CAPITAL REQUIREMENTS IN AGRICULTURE: AN INTERNATIONAL COMPARISON

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Capital requirements may be expressed in various ways but when comparisons are to be made between situations of great variety it is best to express them per unit of annual product. The definition of product also raises difficulties. Here it is measured net of agricultural inputs but still gross of industrial inputs. The study approaches the problem by first considering the capital requirements of the simplest types of agriculture and then moving up the scale towards the more advanced. Simple forms of crop culture using hand tools may require only 0.1 to 0.2 of a year's product in the form of capital. These requirements increase when livestock are added, either for draught power or for their products. Increases also occur when tree and bush crops are introduced. In the less favourable climates, capital is also needed for the provision of shelter. When comparisons are possible between farms of different sizes, the greater capital requirements per unit of product for the smaller farms are clearly to be seen. In general the amount of capital per unit of product in agriculture is tending to fall, both through improvements in techniques and through an increase in the average size of holding.

Land is not capital. Capital consists only of those requirements for agricultural production which are produced by human effort, and which have a definite purchase price or cost of construction. Capital in the form of structures and equipment whose value declines with age is sometimes measured at what it would cost to install new or sometimes after allowing for depreciation which it has undergone. Either method is permissible; but we must make sure that we know what we are doing, and do not confuse the two categories of results. Livestock, whose value may either appreciate or depreciate with the passage of time, are generally valued at the current market price. Certain improvements to land—draining, terracing, diking, watering, etc.—count as capital. The dwellings of the farm family or the farm workers and their families should not be counted as part of the capital requirements of agriculture—on the good grounds that these people would require housing if they were not engaged in agriculture at all. In some forms of agriculture, people and livestock are housed in a single building; in this case, an approximate apportionment has to be made.

It is agreed that plantations expected to last for a number of years—orchards, vineyards, rubber trees, oil palms and the like—constitute capital. Some economists, in addition, have tried to include the capital value of growing annual crops. This of course may vary from the entire value of the harvest at one particular date, to nothing at another time of the year; and it is difficult to find a satisfactory convention for making this measurement. It is more convenient to omit such entries.

Capital requirements may be expressed per farm, per unit of area, or per unit of annual product. If we wish to compare different types of farming, different

times and different countries, between which there may be great variations in the value of money, it is clearly best to express capital requirements per unit of annual product. Even this simple concept may be expressed in varying degrees of "grossness"; it is best to express it net of all agricultural inputs, i.e. we do not wish to count twice animal manure, fodder crops, seeds or purchased livestock.

Some might wish to go further, and to deduct all industrial inputs as well (including depreciation of equipment and structures), thus taking as their unit of measurement the money value of the net income produced by the agricultural sector. In the agriculture of the low-income countries, agricultural inputs (fodder and seeds) are substantial in relation to the gross product, but industrial inputs are small, and there is therefore little difference between the two concepts. In the advanced countries, the relative importance of the industrial inputs becomes very much larger. However, to deduct these might raise some difficult questions about whether to apply the same price indexes to the agricultural product and to the industrial inputs. Moreover even in the advanced countries, there is often considerable uncertainty about obtaining good estimates for depreciation.

For these reasons, agricultural output, the base against which we measure capital requirements, is measured net of agricultural inputs but still gross of industrial inputs. The importance of these latter in the agricultural economy of the advanced countries must of course be borne in mind.

Nor does this study attempt to measure the indirect capital requirements of agriculture, in the form of capital in plants producing fertilizers and equipment, public roads and transport services used by the farmer, etc. These may be very substantial. But they can only be considered in the light of a general study of the capital requirements of the industrial, transport and other sectors of the economy.

The simplest forms of agriculture are found to require very little capital. This indeed goes without saying—forms of agriculture requiring substantial capital are, by definition, those which the simplest economies are incapable of practising. The simplest form of agriculture, requiring hand tools only, is shown by fairly precise studies in Malaysia and Nigeria to require only 0.1–0.2 of a year's product in the form of capital.

Capital requirements naturally increase when we pass from the hand-hoe to the draught animal form of agriculture. Capital is required in the form of larger implements, and also in the form of the draught animals themselves. Data from the Philippines and Madagascar indicate capital requirements amounting to about three-quarters of a year's product in such economies. In India and Pakistan capital requirements equal about one year's product. Here, however, we meet a new principle—on the smallest farms capital requirements per unit of product are substantially greater than on larger farms.

Capital requirements per unit of product are also equal to about one year's product in Japan. Here we have an agricultural economy which is still mostly operated with hand tools, with few draught animals. However, it is a much more sophisticated economy, with substantial investments in the form of orchards, mulberry trees, etc.

It is paradoxical that the growth of the so-called "plantation" tree and bush crops—rubber, coconut, coffee and the like, although practised in low income

countries, is nevertheless one of the most capital-demanding forms of agriculture. The depreciated values of the capital represent on the average about two years' output, and the value when newly planted about twice this amount. Approximately the same ratio applies to cocoa growing in Nigeria, though in this case this form of agriculture is practised entirely by African, not European, farmers.

Turning to information from Europe, we see very clearly the much greater capital requirements per unit of product for small farms, and also a tendency for capital requirements per unit of product to decline with time. For France such information is available from the early 19th century. An increase in the average size of farm holding may account for some of this reduction in capital requirements per unit of product. But information from Britain and from Sweden, where there has been no substantial change in the average size of holding, indicates a very great reduction in the amount of capital required in the form of buildings. The older farms, it must be remembered, had to be provided with buildings capable of housing large numbers of horses; and in any case, in those days when building costs were much lower relative to costs in general, farm buildings tended to be on a more generous scale than they are now. A detailed study in Germany indicates that the ratio of capital requirements to product may be as low as 1.5 on large cereal farms, as high as 3.9 on small grassland farms. Very detailed studies are available for Britain, showing the large savings in equipment required per unit of product on the large farms compared with the small. Since the 1930's, capital requirement per unit of product in the Netherlands has fallen from 4.7 to 1.9, largely owing to economy in buildings. Probably the most economical use of farm capital in Europe is in Denmark, in spite of the low average size of holding.

In the United States, information is available measuring capital requirements both at current prices and at the prices of a base date (1910–1914). The latter show a falling, the former a rising tendency. This is accounted for by the great rise in the relative price of building (and the lesser rise in the relative price of equipment) compared with the price of farm products.

Australia makes very economical use of farm capital. In New Zealand, where the average size of farm is much smaller and production is intensive, capital requirements per unit of product are about the highest in the present day world.

Generally speaking, the amount of real capital required per unit of product in agriculture is tending to fall, both with technical improvements, and with increasing average size of holding. Agriculture, considered in the aggregate, should be a source for releasing capital, not demanding it.

The most rational way to approach this study would appear to be to begin with the capital requirements of the simplest types of agriculture, working up the scale towards the more advanced.

One of the most thorough studies of a community living by subsistence agriculture and fishing, but nevertheless living quite comfortably by Asian standards, was made in Malaysia.[1] In Malaysia there are also large rubber estates,

1. Institute for Medical Research, Kuala Lumpur, Report No. 13, 1950.

but these are mainly worked by wage workers of Chinese or Indian descent, the Malaysians preferring their old way of life.

The study related to 1948, and measurements were originally made in Malayan dollars, which were converted to their real value of 3.6 kgms. of milled rice/dollar (at the exchange rate then prevailing of 0.47 American dollars per Malayan dollar, and the export price of rice from Thailand, the purchasing power of the Malayan dollar was equal to 3.35 kgms. of milled rice). The average farming family (numbers in family not stated, but probably about six) had an income equivalent to 4750 kgms. milled rice/year. The value of their agricultural and fishing equipment and livestock was only 520 kgms. Some allowance might be made for the housing of livestock; but as the whole value of the dwelling was only 1095 kgms. of milled rice, the entire agricultural and fishing capital requirements cannot have been much more than about 600 kgms. of rice, or about one-eighth of a year's income. Families living predominantly by fishing had an income of 2760 kgms. rice/year and a capital stock for agriculture and fishing of only 195 kgms. Estate workers and their families, who also had some part-time private farming activities, had an average family income of 4250 kgms. rice/year, and a capital stock of 197 kgms.

Living predominantly by cash rather than by subsistence farming, though probably not so well off as the Malaysians, a Nigerian farming community[2] in 1952–3 had an average family income (average numbers 8.3) of £124 in cash plus £22 in kind. Their agricultural capital was only 18 per cent of a year's income (£25 in livestock and £2 in implements).

With draught animal cultivation, capital requirements increase substantially. In the Philippines,[3] the average farm family occupied 2.6 hectares. Converting the Philippine peso at its purchasing power (1955–6) of 2.95 kilos milled rice, the family occupied a dwelling worth 1365 kgms. milled rice. Their agricultural capital was as follows (in kilograms milled rice):

Buildings other than dwelling	56
Draught animals	872
Other livestock	333
Tools	285
Supplies	71

Per hectare this amounts to 621 kgms. milled rice, as against the average harvest in the Philippines of only 840 kgms. milled rice/hectare, i.e. 74 per cent of a year's crop.

In Madagascar[4] Merina families near Tananarivo were found to possess on the average two working oxen, a steel plough (which had to be imported), a harrow, a hand cart, and a boat (a necessity at the time when the rice fields were flooded). This represented a capital cost of 70,000 C.F.A., i.e., 140,000 old French francs, equivalent, in the 1950s, to $390, or 3.25 tons of milled rice at

2. Anne Martin, *The Oil Palm Economy of the Ibibio Farmer.*
3. Central Experiment Station, Bulletin No. 1, 1957, p. 63.
4. Gourou, *Vers la Promotion de l'Économie Indigène.*

TABLE 1

CAPITAL REQUIREMENTS OF PLANTATION CROPS, CEYLON AND INDONESIA

	Expected yield (tons/hectare)		Average labour requirements per hectare (Ceylon)	Average investment (Guilders/hectare) Indonesia 1920s	Planting costs[c] Ceylon (Tons milled rice equivalent/hectare)	Ratio to annual crop	
	Crop	Milled rice equivalent[a]				Planting costs Ceylon	Depreciated[e] capital (Indonesia)
Coconut	0.475[b]	0.55	0.25		3.71	6.75	
Coffee	0.59			1100–1200			1.9
Rubber	0.5	1.65	1.25	1200–1500	7.43	4.5	2.4
Palm Oil	0.24			1500			13.0
Tea	0.625	3.77	2.5	1500–2000	14.90	3.95	1.4
Fibres	2.0[d]			2000			2.2
Sugar	14.7			4000			1.9

SOURCES: Smits, Mededeeling No. 96, Centraal Kantoor voor de Statistiek (1931). Ceylon Dept. of Agriculture, privately communicated, 1947.

[a]At prices of 1960–64, based on their export price equivalent of 0.139 $/Kg. milled rice.

[b]Copra.

[c]Values given in 1947 rupees, converted at 2.13 kg. milled rice equivalent.

[d]Sisal.

[e]At 1929 prices.

world prices. This was also probably equivalent to three-quarters or more of a year's income for the family.

Paradoxically, some of the highest ratios of capital to output in the world are found in the plantation crops of low income tropical countries.

The values from Ceylon (for new plantations) should be expected to be about twice the order of magnitude of the depreciated value of existing plantations in Indonesia.

In Nigeria the growing of cocoa, a very slow-yielding crop undertaken entirely by African farmers (intending European plantation owners having been legally excluded by the British authorities) is also very capital-intensive.[5] In the 1920s, the cost of establishing a plantation (including the valuation of the farmer's own labour) was £15/acre, or about twice the value of a year's crop. In the 1930s, when prices were extremely low, although wages were still rising, planting costs stood at about eight times the value of a year's harvest. In 1951/52, when the value of the gross yield was £22/acre/year, wages had risen to bring the planting cost to £50–75/acre (including £7 land price) or a capital cost equivalent to two and a half years' product.

Some information is available for India and Pakistan (Table 2). The study by Mukherjee and Sastry for 1950/51 appears to be the only fully comprehensive review.[6] Its conclusions are approximately confirmed from other sources. The

TABLE 2

CAPITAL REQUIREMENTS IN INDIA AND PAKISTAN MEASURED AS PROPORTION OF ANNUAL PRODUCT

	Livestock	Land Improvement and Irrigation	Structures (not houses)	Implements	Total
All India 1950–51[a]	.48	.35[c]	.17	.07	1.07
All India 1961[b]	.42			.16	
Western Uttar Pradesh 1948–51[d]					
Farms 1–2 hectares	.53			.16	
Farms over 8 hectares	.36			.08	
Average	.42			.10	
East Pakistan[e]	.34		.06	.03	

[a]Mukherjee and Sastry, International Association for Research in Income and Wealth Conference, 1957 (mimeographed).

[b]Reserve Bank of India (quoted Agricultural Situation in India Aug. 1965, p. 360).

[c]Of which 13% public, 87% private.

[d]C. P. Shastri, University of Agra Thesis. Largely irrigated land on which produce per unit area is 3.2 times Indian average. About 30–35% by value of the livestock represent milch cows.

[e]Farouk and Rahim, *Modernising Subsistence Agriculture*, Dacca 1965. Product per unit area 1.6 times Indian average.

5. Galletti, Baldwin and Dina, *Nigerian Cocoa Farmers*.

6. A Study, *Capital Formation in Indian Agriculture* by Pera Shukla, gives results which appear to be too high.

study for Uttar Pradesh shows the relative wastefulness of capital requirements on the small farms.

Japanese official figures[7] indicate a ratio of capital to net value added in agriculture of about 2.2, corresponding to a ratio a little below 2 for gross product net of agricultural inputs. It appears, however, that these include dwellings. More detailed studies by types of farm are available.[8] Here also buildings are not analysed. Making the very approximate assumption that any buildings shown to a value of over 800,000 Yen per farm represent non-residential farm buildings, we obtain ratios of capital to a gross product net of agricultural inputs between 0.3 and 0.6 for rice growers with no other product, 0.9 for a poultry farm, 1.0 to 1.6 for a dairy farm, 1.9 for a mixed farm and 2.2 for a vegetable grower. In these two latter cases orchards represented a capital value equal to about one year's gross output net of agricultural inputs of the entire farm.

For the European countries, we start with Roumania, for which we have an estimate for 1905,[9] and for about 1930.[10] Between these years productivity declined heavily, from 1.4 to 1.0 tons of wheat/hectare/year, with rising population (and also the territories annexed from Hungary and Russia in 1918 were probably less productive than old Roumania); and at the same time with considerably reduced capital input per unit of output.

TABLE 3

AGRICULTURAL CAPITAL IN ROUMANIA AS MULTIPLES OF ANNUAL PRODUCT

	1905	1930
Buildings	0.71	0.41
Equipment	0.31	0.22
Livestock	1.04	0.54
Total	2.06	1.17

For Yugoslavia we have studies for 1953 by Vinski[11] and some further figures, all measured in 1962 prices, from Grdjic[12] which, allowing for price change, are of the same order of magnitude as Vinski's.

It is difficult to measure the capital-output ratio because of violent year by year fluctuations in output. The general average appears to have been as high as 3.0 in the period 1952–6, coming down to 2.7 for the period 1957–63.

For France, present day information is lacking; but we have a remarkable series going back to 1789.[13] These point to the conclusion that early nineteenth century agriculture required more capital per unit of product than does that of

7. Annual Report on the State of Agriculture, 1961, pp. 84–86.
8. Kyoto University Research Institute of Farm Accounting, various reports 1960–64.
9. Serban, quoted Mitrany, *The Land and the Peasant in Roumania.*
10. Manoilesco, Weltwirtschaftliches Archiv, July 1935.
11. International Association for Research in Income and Wealth, 1957–1959 Conferences.
12. International Statistical Institute, 1965 Conference.
13. Toutain, Cahiers d'ISEA, No. 115, Tables 103 and 105.

the present day (Table 4). In France, the male labour force occupied in agriculture reached its maximum in the 1830s, and by 1929 was already 40 per cent below this maximum. Consolidation of small farms was probably an important factor reducing capital requirement per unit of output.

TABLE 4

PRODUCT AND CAPITAL IN FRENCH AGRICULTURE
(billion francs, current value)

	Product Net of Agricultural Inputs	Buildings	Livestock	Equipment and Stocks	Total Capital/ Output
1789	2.6	2.5–3	1.25–3.25		1.9
1815	3.6	3 –3.9	1.3–1.6	1.9–3.0	2.0
1835–40	4.6	3.3–4.3	2.5	2.3–3.3	2.0
1851–53	5.5	6.1–6.4	2.8		(2.0)
1878–82	9.1	6.0	5.8	1.4–3.2	1.5
1892	8.5	5.3	5.2	1.5	1.4
1900–06	9.5	4.4–5.5	7.9		1.4
1908–14	12	5 –7.5	5.9–7.3	1.8–6.0	1.4
1924–25	50	12 –18	38	33	1.7
1929	80	24	60		(1.3)

A recent study in Germany[14] brings out clearly the economy of capital in larger farms, in livestock and equipment as well as in buildings. In Germany, with a rather dense agricultural population, product per unit of area is not very much greater on the smaller farms than on the larger, except for predominantly grazing farms (Table 5).

For England, we have a thorough study of the equipment requirements of farms of different size.[15] The estimates were made for mixed farms in Norfolk with 26 per cent of the land under permanent pasture and 12 per cent under sown pasture. Gross product net of agricultural inputs was calculated from Farm Management Survey for 1960 (the date was chosen in order to fit certain other international comparisons). Allowing for somewhat lower prices in the 1950s, and also for farm prices being above world price level, the ratios should be raised (Table 6). It appears that nearly 300 acres are required before machinery can be used economically under present day conditions. It will also be noticed that the difference between "commonly found" and "minimum" becomes small on the larger farms.

In England, analysis of farm capital requirements is made much more difficult by the traditional distinction between "landlord's capital" (all permanent fixtures) and "tenant's capital" (implements, livestock, stores, sometimes valuation of cultivations). Even in modern times, as tenant farming declines, this Victorian distinction persists, and valuations of buildings and structures have been omitted from most studies of capital requirements.

14. Geuting and Gemmeke, Agrarwirtschaft, April 1956.
15. Sturrock, Farm Mechanisation, October–November, 1955.

TABLE 5

CAPITAL REQUIREMENTS BY TYPES OF FARM, GERMANY (LOWER SAXONY)

	Grain and Beet Farms		Potato and Rye Farms		Mixed Farms (30% area grass or fodder crops)		Farms approximately half grassland		Farms approximately 80% grassland	
	Small	Large	Small	Large	Small	Large	Small	Large	Small	Large
Area, hectares	14	144	39	142	16	161	16	171	13	146
Gross product (DM/ha) per unit of area	2319	2217	2036	1970	1682	1550	1252	1180	887	452
As multiple of gross product:										
Buildings	1.47	1.05	1.40	1.17	1.95	1.34	1.63	1.18	2.58	1.77
Equipment and draft animals	0.36	0.25	0.33	0.28	0.32	0.31	0.33	0.21	0.36	0.29
Land improvement	—	0.01	—	0.01	—	—	—	—	—	0.04
Livestock (not draft animals)	0.25	0.23	0.26	0.20	0.37	0.35	0.64	0.68	0.96	0.85
Total real capital	2.08	1.54	1.99	1.66	2.64	2.00	2.60	2.07	3.90	2.95
Liquid assets (not included above)	0.35	0.40	0.37	0.38	0.41	0.39	0.38	0.36	0.33	0.40

TABLE 6

COSTS OF FARM EQUIPMENT *NEW* ON ENGLISH MIXED FARMS

Area (acres)	Gross Product less Agricultural Inputs (£/acre/year)	Equipment Costs as Multiple of Product		
		"Minimum"	"Commonly Found"	"De Luxe"
50	43.0	0.93	1.31	2.91
100	38.0	0.73	0.92	1.70
200	37.4	0.48	0.57	1.02
300	34.8	0.41	0.46	0.81
500	34.2	0.36	0.43	0.63
600	34.4	0.33	0.39	0.56
800	35.0	0.30	0.36	0.47

Among all the abundant and costly research work in agricultural economics which has been done in the past two decades, there has been practically none throwing any light on the replacement value of farmhouses, other farm buildings, drains, fences and other structures. The Agricultural Economics Research Institute, at considerable difficulty and expense, organized a detailed inspection by a professional surveyor (Mr. H. J. Vaughan) of a substantial number of farms in two sample areas, namely the Banbury Rural District in North Oxfordshire, a cold, hilly and rather unproductive area, and "The Rodings", an area of productive farm land in Essex. The results were published in the *Farm Economist* 1962, No. 2, and are summarized in Table 7.

Analysis of the results (published in *Farm Economist*) showed that for tenanted farms the provision of fixed equipment seemed to be almost at random, and bore no discernible relation to the size of farm. For owner-occupied farms in Oxfordshire on the other hand a clearly marked relationship was found as follows:

$$\text{Log (replacement value per acre of fixed equipment excluding farm dwelling)} = 2.6757 - 0.3349 \text{ Log (size of farm in acres)}$$

This indicates a highly curved relationship, with capital requirements per acre falling from £161 on a farm of 25 acres to £88 on a farm of 150 acres, with a further fall only to £64 on a farm of 400 acres. Averaging the two districts, we find a stock, excluding dwellings, of £40/acre, and annual depreciation of £0.96/acre. The amount of farm land (excluding rough grazings) in the United Kingdom, including Scotland and Northern Ireland, is taken at 31 million acres, giving a stock of structures of £1,240 million in 1960, and an annual depreciation charge of £30 million. Gross annual expenditure on new buildings and work for agriculture is given in the Blue Book *National Income and Expenditure*, and can be converted to 1960 prices by the general index number for non-residential construction. For the period 1948–58 inclusive, new construction fell slightly short of depreciation requirements, but from 1959 onwards rose rapidly. The reason for this is clear. An amendment to the Agriculture Act in 1958 greatly

TABLE 7

VALUE OF FARM IMPROVEMENTS, 1960, SELECTED ENGLISH FARMS
(Pounds sterling/acre)

	Oxfordshire			Essex		
	Full Replacement Value	Annual Depreciation	Present Value	Full Replacement Value	Annual Depreciation	Presen Value
Farmhouse	24	0.16	19.8	24	0.20	24.0
Cottages	9			16		
Other farm buildings	33	0.33	20.1	40	0.40	24.4
Field drainage	14	0.28	5.6	27	0.54	10.8
Fences and gates	11	0.27	9.7	4	0.10	3.5
Farm roads	3	—	3.0	3	—	3.0
TOTAL	94	1.04	58.2	127	1.24	65.7
Selling value of farm			85			140
Unimproved value of land			27			74

reduced the obstacles in the way of land owners raising rents, and therefore gave them much more incentive to improve their property.

At 1960 prices throughout, the computed stock of farm structures was £1,386 millions at the end of 1965, £1,240 millions in 1960, £1,248 millions in 1948. Supplementing this information, we have Thompson's estimate[16] of £12/acre value of structures in 1907 (including 4.5 drainage and fencing and 0.5 roads). Thompson's figure includes cottages, but not, apparently, the farm house and should be reduced to £10 on this account, or £310 million in all. Converting to 1960 prices, this becomes £2,245 million, as against £1,248 million in 1948.

We may assume that depreciation was proceeding at 2.5 per cent per year for the whole period 1929–48, representing a capital stock (at 1960 prices) of £2,020 million in 1929. This is compatible with the assumptions that net capital was stationary from 1907 to 1921 and declining 1.3 per cent per year from 1921 to 1929.

The gross product of United Kingdom agriculture in 1961–62, including additions to stocks, but excluding production grants, was £1,634 millions. Reducing this to world prices by a factor given by Professor Gale Johnson[17] this becomes £1,268 millions. Net of agricultural inputs, which are assumed to be at world price, this becomes £892 millions. This is taken as a base and carried forward and backward by the F.A.O. index of gross product net of agricultural inputs.[18] Earlier years are estimated from Ojala, *Agriculture & Economic Progress*.

TABLE 8

FIXED STRUCTURES ON UNITED KINGDOM FARMS

	1907	1929	1935–9	1950–51	1959–60	1964–65
Depreciated value of structures (£m. at 1960 prices)	2245	2020	1660	1252	1236	1343
Production net of agricultural inputs (£m. at 1961–2 prices)	463	461	464	666	799	994
Ratio	4.86	4.38	3.58	1.88	1.55	1.35

We can now obtain comparative results which show what very great economies are being made in the use of fixed structures by British farmers, by better use of a largely unchanged stock up to 1958, and of the net increment of new construction since (Table 8).

There is some information enabling us to distinguish between different

16. *Journal of the Royal Statistical Society*, Dec. 1907.

17. *Journal of Farm Economics*, Dec. 1964.

18. This index is more suitable for the present purpose than the official Ministry of Agriculture index, which measures product net of agricultural *and industrial* inputs.

types of farms.[19] These values of structures, which are estimated *new*, can be considered in conjunction with the valuation of all other "tenant's capital" (in which equipment is included at its *depreciated* value) as given in Farm Management Survey. Definition of "tenant's capital" here used, however, includes some valuations of cultivations and other items which we have excluded elsewhere.

It must be remembered that the production for different types of farms given here is at current prices of 1960, not reduced to the prices of the mid-1950s, nor to world price level (Table 9).

Agriculture (including horticulture) in the Netherlands, which now has a real product per man-hour one-third higher than in Britain, as well as very much higher productivity per unit of area, has also shown large capital economies. The capital stock of Netherlands agriculture in 1938[20] amounted to 4.3 billion guilders, including 2.8 billion buildings and 0.7 billion livestock—equipment being estimated at only 0.1 billion. In 1957 the corresponding figure[21] was estimated at 9.9 billion guilders, including 3.0 billion for livestock, 0.8 for stores, and 0.2 for orchards. Product net of agricultural inputs[22] was 0.92 billion guilders in 1938–9 and 4.45 in 1954–5, which latter figure can be extrapolated to 4.66 for 1957–8. The ratio of capital to output therefore was 4.7 in 1938 (including 3.05 for buildings) and only 1.9 in 1957.

In the Netherlands agricultural prices in the 1950s can be taken to be, in effect, at world level. The same is true of Denmark, for which a national aggregate estimate has been made.[23] This study however records net product at factor income level i.e. after deduction of all industrial inputs. Judging from the Danish input-output table, these figures should be raised by about 18 per cent to bring them to the level of gross product net of agricultural inputs.[24] (Table 10). In this case, the use of capital must have been exceptionally parsimonious, even before the further economies enforced by the war. In subsequent years there has been some rise in the ratio which, however, remains low in comparison with other countries.

Swedish gross agricultural product in 1955–6 net of agricultural inputs was 3,774 million kronor. Converted to world prices[25] this becomes approximately 3 billion kronor. In Sweden, the ratio of value of farm buildings to output is exceptionally high. In the first place, agricultural employment has been reduced more rapidly in Sweden than in almost any other country, and there has not been a great rise in output; secondly the climate is demanding; but also because of high wages and the difficult climate for building, Swedish building costs are

19. Langdon, "Buildings and Fixed Equipment in Agricultural Land Classification," Agricultural Land Service Technical Report No. 8, 1962 (quoted Peters, *Farm Economist*, 1966). Unfortunately the figures as given include the price of the dwelling which is stated at £3,000 for the smallholdings, and is assumed to be £4,000 for holdings between 100 and 200 acres, and £5,000 for the large farm. The costs referred to the period 1954–60.

20. Derksen, National Institute of Economic and Social Research (London) Occasional Paper 10.

21. Verrijn Stuart, *Het Laudbouwcredit in Nederland 1960.*

22. Landbouwcijfers, 1956, pp. 74–75.

23. Bjerke, World Population Conference 1965.

24. Danish Statistical Department, National Regnskapsstatistik, 1947–60, p. 60.

25. Gale Johnson, *Journal of Farm Economics*, Dec. 1964.

TABLE 9

CAPITAL REQUIREMENTS OF DIFFERENT TYPES OF FARM, ENGLAND AND WALES

	Area (acres)	Gross Production Net of Agricultural Inputs, 1960[a] (£)	Ratio to Gross Production		Percentage Composition of "Tenants' Capital"			
			Structures (new)	"Tenants' capital" (incl. equipment depreciated)	Livestock	Equipment	Stores	Cultivations
Dairying	40	1845	1.76	1.30				
	70	2740	2.36	1.30	56	33	5	6
	120	4365	1.95	1.31				
Mixed	40	1755	1.54	1.07				
	110	4110	1.58	1.21	42	36	9	13
Arable	40	2330	1.03	0.73				
	250	8000	2.38	1.18	26	37	11	26

[a]Interpolated from Farm Management Survey.

TABLE 10

CAPITAL REQUIREMENTS IN DENMARK
(Billion Krone of 1955 Purchasing Power)

	1949–51	1955	1961
Product Net of Agricultural Inputs	4.27	4.78	5.302
Capital	4.90	6.74	8.17
Ratio	1.12	1.41	1.54

exceptionally high. Holmström[26] has made an interesting categorization of farm buildings, all measurements being in billions of kronor at 1954 values. The total stock, at full replacement value, was as high as 35.3 billion, including 14.4 billion for farmers' dwellings and 3.1 billion for farm workers' dwellings. The remaining 17.8 billion included 7.8 billion stalls for horses and cattle. If we omit all clearly obsolete buildings, and assume the redesign of others to modern standards, the total is reduced only to 16.7 billion; excluding stalls on farms now without livestock only reduces it by a further 0.2 billion to 16.5. The depreciated value is estimated at 11.5 billion (3.8 times output) or 65 per cent of the replacement value of 17.8 billion.

For the United States we have two comprehensive reviews on a national scale[27] (Table 11). For historical comparisons of capital inputs at a given price level, data are first expressed uniformly at prices of 1910–14 (1912 with Goldsmith's data). Both sources agree in showing a peak in capital requirements in the early 1920s, followed by a substantial decline. Tostlebe's figures throughout are higher than Goldsmith's, principally in respect of structures. It is possible that Tostlebe included farm residences.

Expressing in current prices, however, while we get a similar result for 1929, we find capital requirements subsequently showing an increase, not a decrease. The difference between the current price and the fixed price series appeared sharply in the 1930s, and has since become larger. The reasons are clear. The price of building has risen very much relative to the price of farm products, and indeed relative to all other prices. The relative price of equipment has also risen sharply; likewise the price of livestock, in relation to prices of agricultural products in general.

Tostlebe makes a most interesting analysis of regional differences in the capital/output ratio at various dates. The modern highly productive agriculture of the Pacific States has a capital/output ratio only about two-thirds of the United States average, alike in buildings, implements and livestock. Above-average building requirements are found in the areas which are alike long-settled and with cold winters—the North East and Appalachian areas, the Lake States and the Corn Belt. However, the South East, which is long-settled but warm, and the Mountain States which have cold winters but are recently settled,

26. Meddelande från Jordbrukets Utrednings Institut, 9–58.

27. Tostlebe, *Capital in Agriculture*, National Bureau of Economic Research; Goldsmith, *The National Wealth of the United States in the Post-War Period*, p. 206.

TABLE 11

CAPITAL REQUIREMENTS IN U.S.A.: CAPITAL AS MULTIPLE OF PRODUCT

Date	Gross Product Less Agricultural Inputs[a] ($ billion)	Tostlebe					Goldsmith[c]				
		Buildings	Equipment and Draft Animals	Other Livestock	Crop Inventories	Total	Structures excluding residences	Equipment	Livestock	Other Inventories	Total
At 1910–14 prices:											
1870	2.51		0.52	0.58	0.31						
1880	3.85		0.48	0.51	0.34						
1890	4.67		0.55	0.54	0.39						
1900	6.01	0.76	0.53	0.43	0.34	2.06	0.33	0.22	0.93	0.31	1.79
1910	6.40	1.00	0.62	0.40	0.35	2.37	0.43	0.35	0.88	0.40	2.06
1919–21	6.96	1.08	0.70	0.43	0.36	2.57	0.51	0.33	0.90	0.34	2.08
1924–26	7.50	0.98	0.58	0.38	0.32	2.26					
1929–31	7.98	0.90	0.55	0.35	0.30	2.10	0.46	0.32	0.71	0.27	1.76
1934–36	7.01	0.92	6.47	0.40	0.21	2.00					
1939–41	8.92	0.70	0.40	0.34	0.28	1.72	0.33	0.28	0.64	0.26	1.51
1949–51	11.12	0.68	0.47	0.29	0.28	1.72	0.32	0.46	0.52	0.27	1.57
1958	13.0						0.32	0.41	0.47	0.32	1.52
At current prices[b]											
1929	11.78						0.50	0.33	0.55	0.25	1.63
1939	6.89						0.59	0.51	0.74	0.31	2.15
1949–51	23.4						0.51	0.60	0.70	0.31	2.12
1958	25.6						0.65	0.72	0.70	0.31	2.38

[a]Inputs of purchased feed, which were about 4% of gross product in 1910–14, assumed 2% in 1900 and ignored in earlier years. Data from U.S. Agricultural Statistics & Historical Statistics of United States, Series K, p. 140–143. Since 1910 extrapolated on official index which excludes fodder and farm work animals.

[b]Excluding direct government payments and imputed rental of farmhouses, less 80% of gross agricultural inputs, and further (except 1929) reduced by a factor of 1.16 to convert to world prices (Gale Johnson, Journal of Farm Economics, Dec. 1964).

[c]Data in lines 5, 6, 8 & 10 refer to 1912, 1922, 1929 and 1939 respectively.

both have below-average building requirements. Though the Pacific States are economical of implements, the Great Plains, the Lake States and the Delta States have a ratio to output some 20 per cent above the national average.

Measuring throughout at prices of 1910–14 (the results would be different at current prices), we can see a striking fall in the capital/output ratio in what is believed to be one of the most capital-intensive forms of agriculture, namely the growing of sugar cane in Hawaii[28] (Table 12).

TABLE 12

CAPITAL PER UNIT OF PRODUCT, CANE SUGAR PRODUCTION IN HAWAII (at prices of 1910–14)

	Manufacturing Equipment	Unharvested Crops	Total
1870	1.15	0.88	3.00
1880	1.15	0.88	2.99
1890	1.02	0.74	2.64
1900	0.98	0.73	3.11
1910	0.68	0.77	2.47
1920	0.71	1.05	2.90
1930	0.59	0.60	2.08
1940	0.48	0.47	1.57
1945	0.39	0.58	1.55
1950	0.30	0.48	1.24
1957	0.31	0.43	1.13

TABLE 13

CAPITAL REQUIREMENTS IN AUSTRALIA PER UNIT OF GROSS OUTPUT LESS AGRICULTURAL INPUTS

		Average Size of Holding (thousands of acres)	Structures	Equipment	Livestock	Total
Pastoral Zone	W. Australia	468	.47	.09	.89	1.45
	S. Australia	61	.88	.19	.59	1.66
	Queensland	32.5	.65	.14	.86	1.65
	N.S.W.	19.7	.70	.18	.76	1.64
Wheat and Sheep Zone	W. Australia	3.6	.57	.58	.39	1.54
	S. Australia	2.4	.59	.39	.34	1.32
	N.S.W.	1.9	.80	.37	.65	1.82
	Victoria	1.6	1.01	.47	.44	1.92
High Rainfall Sheep Zone	N.S.W.	2.0	.78	.28	.92	1.98
	W. Australia	1.7	.78	.49	.58	1.85
	S. Australia	1.0	.71	.37	.49	1.57
	Victoria	0.9	1.14	.39	.86	2.39
Wheat Farms	Australia	2.0	.72	.49	.42	1.63

28. Mollet, Journal of Farm Economics, May 1962.

For Australia, the Bureau of Agricultural Economics has some information[29] (Table 13).

As we proceed from the very large and near-arid pastural holdings to the comparatively small holdings in the high-rainfall sheep land and the wheat farms, there is a slight tendency for capital requirements to increase, but it is not marked. On the whole Australia uses agricultural capital very economically.[30]

In New Zealand on the other hand, which has the most productive agriculture in the world in terms of product per unit of labour input, capital requirements are substantially higher, apparently not changed over a long period in real terms, though rising if expressed in current money terms, with structures and equipment becoming more costly relative to farm products[31] (Table 14).

TABLE 14

NEW ZEALAND CAPITAL REQUIREMENTS

	1929	1954
Gross Product (£m.)	133.3	224.5
Capital per Unit of Gross Product		
Structures	1.72	1.73
Equipment	0.19	0.28
Livestock	0.95	0.82
Total	2.85	2.83

Les besoins de capital peuvent être exprimées en diverses façons mais quand on fait des comparaisons entre des situations très éloignées il vaut mieux les exprimer par unité de produit annuel. Définer 'produit' est aussi difficile. En ce cas il est mesuré en unités nettes des coûts agriculturelles mais cependant en unités brutes des coûts industrielles. L'étude aborde le problème d'abord en considérant les besoins de capital des plus simples types de l'agriculture et puis en montant peu à peu vers ceux plus avancés. Les formes simples de la cultivation qui se servent des outils à main peuvent exiger, comme capital, seulement entre 0.1 et 0.2 de la production annuelle. Ces besoins sont augmentés par l'addition des récoltes d'arbre et d'arbuste. Sous des climats moins favorables le capital s'emploie aussi pour la provision de l'abri. Là où les comparaisons sont possibles entre des fermes de diverses grandeurs, on voit clairement dans les plus petites les plus grandes besoins de capital par unité de produit. Généralement dans l'agriculture, la somme du capital par unité de produit a la tendence à tomber grâce à des améliorations dans les techniques et aussi à cause du surcroît de la grandeur moyenne des fermes.

29. The Australian Wheat Growing Industry 1959–60 to 1961–2; the Australian Sheep Industry Survey 1954.

30. Some very high estimates prepared by Guttman and Gruen (Review of Marketing and Agricultural Economics, Dec. 1955 and March 1957), also quoted by O'Hagan (F.A.O. Monthly Bulletin June 1958) cannot be accepted.

31. Philpott, Australian and New Zealand Association for the Advancement of Science Proceedings Jan. 1957. All data expressed at 1949–50 prices.