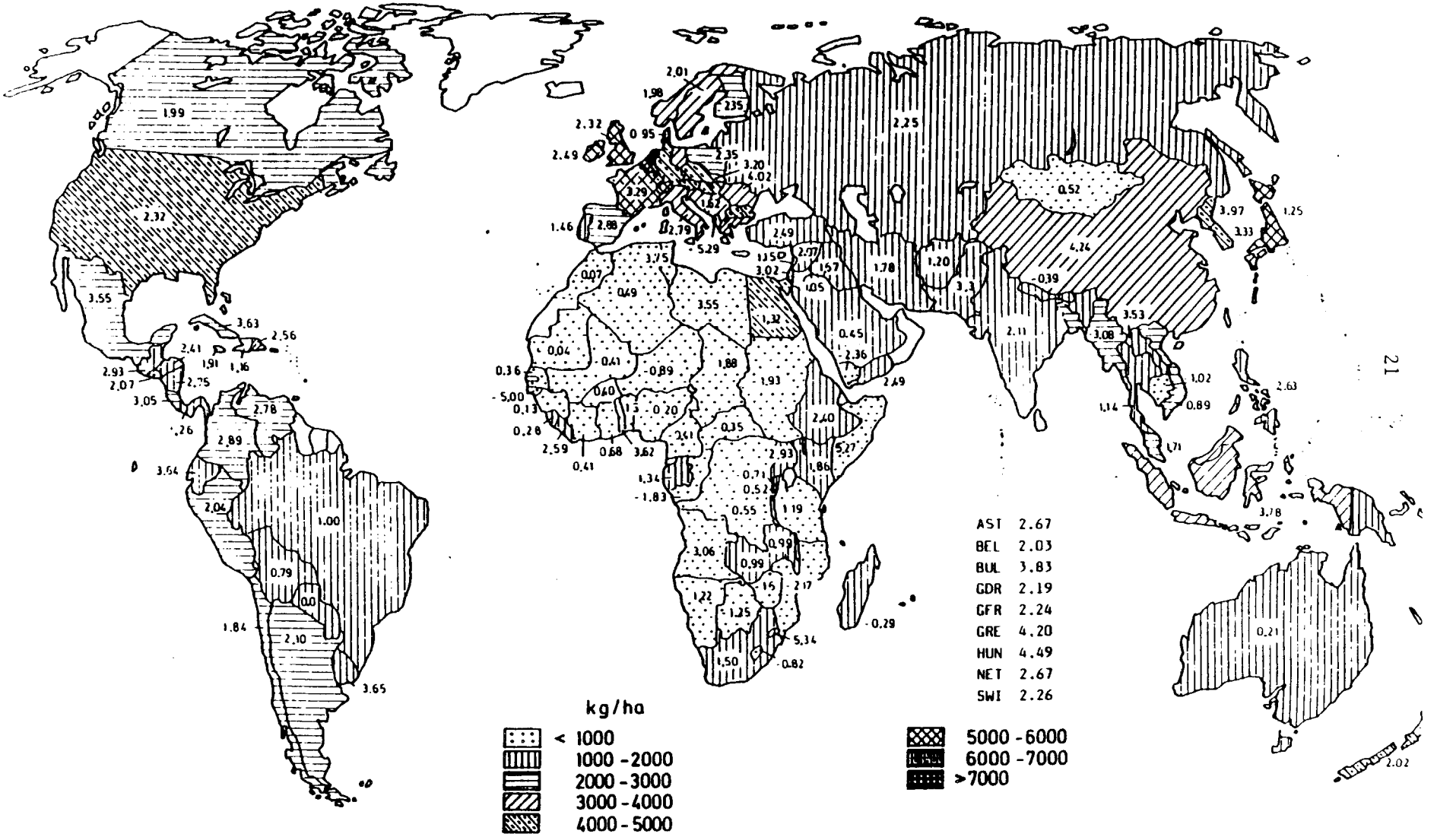
productivity relative to arable land (p. 465) would probably have been another useful indicator of the state of agricultural technology attained in a country.

Figure 2 complements the Hayami-Ruttan country grouping, showing the level of grain yields in eight distinguishable classes for 1980. The class width is one ton. The annual increase in yield has been inserted in each country for the period 1960-1980. Grain yields and their rate of growth represent the state of agricultural technology in each country.

The level of agricultural technology depends further on the density of demand per unit of land (number of persons x income per capita). A comparison of both figures confirms the geographical pattern of land productivity differences. Yields higher than four tons of grain per hectare can be considered as an indication of a higher level of agricultural technology, characteristic of Western Europe, Japan, North and South Korea, New Zealand, the U.S.A. and densely populated Egypt.

Comparatively high growth rates of grain yields in Eastern and Southeastern Europe show no barriers to increasing land productivities in these countries (26). Similar observations and conclusions can be drawn for the countries omitted in the Hayami-Ruttan group in Asia and South America. The situation in large parts of Africa is frightening. Low grain yields are combined there with decreasing grain yields. Most parts of Africa entered the modern area of science, education and research in the 1960s. This occurred a hundred years later than in Europe, North America

Figure 2: Level of grain yields (kg/ha): World 1982
Annual growth rates of grain yields (%), Period 1962 - 1982
Five - Year - Average



or Japan. Thus, many regions of Africa are still prone to animal and human diseases unknown in the northern hemisphere, have chronic water deficiencies, poor soils, insufficient transportation networks and labour forces comparatively less trained in administration, education, and research. Clearly, the specific cultural endowment central to the induced innovation hypothesis' has not yet taken root everywhere. Large investments are needed to reverse these pernicious conditions. The authors have been wise not to suggest an African development path.

4. Problems of choosing inputs as proxies for land or labour substitutes.

H-R developed an ingenious method to determine the quantity of inputs in use in each country. Fertilizer was taken as a proxy for land substitutes and tractors for labour substitutes. Fertilizer is an immediate complement to biological technologies and tractors are indispensable for field mechanization. However, governments can substitute for land scarcity not only by higher utilization of biochemical inputs, but via agricultural imports. Japanese imports are more than four tons of grain and oilseeds per hectare of agricultural land. This suggests that in advanced countries fertilizer use may give inaccurate econometric measures as the sole proxy for land substitutes, especially where it is economically and ecologically cheaper to import rather than to produce food.

Tractor mechanization--a mobile form of power--was affected by the relative extent of the land base in North America and

Europe. In the vast open areas of North America, mobile power came first to the plains, followed slowly by publicly subsidized rural electrification. In Europe and Japan, rural electrification, a stationary power source, brought power at an earlier date to the farming community for livestock operations, threshing, and drawing water. The sources of power (or energy) in any country thus depend on the mix of mobile and stationary power. As H-R note, higher labour productivity can only occur if more energy can be applied per agricultural worker.

5. Agricultural productivity and initial food consumption levels.

The African case has shown that agricultural development does not take place everywhere at the same time and at the same rate of progress. The diversity of agroclimatic conditions, and factor and cultural endowments favour or disfavour "take-off". Table 1 contains 100 years of agricultural productivity history in six developed countries, expressed as wheat units per capita. In 1880 the U.S. produced two wheat units per capita, double that of Germany and France. The slight increase which occurred between 1880 until 1980 indicates that two wheat units represent a satiation level in food consumption. As consequence, the U.S.A.--and Denmark--had to export their abundance from the beginning.

Japan's agricultural productivity levels (fish from ponds, rivers and the sea excluded) where in 1880 lower than those of European countries. The already high yields of rice needed

comparatively less seed per unit of output than the cereals grown in Europe. Further, the very small amounts of feed which had to be given to draft animals or other grain consuming livestock permitted better use of the food energy produced. The food intake per capita was probably less than in Western Europe,[3] but on the average much better and more regular than in the drought stricken countries of Saharan Africa or other poor countries. The reported rice riots in Japan indicate the sensitivity to rising food prices, as in many developing countries. The food consumption level in Japan was at least above the minimum requirement of 300 kg grain equivalents per capita stated by Clark (5), but still above food consumption levels of present India and Bangladesh (Table 2). However, as soon as the per capita income rose in Japan to sufficient levels, the general pattern of converting increasing quantities of feed into higher valued livestock products prevailed (25).

Table 2 demonstrates the remaining differences between the three country groups in the levels of food consumption measured in wheat units produced per capita. Besides India and Bangladesh, most countries of the low income group are beyond the immediate threat of the Malthusian trap.

IV. Conclusion.

Hayami and Ruttan made a seminal contribution, advancing our knowledge in many directions concerning the theory, history and present state of world agriculture. It is doubtful that another volume will soon combine so much theoretical and empirical

Table 1: Historical and present levels of agricultural output
Six countries, 1880, 1980

Country	Agricultural output 1000 Wheat units	Population 1000	Wheat Units / capita		
	1880	1880	1880	1980[a]	1880 = 100
Denmark	3 408	1 925	1.770	3.176	179
France	36 589	37 700	0.971	2.424	250
Germany[b]	45 137	45 095	1.000	1.285[c]	129[b]
Japan	15 706	37 000	0.424	0.573	135
United Kingdom	20 847	35 000	0.594	1.015	171
USA	103.711	50 200	2.066	2.185	106

a) Calculated according to sources in table 2.- b) Figures for 1880 refer to the German Empire, for 1980 to the Federal Republic of Germany.- c) The Federal Republic of Germany disposed in 1980 with 13.2 million hectares for 61.5 million people only over 36.4 % of the agricultural land which was available 1880 for the German Empire. This mainly explains why despite similar increases in land productivity the agricultural output per capita increased less than in Denmark, France or the United Kingdom.

Source: Agricultural output: V.W. Ruttan, H.P. Binswanger, Y. Hayami, W.W. Wade, A. Weber. In: H.P. Binswanger and V.W. Ruttan (Ed.), Induced Innovation. Baltimore and London 1978, p. 82-87.- Population: 1880 - W.S. Woytinski and E.S. Woytinski, World Population and Production, Trends and Outlook New York 1953, p. 44.

Table 2 : Present levels of agricultural output

43 countries - Hayami-Ruttan country grouping

1980

Country Grouping	Wheat Units millions	%	Population millions	%	Wheat Units capita
I. 17 High Income Countries GNP/capita > 6000 US-$	1 179	53.4	675	31.8	1.7[a)]
II. 14 Middle Income Countries GNP/capita ≧ 1500 ≦ 6000 US-$	491	22.2	382	18.0	1.3
III. 12 Low Income Countries GNP/capita < 1500 US-$	539	24.4	1 067	50.2	0.5[b)]
Total	2 209	100	2 124	100	1.0

a) Only Japan (0.6) and Norway (0.9) produce less than one wheat unit per capita. They have sufficient purchasing power to improve their consumption levels by importing food (like Libya (0.4) in Group III or Venezuela (0.8) in Group II).

Further, Japan and Norway have - and had in the past - a more than average fish catch per capita.

b) Bangladesh (88 millions) and India (684 millions) which account 72.3 % of the population in this group depress the result because they produce only 0.4 wheat units per capita.

Source: Agricultural output: Y. Hayami and V.W. Ruttan, Agricultural Development. An International Perspective. Baltimore and London 1985, p. 457.- Population: FAO, Production Yearbook 1982.

knowledge in one book. The second edition will thus find admirers where ever people are interested in learning about the fundamental processes of agricultural development.

Endnotes

1. The increasing importance fish had in Japan's modern development can be derived from C. Clark's figures. The share of fishery in the combined output with agriculture was 1894-96 already 7.8%. It increased over 12.9% in 1921 up to 23.4% in 1934-38 (4, p. 266, 430).

2. International level comparisons of monetary variables (exchange rates) have not the precision an ardent student would like to have. It leads even to paradox and controversial situations. To give one example: The World Bank statisticians stated in their yearly reports for Germany (West) a GNP per capita in 1979 of 11 730 U.S.-$. In 1984, five years later, they counted only 11 130 U.S.-$ or a decline of 5.1%. However, according to the German national accounts--counted in constant DM--there was an increase of 5.1% of the GNP/capita!

3. In 1880 food imports and food exports had only a minor importance. This is different from the situation in 1980 when many high income countries (Netherlands, Japan, Germany, etc.) had the purchasing power to import heavily. Therefore, the agricultural output of 1880 per capita of the whole population is a better indicator of levels of food consumption than the figure for 1980 calculated in Table 2.

References

(1) Antle, J. M., Infrastructure and Aggregate Agricultural Productivity: International Evidence. Economic Development and Cultural Change, Vol. 31 (1983), pp. 609-619.

(2) Areboe, F., Ursachen und Formen wechselnder Betriebsintensität in der Landwirtschaft. In: Thünenarchiv, 2. Band, Jena 1909, p. 363-904. Here quoted from: Friedrich Areboe, Würdigung und Auswahl aus seinen Werken. Ed. by A. Hanau, M. Rolfes, H. Wilbrandt, E. Woermann. Hamburg und Berlin 1965, pp. 245-265.

(3) Brinkmann, Th., Die Ökonomik des landwirtschaftlichen Betriebes. In: Grundriss der Sozialökonomik, VII. Abt. Land und forstwirtschaftliche Produktion, Versicherungswesen. Tübingen 1922. English edition: Theodor Brinkmann's Economics of the Farm Business. With introduction and notes by Elizabeth Tucker Benedict, Heinrich Hermann Stippler and Murray Reed Benedict, Berkeley, California, 1935, pp. 37.

(4) Clark, C., The Conditions of Economic Progress. 3rd edition. London, 1957.

(5) Clark, C., Problems of Subsistence Agriculture. Zeitschrift fur Ausländische Landwirtschaft, Vol. 8 (1969), pp. 229-247.

(6) Evenson, R. E. and Y. Kislev, Agricultural Research and Productivity. New Haven and London, 1975.

(7) FAO, Potential Population Supporting Capacities of Lands in the Developing World. Technical Report of Project FPA/INT/513. Land Resources of the Future. Rome, 1982.

(8) Hallett, G., Economic Journal, Vol. 82 (1972), No. 326, pp. 792-793.

(9) Hayami, Y., Responding letter to A. W. of April 16, 1986.

(10) Herlemann, H.-H., Technisierungsstufen der Landwirtschaft. Berichte über Landwirtschaft, Vol. 32 (1954), pp. 335-342.

(11) Herlemann, H.-H., Stamer, H., Produktionsgestaltung und Betriebsgrösse in der Landwirtschaft unter dem Einfluss der wirtschaftlich-technischen Entwicklung. Kiel, 1958.

(12) International Institute for Applied Systems Analysis (IIASA), Food and Agriculture Program, Newsletter, Number 2, April 1979, pp. 6-13.

(13) Johnston, B. L., The Journal of Economic Literature, Vol. 11 (1973), No. 1, pp. 133-135.

(14) Linnemann, H., J. de Hoogh, M. A. Keyzer and H. D. J. van Heemst, MOIRA-Model of International Relations in Agriculture. Amsterdam, 1979.

(15) Maddison, A., Economic Growth in Japan and the USSR. London, 1969.

(16) Peterson, W., International Farm Prices and the Social Cost of Cheap Food Policies. American Journal of Agricultural Economics, Vol. 57 (1979), pp. 12-21.

(17) Pewetz, W., Schrifttum der Agrarwirtschaft, Vol. 12 (1972), Heft 5, E 2535 d 2, Nr. 287.

(18) Porter, J. M., Agricultural Economics Research, Vol. 24 (1972), No. 2, pp. 47-48.

(19) Sahota, G. S., Economic Development and Cultural Change, Vol. 21 (1973), No. 4, Part I, pp. 722-731.

(20) Schuh, E., American Journal of Agricultural Economics, Vol. 55 (1973), No. 1, pp. 123-126.

(21) Schultz, Th., Kyklos, Vol. 15 (1972), No. 3, pp. 642-645.

(22) Schultz, Th., The Value of the Ability to Deal with Disequilibria. The Journal of Economic Literature, Vol. XIII (1975), pp. 827-846.

(23) Tracy, M., Agriculture in Western Europe: Challenge and Response, 1880-1980. 2nd edition. London, 1982.

(24) Weber, A., Weltwirtschaftliches Archiv, Bd. 109 (1973), Heft 1, Schrifttum, pp. 26-32.

(25) Weber, A. and E. Weber, The World Protein Structure and Future Nitrogen Requirements, European Review of Agricultural Economics, 1974/75, pp. 169-172.

(26) Wong, L.-F. and V. W. Ruttan, A Comparative Analysis of Agricultural Productivity Trends in Centrally Planned Economies. (Economic Development Center, Bulletin Number 86-4), St. Paul, August 1986.