INVESTMENT FOR FOOD

D. GROENVELD

STELLINGEN

I

In the process of preparing land improvement projects (irrigation, drainage, jungle clearance, etc.), the first steps should be taken by agronomists and agricultural economists, rather than by civil engineers.

II

Where physical conditions allow for a choice between irrigation by a reservoir-fed canal system, or by a set of tubewells, the latter is, as a rule, preferable on technical grounds.

III

Dissolution of tribal ownership and tribal use of land as effected by the Governments of Kenya and Southern Rhodesia is essential for progress in agricultural production.

(S. D. Neumark, Some Economic Development Problems of African Agriculture. Journal of Farm Economics. Feb. 1959. p. 45; and E. S. Clayton. Safeguarding Agrarian Development in Kenya. Journal of African Administration. July 1959. p. 148.)

IV

In designing a farm system which will give African farmers security of food supply, as well as an attractive cash income, careful attention should be paid to finding an equilibrium between the requirements and the availability of on-farm labor.

(E. S. Clayton, Labor Use and Farm Planning in Kenya. The Empire Journal of Experimental Agriculture. April 1960. p. 83 etc.)

V

The conclusion of the general report on the *All-India Rural Credit Survey* that the formula, "one (cooperative) society to one village" has failed, and that the future is with the building of bigger cooperative societies covering areas larger than a village has significance for several underdeveloped areas.

(The General Report of the All-India Rural Credit Survey. p. 233 and p. 178.)

VI

Belshaw's thesis that farm credit should be equally available on comparable terms in different areas and for different classes of borrowers, runs contrary to the policy advocated in several development plans.

(Dr. Horace Belshaw, Agricultural Credit in Economically Underdeveloped Countries. FAO, Rome. 1959. p. 89.)

VII

In estimating the net benefits of land improvement projects at farm level in peasant farm regions, one should limit oneself to estimating increases in cash expenses, since the full costs of peasant farm operations cannot be estimated to a satisfactory degree of accuracy for organizational and conceptional reasons.

(D. Groenveld. The Economic Evaluation of Land Development Projects. Netherlands Journal of Agricultural Science. Feb. 1959.)

VIII

The primary aim of adult education for farmers should be to raise the ability of managing an enterprise, since this is often the most important single determinant of farm income.

(Martin, Canter and Singh. The Effects of Different Levels of Management and Capital on the Incomes of Small Farmers in the South. Journal of Farm Economics. Feb. 1960. p. 101.)

IX

The most urgent problem for agricultural research in several underdeveloped countries is that of plant nutrition.

X

The work of agricultural experiment stations in tropical regions should, during the next decades, be directed toward the problems of establishing peasant farms producing subsistence for the peasant family as well as a cash income.

XI

Investments for food production in underdeveloped countries, tend to be inadequate, because:

a. several governments are biased to favor industrialization;
b. private capitalists expect higher returns from commerce and industry than from food production; and
c. peasants, as a rule, do not see why and how they should invest in their own farms.

XII

Albert O. Hirschman does not have a real argument against balanced growth; he merely favors a balance achieved after "incentives and pressures... create... further action" eliminating the unbalance, over a balance achieved after careful planning.

(Dr. Albert O. Hirschman, The Strategy of Economic Development. New Haven. 1958. p. 202, 203.)

D. GROENVELD

DIT PROEFSCHRIFT MET STELLINGEN VAN

DOUWE GROENVELD,

LANDBOUWKUNDIG INGENIEUR,
GEBOREN TE AMERSFOORT, 8 FEBRUARI 1908,
IS GOEDGEKEURD DOOR DE PROMOTOR

DR. TH. L. M. THURLINGS

HOOGLERAAR IN DE STAATHUISHOUDKUNDE

DE RECTOR MAGNIFICUS
DER LANDBOUWHOGESCHOOL
W. F. EIJSVOOGEL

Wageningen, 19 september 1961

INVESTMENT FOR FOOD

INVESTMENT FOR FOOD

PROEFSCHRIFT

TER VERKRIJGING VAN DE GRAAD VAN DOCTOR
IN DE LANDBOUWKUNDE
OP GEZAG VAN DE RECTOR MAGNIFICUS, IR. W. F. EIJSVOOGEL,
HOOGLERAAR IN DE HYDRAULICA, DE BEVLOEIING,
DE WEG- EN WATERBOUWKUNDE EN DE
BOSBOUWARCHITECTUUR,
TE VERDEDIGEN TEGEN DE BEDENKINGEN VAN EEN
COMMISSIE UIT DE SENAAT VAN DE
LANDBOUWHOGESCHOOL TE WAGENINGEN
OP VRIJDAG 20 OKTOBER 1961 TE 16 UUR

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VOORWOORD

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De meningen uitgedrukt in dit boek zijn voor de verantwoordelijkheid van de schrijver en mogen in geen geval worden gezien als de vertolking van het standpunt van de Wereldbank.

Silver Spring, September 1961

CONTENTS

SAMENVATTING

Wellicht is het voor de lezer nuttig in het kort te herhalen hoe onze cijfers zijn opgebouwd.

Allereerst is verondersteld, dat de bevolking van de drie onderontwikkelde landen tussen 1950 en 1980 zal toenemen met 1.9% per jaar of met 80% in de periode over 30 jaar.

Ten tweede is als waarschijnlijk aangenomen dat het reële inkomen per hoofd zal toenemen met 0,5% per jaar, wat zou betekenen een toename van 17% in 30 jaar. Aannemend een inkomenselasticiteitscoefficient van 0,6 voor voeding, zou de bovenbedoelde inkomenstoename resulteren in een grotere uitgave van het inkomen per hoofd aan voedsel en wel van 10%. De combinatie van deze twee factoren zou leiden tot een vergroting van de vraag naar voeding van bijna 100% in 30 jaar of 55% in de twintigjarige periode van 1960 tot 1980 of van 2,3% per jaar. Per continent is de toename der vraag over de periode 1960–1980 geschat op 60% voor Azië, U.S.S.R. en China niet inbegrepen, 70% voor Latijns Amerika en 50% voor Afrika.

Vervolgens is de aandacht gevraagd voor de wijze waarop de vereiste toename van de productie kan worden verkregen en een onderscheid is gemaakt tussen toename der opbrengst per eenheid areaal en een uitbreiding van het areaal landbouwgrond. Dit leidt tot een schatting van het aantal hectaren nieuw land, vereist in de drie werelddelen. De totale aantallen belopen voor de periode 1960–80: 40,6 miljoen hectaren bouwland en 77,9 miljoen hectaren weidegrond of samen 118,5 miljoen hectaren.

Cijfers over de investeringen, die nodig zijn om de aangenomen verbetering in opbrengsten en de aangenomen uitbreiding van het areaal teweeg te brengen zijn verzameld uit drie bronnen: nationale rekeningen, algemene ontwikkelingsplannen en bepaalde projecten. Er zijn indicaties

dat toename in de productie van 2% per jaar in het verleden verkregen is door middel van een gemiddelde investering van 9 dollar per hectare bouwland of 3,5 dollar per hectare landbouwgrond (weidegrond inbegrepen). In de ontwikkelingsplannen van een aantal landen werd als gemiddelde een overheidsinvestering van 5 dollar per hectare bouwland of 2,5 dollar per hectare landbouwgrond aangenomen. Deze indicaties leiden tot de conclusie dat in de periode 1950–60 per jaar ongeveer 7,6 miljard dollar werd geïnvesteerd in de drie werelddelen tesamen. Waarschijnlijk werd iets minder dan de helft van dit bedrag door particulieren geïnvesteerd.

Daar naar onze mening de productie in de periode 1960–80 10% sneller moet toenemen dan in de afgelopen 10 jaar, werd als een eerste benadering het benodigde investeringsbedrag per hectare verhoogd tot 10 dollar per hectare bouwland of 4 dollar per hectare landbouwgrond. Deze cijfers zijn gebruikt voor een eerste grove schatting van het totaal der benodigde investeringen in de periode 1960–80. Dit totaal wordt geschat voor de drie werelddelen tesamen op 8,6 miljard dollar per jaar, waarvan 5,9 miljard dollar overheidsinvesteringen.

Daarna is een poging gedaan om te scheiden wat nodig is voor het in cultuur brengen van nieuw land en van wat nodig is voor de verbetering van land, dat reeds in gebruik is. Dit is gedaan met behulp van cijfers over een groot aantal afzonderlijke projecten. 'Vuistregel'-cijfers voor verschillende soorten van investeringswerken zijn toegepast in drie hypothetische landontwikkelingsplannen, één voor elk werelddeel. Het blijkt dan dat het openen en gebruiksklaarmaken van 118,5 miljoen hectaren nieuw land in totaal 51,9 miljard dollar zou kosten, of 438 dollar per hectare. Dit werk zou dus 2,6 miljard dollar per jaar opeisen. Daarenboven zou per jaar 4,3 miljard dollar door de overheid besteed moeten worden aan maatregelen en werken voor de verdere verbetering van het bestaande landbouwareaal en wel op basis van 2 dollar per hectare. De totale jaarlijkse overheidsinvesteringen voor uitbreiding der voedselproductie zouden dan 6,9 miljard dollar moeten bedragen, of 138 miljard dollar in de 20-jarige periode. Ongeveer 30% van dit totaal zou in buitenlandse betalingsmiddelen besteed moeten worden.

INTRODUCTION

I.1. Purpose of this Study

This study discusses the factors which determine at what level investments for food production should be made to ensure the growth in the supply of food in line with effective future demand. Furthermore, it endeavours to give an approximation of the magnitude of such investments. Finally, a comparison is made between the estimate, resulting from the study, and similar earlier estimates.

A forecast of the population growth and of the increase in prosperity [1] are being used here as factors determining the growing demand for food. It is assumed implicitely that investments required to bring about the above-mentioned increase in income will be provided one way or another. The problem of distribution of the total investments among the different sectors of the economy is not being discussed in detail. It is felt that the discussion can be restricted to an estimate of the impact of the population growth and increase in prosperity on investments in the production food. For the purpose of this study, investments in food production are defined as annual public and private expenditures for the purchase or improvement of implements, machinery and livestock utilized in such production; for the construction of permanent works, such as farm buildings and land improvements; and in inventory changes. The total of these items represents gross investments convertible, by deducting depreciation, into net investments.

An average value of income elasticity has been used in estimating the impact of the increase in prosperity on the demand for food. This method

[1] Level of per caput income.

presupposes that the relative price of the food-basket does not change, so that price-elasticities do not interfere with our analysis.

Some increase in absolute agricultural income, in line with the developing economy, is included in our hypotheses, as well as some development in agricultural techniques which is needed to offset the influence of the above-mentioned increase in agricultural income on the costs of agricultural production.

I.2. Emphasis on Economic Problems

Although technical problems are being touched upon in subsequent chapters, the nature of this study is primarily an economic one in view of the fact that it deals, as mentioned before, with an estimate of the investments required in agriculture for food production purposes. This study focusses on the investment problem, yet, organizational, institutional or technical questions are not considered unimportant. They are probably equally as important as the question of investments itself. However, this last question has not been given sufficient attention in postwar discussions. It has been mentioned but only "en passant" and, mostly in qualitative terms. Where figures were given they were derived from overall estimates.

Moreover: one must restrict oneself, and this one question of investments in foodproduction is large enough for one study.

Many publications have shown clearly that the soil can produce much more food than it does now. And the sea can supplement, whatever deficit there might be. However: "the question is not whether we can produce enough, but rather at what cost", as Byran T. Shaw, administrator of the Agricultural Research Service of the U.S. Department of Agriculture, put it bluntly [1]. The United Nations Secretariate expressed the same thought in somewhat more detail in its 1957 Report on the World Social Situation [2]. The report says in substance, "that it is clear that the technological obstacles to a further expansion of output are not insuperable. This is not to imply that such further expansion may be taken for granted. To the contrary", the report continues, "there is a continuing need for planned efforts to raise food output far beyond present levels, if satisfactory food standards are to be reached in future years. Land reforms, irrigation, provision of more fertilisers and better seeds, must be pushed forward with equal if not greater vigor than in the

recent past. Most of all, there is a need for a larger volume of foreign capital in those countries where domestic resources are at present inadequate for agricultural development and are likely to remain so for many years", thus this U.N. report. The last mentioned factor should be put somewhat broader: it is not only the need for foreign capital that ought to be met, but it is in general the need for investment capital as such, local and foreign.

It is assumed that the overall required investmentfunds will be available in one way or another and the study concentrates on the problem of the allocation of an adequate portion of the total to agriculture for food-production.

The alarming rate at which the population increases, in what one is accustomed to name the underdeveloped areas, will be discussed in chapter 3. It suffices here to state that whereas until say 50 years ago the increase in population in agricultural regions in underdeveloped countries was closely conditioned by the size of the crop, this link has, in our day, lost much of its strictness as a result of the introduction in such areas of simple modern health measures. In the past, crop failures resulted in lowering the resistance of individuals to disease which caused a high mortality rate. Modern sanitary measures and medical care prevent the large-scale spread of disease, thereby lowering the mortality rate. This is, of course, in itself a fortunate development, but it tends to accentuate the problem of how to expand food production fast enough so as to keep pace with the population growth.

Health measures have had little influence on the birth rate, but they have indeed prevented many millions from dying an untimely death. "Public health measures are enormously productive in these early stages of application. The death rate may fall, and the population begins to rise, putting pressure on the food supply and the institutional structure of agriculture" [3]. The consequences of the application of health measures are clearly set out in the U.N. report referred to above. This report reads, in part: "It will require a dramatic increase in food supplies to feed the population of the world at the current levels of consumption in, say, 25 years from now. Supplies of cereals for instance, would have to be increased by some 300 million ton or 43%. If the population of Asia [1] is

[1] Near East and Far East.

to be fed at slightly improved levels, the supplies of cereals on that continent will have to increase by about 80% in 25 years. The corresponding figure for Latin America would be about 45%" [4].

The rapid growth of the population obviously does not only affect the demand for food, but also the requirements for capital. The faster the population increases, the larger must be the portion of the annual national income [1] to be invested in the maintenance alone of the stock of production equipment at the existing per worker level [5]. This point will be further discussed in chapter 1.

I.3. The Setting of our Problem

The problem may be sketched roughly as follows: The population of hitherto underdeveloped countries will be growing rapidly. In one way or another, economic progress will be achieved. The demand for food will increase with the increasing population and improvements in diet, as a result of economic progress. So as not to interfere with the progress of economic development the relative price of food must be kept stable. What are the sums that should be invested in agriculture, either in opening up new lands or in improving agricultural areas that are already producing?

I.4. The Organisation of this Book

The impact of the magnitude of gross domestic capital formation on the rate of economic growth, and the influence of the rate of the population growth on this problem are discussed in chapter 1. It also sheds some light on the question of the share of agriculture in national income and in capital formation. Chapter 2 endeavers to make clear why it is necessary to pay special attention to the allocation of investments to foodproduction. It appears that one cannot except an automatic adjustment.

I.4.1. THE RECENT PAST AND THE SUPPLY FACTORS

The growth of the population and of foodproduction in the recent past, together with a discussion of factors influencing food supply in certain

[1] Assuming no change in the amount of capital required to produce one unit of food.

regions form the subject of chapters 3 and 5. It appears that in most regions per caput supply has improved slightly since pre-war years. There has also been some improvement in diets in some regions. There is no room for complacency however, since large numbers of people are still inadequately fed, and also in view of the expected increase in numbers of consumers. From a discussion in chapter 6, of exports and stocks of major commodities it appears that the great bulk of the supply for continents is produced on those continents themselves. Exports and imports make a difference of only a few percents of total supply. There are good physical and economical reasons why this has been so in the past, and why it will be the case in the foreseeable future. One reason is that it is in general advantageous to make people continue to work in the sector of the economy in which they are accustomed to work [1]. Secondly a rapid expansion of exports from "new" countries encounters often the technical problem, that these "new" countries are not easily able to supply products of the quality that can compete with the products of the advanced countries. These countries will moreover for reasons of internal stability not open their borders completely for the products of the new exporters. Thirdly an enlarged importation of food from the developed countries, with a simultaneous diminishing of other imports, is not desirable in a period of economic growth, as this diminishing of "other" imports would necessarily effect to a large degree the import of capital goods. This indicates that the existance of "surplusses" in some countries does not really solve the problem of how to make sure that there will be enough food for the populations that are expected by 1980 in such continents as Asia, Africa and Latin America. Basically the problem of populationgrowth and foodproduction is not a worldproblem: it is a problem of certain regions and certain countries.

I.4.2. DEMAND FACTORS

Chapter 4 deals with estimates about the expected increase in population and it includes the most recent U.N. forecasts. These figures are much higher than earlier estimates, which adds to the urgency of our problem. Most of the numerical increase will be in Asia, but Africa and Latin America are expected to show very rapid percentage-wise growth.

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[1] The principle of continuity.

Food habits are likely to change gradually as the process of economic development unfolds [1]. The demand for "protective foods" will increase more than the demand for starchy basic foods. This trend will be clearer in North America and Europe [2] than in Asia, Africa and Latin America. Although this difference in demand-development is recognised, lack of data make it impossible to differentiate between the growthtrends in the demand for various types of food.

This study refrains from using an "ideal" diet while forecasting demand: past trends are simply extrapolated into the future. This is probably more realistic, than basing demand forecasts on what people "should" eat.

A discussion in chapter 8 of various technical possibilities to increase the production of food reveals that it will easily be possible from a technical viewpoint to satisfy demand in 1980, and thereafter. The problem is however, how to take advantage of the various technical solutions to the problem. Various organisational, educational, institutional and financial difficulties must be overcome in the effort to keep foodproduction increasing at a "sufficient" rate.

Some of the difficulties in estimating the "required" volume of investments are tackled in chapters 8, 9 and 10. As a first step the required increase in supply is divided into a part that can be satisfied by increases in yield of land that is already in production, and a part that will have to be produced on additional land. Future increases in yields are not estimated on the basis of what could possibly be achieved in 1980 if everybody concerned did what he ought to do according to the standards of agricultural sciences. As in the case of diet, past trends have been extrapolated, taking into consideration however that the movement to give farmers good technical assistance gains momentum and will have a greater effect in the next 20 years than it had in the recent past.

Past improvements in yield per unit did not occur without effort. To the contrary, they are the result of continuous research and educational work, and of a long series of investments in equipping the farm-area, improvements of land, equipment, livestock, buildings and storage facilities. Two sets of figures on investments are discussed in chapter 9. One is about

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[1] See: chapter 7.

[2] And among the small better off groups in the underdeveloped areas.

overall gross investments in agriculture, based on national accounts of various countries. The other is about planned investments in agriculture, according to developmentplans of a number of countries. The total figures have been converted into amounts per hectare agricultural land. They [1] give an indication of the level of investments that helped create the recent trend in agricultural production.

A third set of figures is produced in chapter 10. This one refers to specific projects designed to increase the area of farm land, or to improve the productive capacity of such land, or to help in other ways to improve or increase agricultural production. Many of the figures refer to projects that have been considered by the International Bank for Reconstruction and Development (IBRD). These figures have been used to estimate, on the basis of hypothetical land development programs, what investment would be necessary to create new facilities for the production or storage of food.

All estimates have been made for Asia, Africa and Latin America, because these will be the three critical areas, with respect to the expansion of foodproduction. In Europe, Australia and North America there are to the contrary already "surplusses" and production will increase on these continents sufficiently.

I.4.3. RESULTS OF ESTIMATES

It would appear from our estimates that for the 20 year period 1960–1980 a sum of about U.S. 138 billion dollars would have to be invested mainly in public works to help foodproduction in Asia, Africa and Latin America to increase at a "satisfactory" rate. About 86 bln. dollars should be spent on improvements on existing farms. For expansion of the farm area will have to be spent a sum of 52 billion dollars. The annual total would be 6.9 bln. dollars, 3.4 bln. dollars of which in Asia.

These figures are considerably higher than former estimates, but they are considered to be more realistic, and more up to date [2].

Although the study culminates in these estimates the main purpose is

[1] Specially the first set.

[2] See chapter 11.

to underline the need for more investments in foodproduction, despite "surplusses", and to demonstrate a way in which an estimate of the required investments could be made. The study raises probably more questions than it answers. It shows at how many places reliable information is lacking. The need for such information is very urgent. All those concerned in one way or another with the planning of the allocation of resources to various fields of economic development would benefit if work by a large research-unit would augment our understanding of the problem of this study, and would in time develop a fairly reliable estimate of the required "investments for food". An outline of the required research is briefly given in chapter 12.

CHAPTER 1

THE NEED FOR INVESTMENTS IN AGRICULTURE

1.1. Population Increase and Required Investments

An aim of this study is to show a method that can give a reliable quantitative estimate of the investment to be made in food production [1] in underdeveloped regions. It is, therefore, right to try to clarify beforehand some of the relations between national income, savings and investments, consumption – total and of food – and population.

Before doing this, however, it would be useful to introduce the concept of the capital/output ratio.

1.2. Capital/Output Ratio

The capital/output ratio, c/o ratio, is a convenient tool used in discussing the need for certain investments to achieve a given goal in production. There are two types of c/o ratios. The first type may be defined as the ratio of total existing capital stock to annual output, or, average c/o ratio. The second type may mean the ratio annual capital formation to annual increment in output, incremental c/o ratio or ICOR. Both ratios are useful instruments in discussing economic growth problems. However, one should use them very cautiously, because the statistical basis for any c/o ratio is very weak.

A report prepared by the Organization of American States (O.A.S.) gives some idea about the order of magnitude of c/o ratios [1]. It seems

[1] Primary food production in agriculture only; production in manufacturing industries has not been included. Principally, fishing and forestry have not been included, but it is possible that some of the over-all figures on investments in agriculture include fishing and forestry. Those figures include also investments for the production of fibers, rubber a.o. raw materials, and it is impossible to eliminate them.

that for Latin America the c/o ratio was 2.5 for the period 1950–1956. It fluctuated, of course, from year to year. For Columbia, the ratio varies from 3.4 to 2.9; for Mexico, from 2.5 to 2; and for U.S.A., from 5.1, in the great depression, to a minimum of 1.9 in 1944/45. Meier and Baldwin [2] collected data on c/o ratios for underdeveloped countries and they found a range from 2 to 5, or even 6 to 1 for the non-agricultural sector.

The c/o ratio for any one year is not very meaningful. It should be studied preferably in a series of progressive averages, and the autonomous improvement of labor productivity should be eliminated as much as possible. It will then appear that the c/o ratio for large aggregates tends to be fairly constant [3]. As a rule of thumb, one could accept for agriculture in general, a ratio of 4:1. There are, however, numerous variations from nation to nation, especially in the agricultural sector.

The Economic Commission for Asia and the Far East [4] has published some examples of general incremental c/o ratios for countries in it's region.

TABLE 1. *Incremental capital/output ratios in Asia*

Burma	Period 1950/51–1955/56	2.7 to 1
China Mainland	1952–1956	2.8
India	1951/52–1956/57	1.8
Indonesia	1956–1960 (plan)	2.3
Japan	1952–1957	3.4
Philippines	1952–1957	0.6
Thailand	1952–1957	3.0

1.3. A Development Formula

The Economic Commission for Asia and the Far East (ECAFE) presented a table clarifying the relations between capital requirements, increase in population and the increase in per caput income, if the capital output ratio is given [5]. (See table 2)

This table is constructed on the basis of a formula, which is greatly used today, and which can be found in many publications [6]:

$S = K/Y\,(\Delta N + \Delta H)$

where

TABLE 2. *Capital Requirements (if, according to ECAFE, ICOR is 3 to 1)*

	Planned % Increase in Per Caput Income	Increase in Population	Capital Requirements
a.	1% per year	0% per year	3% of nat. income
	1	1	6
	1	1.5	7.5
	1	2	9
	1	2.5	10.5
	1	3	12
b.	3	0	9
	3	1	12
	3	1.5	13.5
	3	2	15
	3	2.5	16.5
	3	3	18

S = percentage of national income saved [1]
K/Y = capital to national income; capital coefficient
ΔN = percentage increase in numbers
ΔH = percentage increase in income per capita.
This formula can be used under the hypothesis of a constant capital/output ratio, which was done by ECAFE.

The relations developed above can help to explain four simple cases of development.

1.4. Four Cases as Examples

Case a refers to a static economy. In this situation the population has to make investments only for the replacement of worn out capital goods. Some of these goods may last 5 years; others 20 or even 50 years. Let us assume that the average useable life of capital goods in 20 years. This would call for the replacement of 5% of the capital stock per year. Assume further, for simplicity's sake, that the value of capital stock is equal to the gross national income [2]. In this case, the economy would have to set aside 5% of its gross national income per year for investments.

[1] And invested.
[2] C/o ratio = 1.

This case does not resemble the actual situation in underdeveloped regions in any way. The population and national income are increasing, be it that income per capita is improving slowly and should be improving more rapidly. As a result of this factor, consumption per capita is increasing as a whole, and its composition is also changing. Gradually, a smaller portion of income will be spent for food, and a larger portion for industrial goods and services. How do these changes effect the percentage of income to be spent on investments over the various sectors of the economy? Discussions of cases b, c and d may provide some preliminary insight into this matter.

Case b. The population will increase by 20% in 10 years, but the per capita income will remain constant. Total consumption would thus be 20% larger at the end of the decade than at the beginning, and the capital goods would have to be expanded in order to produce this extra 20%. For simplicity reasons, we ignore the possibility of greater efficiency in the use of capital goods and the time lag between investment and the beginning of full production.

Assume that the capital/output ratio for additional production or ICOR is 3:1 [1] so that the economy would have to spend three monetary units on additional capital goods to produce one unit of consumption goods in one year. Then it would have to create in order to achieve a 20% increase of total income over a 10 years period an annual income increase of 1.7% [2] and therefore the annual net investment would be 5% and the total gross investment would be 5% plus 5% for the replacement, or 10% of the annual gross national income.

Case c. The population will increase again by 20% in 10 years and per caput income will also improve by 10%. Total consumption would, at the end of this period, be 132% of the volume shown at the beginning of the period. Under the same assumptions stated in case b, with respect to the relation between needed capital and income [3], the economy would have to spend on new investments about 7% of the annual gross national income. Total investments would have to be 7% plus 5% for replacements, or 12% of the annual gross national income.

[1] It will tend to be higher than 1, because of the effect of the Law of Diminishing Returns.

[2] On a compound interest basis.

[3] 3:1.

Case d. The growth rates are the same as stated in case c, but we assume now that the improvement in the volume of consumption will be followed by a shift from food to industrial goods and services. This would not necessarily effect the total volume of investment, but it might cause a shift in the distribution of investments between the different sectors of the economy. This depends upon the ratio of capital to income in agriculture and in industry. If both ratios were identical then we would have to say "will cause" instead of "might cause".

In case the increment in food supply would have to be produced on the area already in production with traditional techniques, a rise in the c/o ratio would have to be expected, and it would be likely that agriculture would require more than its share of gross national income for investments. Improvements in techniques and an expansion of the area might result in a lower c/o ratio.

In summarizing, we can now say that case a shows a constant demand for agricultural produce; case b a growing demand for agricultural produce, proportional to the increase in population; case c a growing demand for agricultural produce proportional to the increase in population and per caput income; and case d shows a growing demand, depending on an increase in population and per caput income; the effect of the first factor is proportional, but that of the second not. It appears then that the growth in demand for agricultural produce depends on:
the increase in population
the increase in income
the income elasticity [1] of agricultural products [2].

1.5. Gross and Net Capital Formation

In cases b, c and d a distinction was already made between investments for replacements and for expansion and improvements. This is reflected in the terms, gross capital formation and net capital formation. The difference is the amount of investment necessary to keep the capital stock in operating condition. This was the only investment made in case a.

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[1] Income elasticity is the percentage change in expenditures for a good or category of goods, or services, if income increases by 1%. See further chapter 7.

[2] The relative price level of agricultural products to other goods, given as constant.

In bookkeeping terms, this is called "depreciation", but in this context can be named capital consumption. The share of gross capital formation to be used to offset capital consumption varies with the composition and character of the stock of capital goods. It is likely to be lower in countries in early stages of development than in highly industrialized countries, in as far as in the first group much of the capital stock exists of goods of long duration like landimprovement works, roads, canals, urban development. Nevertheless capital consumption in Latin America seems to be of the order of 8–9% of net national product, or 35–40% of gross capital formation [7]. Gross capital formation has, for the countries concerned, been estimated at over 20% of net national product.

1.6. Starting the Process of Economic Development

Case c above can only apply to a country that is involved in a process of economic development. But what are the conditions to be fulfilled before a country enters this stage? Rostow [8] threw new light in this question by introducing the term "take-off". He gives three definitions of "take-off" which do not cover each other completely, but which taken together characterise the phenomenon well. "Take-off" is the relatively brief time interval of two or three decades wherein the economy, and the society of which it forms a part, transforms itself in such ways that economic growth is subsequently more or less self sustained. It is also a period of economic revolution, tied directly to radical changes in methods of production. In the third place it is the period during which the rate of investment increases so that real output per caput rises significantly, with the result that thereafter the rising trend in per caput output is perpetuated. As a rough indication Rostow classifies a number of countries in three groups: those with pre-take-off economies, which have a ratio of investment to net national product of about 5%; those attempting take-off, with an investmentratio of 5% to 10%, and thirdly the group with growing economies and investmentratios of 10% or more. A jump of the ratio of investment to net national product from 5% to over 10% is considered by Rostow a necessary condition for take-off [1] [14].

[1] ROSTOW gave a general review of his growth theory in *The Economist* of August 15 and 21, 1959. He explains here again that one of the conditions for "take-off" is an investmentquote of more than 10% of national income.

The continuation of economic growth after take-off asks not only for a certain level of investments, but also for the fulfillment of three conditions:
a continuous re-adaptation of the sectors of production to the demand that belongs to the shifting level of income;
a continuous development of the technique, so that even with a constant population, and a constant area the productionfunction of capital is continuously moving upward. This means in essence that men have to be willing and able to produce new things and to apply new methods of production [1];
a loosening of the institutional environment of men, which will make them free to develop new habits of production and consumption.

1.7. The Rôle of Agriculture in the Take-Off

It will be clear that the beginning of economic development asks for a social and socio-psychological revolution. Acquiring a certain level of investments alone is not enough, the other conditions must also be fulfilled. There should be an active entrepreneurial class, which is able and willing to invest and to use the created capital goods efficiently [10].

If we try to apply Rostow's theory to agriculture the prerequisite for an agrarian revolution would be a class of larger commercially minded farmers. Agrarian revolutions have generally preceded or accompanied the take-off, but a wider-based revolution in outlook must come about after the initial period. The agrarian revolution made possible the feeding of the rapidly growing and urbanising population, thereby creating a labour force for industry.

In this way Rostow helps to clarify the link between our specific problem and the general problem of sustained economic growth. Most underdeveloped countries have basically an agrarian economy. They must increase the productivity of their agriculture if they are even to expand their national income at such a rate that per caput income increases sufficiently to enable people to save enough for futher expansion. Improvement of the productivity of agriculture will have two immediate effects. It will make people available for non-agricultural jobs, and it will produce food for the non-agricultural population at reasonable prices.

[1] Research, education, and advisory work.

Both effects are explicitely mentioned in a report of the Government of South Rhodesia on its plan to develop African agriculture [11].

Strong emphasis on the need for development of food production together with industrial production is expressed by Meier and Baldwin [12]. They establish three criteria for evaluating investments:
they should be directed to "growing points", that is to areas that promise rapid growth;
investments that have a favorable effect on the balance of payments should have priority;
growth has to be more or less "balanced".

The concept of "balanced growth" and its relevance for this study will be discussed further in 2.2.

1.8. Changes in Consumption Patterns

In case d, we introduced the complication that there tends to be a shift in the way in which people spend their income as it increases. A few details of this process will be discussed in chapter 7. However, some general aspect should be mentioned here, using concepts introduced by Theod. W. Schultz. For his discussion, he divides the economy into two sections: the agricultural sector and the balance of the economy. The firms and households in the agricultural sector are supposed to buy only non-agricultural products and services and to sell only farm products to the rest of the economy [13].

The supply and demand curves of these two broad groups of products may change in different ways in countries which are in various stages of development. With respect to the supply and demand fo farm products one can distinguish three cases. They may move up at the same pace; demand may outrun supply or supply may outrun demand. The first case is the situation for which we make our calculation about needed investments in agriculture. As we will discuss further in the next chapter, there is no automatism which guarantees this perfect balance in growth of demand and supply. This is also Schultz's opinion, as shown in his theory about the other two cases. Case two is, according to Schultz, the situation with which the older English economists like Ricardo, Malthus and Mill were concerned. Schultz presents their train of thought essentially as follows:

national production increases for some reason, which in turn increases the supply of capital;
consequently the fund available to pay wages becomes larger;
demand for labour improves, and wages increase;
higher wages induce a growth of population and thus the demand for food expands;
production of food has to be increased by using poorer land, which gives diminishing returns on the additional inputs of capital and labour [1];
consequently rents increase, profits decrease, real wages return to their former level, but in the process, a larger share in national income has been acquired by the landowners.

This train of thought was, as stated before, developed in old England but it still applies to a certain extend to underdeveloped countries.

The third case applies most clearly to the U.S.A. Here the supply tends to outrun the demand over a longer period. This situation occurs when there is a slackening in the rate of increase of the population, when the income elasticity of farm products is low, because people are relatively well-off and when large scale advances in techniques are applied in agriculture [14].

Schultz then turns to a phenomenon we have mentioned already. As incomes rise a smaller portion is spent for food, in other words, the income elasticity for food decreases while the economy develops. Moreover people will be asking for more additional services [2]. This tends to decrease the share of the farmer in the consumer's dollar.

Here Schultz makes a distinction between areas in early development and well-developed areas. He uses the following examples. Suppose that the population increases by 20% in a decade and that income per caput rises by 25%, while the income elasticity for farmproducts is 0.75. Under these conditions, and "ceteris paribus" the demand for farm products would increase by 42.5%.

Suppose for a different stage of development that the population increases by 14% in a decade, and that per caput income improves by 33% in that period. Income elasticity for food is supposed to be low in this situation since income is relatively high, and it is fixed at 0.25. The

[1] Law of Diminishing Returns.

[2] Better stores, fancy packing, semi-prepared state of foods.

demand for farmproducts would in these conditions in a decade expand by only 23.4%. This situation resembles the present day position in the U.S.A. [15].

Continuing his analyses Schultz distinguishes between three types of countries:
the high food drain type; 75% or more of income is spent on food; this is the pre-industrial group of economies;
the intermediate food drain type; 25–75% of income is spent on food; this is the group of economies in the transitional stage;
the low food drain type; 25% or less is spent for food; this is the situation in the industrial economies [16].

In general, economic development is associated with industrialisation. As development progresses the relative contribution of agriculture to national income decreases. This is illustrated in annex 1, which shows that agriculture contributes 50% or more to net national product in underdeveloped countries. The percentage is 30–40% in the intermediate group, and it may drop to 10% or even less in the highly developed countries. The table also shows that in almost all countries the percentage contribution of agriculture decreased from 1950 to 1957.

1.9. Share of Agriculture in Investment

Off-hand, one would expect the proportion of investment allocated to agriculture to be about equal to the percentage contribution of agriculture to net national product. This is, however, not so.

Annex 2 gives some statistical information on this subject. Although there are only three really underdeveloped countries listed in this table, one might deduce that the share of agriculture in investment is about 30% in underdeveloped countries as against a 50% contribution of agriculture to national income [1]. A share of 30% is, however, probably too high as an average. The World Economic Survey, 1959, lists eight semi-developed countries where the share of agriculture in Gross Domestic Fixed Capital Formation ranges from 6% to 27% of the total [17]. Also, in developed countries the share of agriculture in investments is generally smaller than the percentage contribution of agriculture to national

[1] See: annex 1.

income. Furthermore, the percentage allocated to agriculture decreased in most countries from 1950 to 1957, as the economies are shifting from agriculture to industry, mining and services.

A better estimate of the magnitude of "investment for food" would be available if the investments for food storing, trading and processing were added to investments in farms, but such figures do not exist. The concept of "agro-business" is not yet sufficiently familiar to have such investment estimates available [1] [18].

The relatively small allocation of investments to agriculture is not necessarily in all cases alarming since in the process of development the demand for non-farm goods and services will rise faster than the demand for food, as Schultz helped us to see.

Also a more rapid decline of the share of agriculture in investments than of the contribution of agriculture to national income would not be alarming if by a special development of the technique of agriculture the ICOR of agriculture would be lower than the ICOR of industry [2]. It is, however, necessary to warn against complacency since agriculture, operated in general by private, one-man firms, often has difficulties in attracting capital, and also since the farming group sometimes shows little willingness for self-investments. Moreover there are several countries where the authorities directing public investments have a preference for industry instead of for agriculture.

It is possible that in the planning of development too little attention is paid to investments for foodproduction, and this might, if and where it is the case, cause serious difficulties. It might even endanger the unfolding of the development process. This problem is discussed further in chapter 2.

1.10. The Need for Foreign Exchange

Almost by definition underdeveloped countries have to spend a large share of their investments in the form of foreign exchange in order to import machines, raw materials and technical services for the establishment of capital goods. The Organisation of American States gives in its

[1] "Agribusiness" is the sum total of all operations involved in the manufacture and distribution of farm supplies, production operations on the farms, and the storage, processing and distribution of farm commodities and items made from them.

[2] See also case d, in 1.4.

already mentioned report [19] two estimates which help to form an idea of the magnitude of this problem.

In the first place O.A.S. has estimated what portion of gross domestic investments had to be spent in recent years on import of capital goods.

TABLE 3. *Portion of investments spent on imports of capital goods*

Country	Period	Percent of gross domestic investments
Brazil	1939–1954	20–45%
Chile	1940–1954	28–62%
Columbia	1939–1947	32–36%
Mexico	1947–1956	30–47%
Latin America	1946–1953	37.6%

The United Nations Secretariate made similar estimates for the period 1950/51 to 1957/58 and found that in eight less developed countries imports of capital goods account for 25% to 78% of the Gross Domestic Fixed Capital Formation [20].

The Organisation of American States also estimated the portion of capital goods imports in total imports for the period 1953–1957. It varied from 19% for Cuba to 62% for Venezuela. For most Latin American republics it fluctuated between 30% and 40%. For Latin America as a whole, and for the period of 1946–1953, the percentage of capital goods imports was 39.4% [21].

The United Nations report concludes that "It is apparent that variations in the share of food in total imports frequently were partially offset by variations in the share of capital goods". It cites India as an example. "It appears, therefore, that in food-importing countries, deficiencies in domestic food production have often adversely affected the level of investments through limiting imports of capital goods" [22]. This explains, in part, why the governments of so many underdeveloped countries are so keen on arranging for foreign capital to help finance their development.

CHAPTER 2

ALLOCATION OF INVESTMENTS AS A PROBLEM OF POLICY

2.1. The Concept of Investment Allocation

In the former chapter the term "allocation of investments" to agriculture or to other sectors of the economy has been used rather loosely. The word "allocation" can be used in the very wide sense of any decision, taken by no matter who, about the use of the available product or the possible investments. A narrower interpretation of "allocation" is, however, used here. In this study "allocation" refers to the activities of an authority [1] who by his decisions determines how much capital will be used for various purposes.

One may ask legitimately: is there really a question of allocation; is not the distribution of investment funds exclusively the result of the interactions of marketfactors? or anyway should it not be so?

If one had to assume that investments in underdeveloped countries in the next few decades would be made only on the basis of market considerations, then the argument of this study would be quite different from what it is now. In that case the discussion might be about the question whether there would or would not be a large demand for investment funds from the producers of food. The discussion is however rather about the question whether those authorities that influence in some way the distribution of investment funds would do wise to allocate to foodproduction larger sums than they might be expected to allocate to this purpose on the basis of recent past experience. Apparently it has been assumed implicitely that there is a question of allocation, at least to a certain degree, but it is proper to state this here explicitely.

No matter whether one approves of it or not, the fact is that in most

[1] As distinct from a multitude of private people.

countries governments have a certain degree of influence on the distribution of investment funds. This applies of course fully to the allocation of public funds; governments, however, influence also to a larger or smaller degree the direction in which private funds are invested.

2.2. Balanced Growth, a Problem or a Spontaneous Process?

One important reason for the lack of growth of economies or sectors of economies, is that the market for their product is so small that there is no reasonable prospect of a satisfactory return on investments. This difficulty vanishes, at least in principle "in the case of a more or less synchronised application of capital to a wider range of different industries" [1]. In that case the result will be an overall enlargement of the market, and people working on a number of complementary projects become each others customers. "Such a development is labelled balanced growth" and the case for it rests on the need for a "balanced diet" [1].

As mentioned already in chapter 1 Meier and Baldwin emphasize the need for balanced growth [2]. Their discussion develops in a somewhat condensed form as follows: agricultural development and industrial development are complementary, and the rate of industrial development is largely dependent on the rate of agricultural development. Greater employment in non-agricultural sectors will result in a larger demand for foodstuff in the marketplaces. Prices will rise, income of farmers will improve, and they will tend to increase their consumption of nonfarmproducts, and of foodproducts. The supply of food must therefore rise rather rapidly in order to avoid an relative increase in foodprices.

Not every author on economic development is in favour of the idea of planned balanced growth. A. O. Hirschman for instance does not believe that it is possible to attain by way of planning a proper balance, and he favours definitely unbalance [3]. Fleming points to the many difficulties one must expect, if one attempts to initiate balanced growth. Especially the in-elasticity in the supply of capital from abroad [1] tends to render the

[1] In the opinion of the present author it is not in the first place a matter of in-elasticity but of restricted liberty to use foreign capital, since the inflow of capital is often tied to specific purposes.

doctrine of balanced growth inapplicable [4]. However, acknowledging the difficulties, balanced growth seems still a goal worth aiming at.

Once the desirability of balanced growth is recognized the question arises whether such growth can be expected to develop as a spontaneous process, or whether a certain amount of government guidance and interference is required. Nurkse [5] indicated that in the countries which develop early, and without much positive action of their governments, this development was initiated and sustained by an active, commercially minded, middle class. Such a class is virtually not-existent in the backward countries of to-day.

Those that might act as entrepreneurs in the modern sense of the word are often not willing to do so, because of the large and, to them, unknown risks. The government will in that situation have to bear part of the risk of starting new enterprises at least for the begin-period. This is for instance the rôle of the Development Corporation in Pakistan [6].

Another reason why the state may have to play an active rôle in a development process is the need for the creation of a large amount of social overhead capital. Even in the United States of the 19th century the government was active in this field, although part of this capital was created by private companies [7].

The main argument in favour of a certain degree of government guidance and assistance is however that the development effort has to be of a certain minimum magnitude in order to have sufficient impact. There is supposed to be a "critical minimum effort" [8]. This effort [1] needs capital investments on a scale and of a type, that will only be possible through joint efforts of the underdeveloped countries, and of those advanced countries able to provide large scale capital investments [2] [9]. Such efforts can only be organised by, or with the help of, governments.

It can thus be accepted that balanced growth will as a rule not be a spontaneous process; it will have to be guided and assisted by governments, and it involves therefore problems of policy.

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[1] There is a close link between this concept and Rostows idea of a "take-off", see chapter 1.

[2] MEIER and BALDWIN are here quoting B. HIGGINS, *The Dualistic Theory of Underdeveloped Areas.*

2.3. Two Categories of Investments: Public and Private

Although the various types of investments required for a proper development of agriculture will be mentioned in chapter 9, it is useful to distinguish here between two main categories: public investments and private investments. The reason is that the set of factors which determine the distribution of available funds is quite different for each of these categories.

With respect to public investments considerations of direct rentability or profitability play only a remote rôle, although they are not completely excluded. Some governments for instance use estimates of expected taxrevenue as a criterion for the distribution of funds over various irrigationprojects. This is, or was at least, the case in India. In general however, one can say with Dosser [10], that the allocation of public investments is more based on socio-political ideas and on the bargaining strengths of certain groups, than on economic criteria.

One would expect this to be the case to a lesser degree in countries where development is guided by a plan, than in countries where no plan – yet – has been formulated. In practise there is, however, not too much difference. In the first place there are many documents that bear the name "plan" but which are in fact not more than more or less well considered lists of proposed projects. Politics, considerations of geographical distribution and efforts of "pressure groups" have usually a great and rather unchecked influence on the composition of such lists of projects. In the second place: socio-political considerations are taken into account in the preparation of even very well-designed plans; no realistic plan can be based exclusively on economic considerations. But in that case there are some safeguards against too great an influence of non-economic factors.

A real plan will, according to Meier and Baldwin, at least "have four main components":

specific production "targets" representing increase in the quantitative production of desired commodities;

a capital budget, comprising public investment projects;

a "human investment budget", covering government expenditures that represent investment in the people-education, manpower training, health;

regulatory measures governing the activities of private individuals, enter-

prises, and institutions intended to redirect and guide these activities in a manner contributing to the achievement of the objectives in the plan[1] [11].

A very useful technique in the formulation of plans is the input-output analysis. Dosser points out that this technique is apparently not used, or insufficiently, in the various development plans of the British colonies [12].

It is thus clear that the use of public investment funds is only to a small degree directed by economic considerations. Such considerations are of more importance with respect to private investments, although this is more so in the case of investments in commercial undertakings in industry, trade or transport, than in the field of agriculture.

2.4. Decisions about Private Investments in Agriculture

There are a number of factors which make it unrealistic to expect that private investments in foodproduction in underdeveloped countries will be directed purely, or even largely, by economic considerations.

Most of these factors are related to the demand for and the use of investment funds:

The social environment is often not ready to enable the individual or small groups of farmers to use development funds properly. For instance, communal property of the land, as it is still known in various parts of Africa, offers no incentive to a farmer to improve the land he cultivates momentarily. The governments of Kenya and South Rhodesia have seen correctly that the individualisation of landrights is a pre-condition for farmdevelopment; similarly the custom to consider the possession of livestock as a measure of social status, rather than as a means to produce meat or milk, prevents the cattle owners from adopting rational husbandry-rules. It is also possible that the poor development of commerce impedes the penetration of the application of commercial considerations in agriculture. Sometimes there are no proper collecting-trade-channels for the sale of extra produce; in other cases there is no proper distributing trade, so that the farmer does not easily see what he could buy with the extra money he might earn by extra production. This situation one finds

[1] See also various publications of Prof. Dr. J. TINBERGEN and of the NETHERLANDS PLANBUREAU, especially: J. TINBERGEN, *The Design of Development*, the Economic Development Institute of the I.B.R.D., Baltimore, 1958.

for instance in Thailand, the southern Sudan and the Andean valleys of Peru.

The organisation and the size of the farms may not be suitable for the introduction of new lines of production. This problem may be closely connected with land-tenure problems, and it can be considered a special, though very important, case of the first category.

The farmer, as a human being, is often not ready to adopt new techniques, he is often too wrapped up in traditions, tabu's or "adat", and therefore not free in his decisions. Development officers in Indonesia, and other Asian and African countries encounter many examples of this nature. It is often necessary to develop a capitalistic, commercial state of mind in the farmer, by means of a time consuming process of education. He must be taught that he may be better off in the end if he borrows money now, to develop his farm and to produce more or better, so that he can sell more, repay his loan with interest, and as an endresult have a surplus for his own use. In other words, the farmer must learn to see the difference between the traditional loans for consumptive purposes and loans for development purposes.

However, there are also often difficulties on the supply side. In most underdeveloped countries the bulk of the loans is offered by private people as traders, landowners, relatives. These lenders are, in general, not equipped to make proper development loans on correct terms and at reasonable rates of interest. The private banks and commercial houses usually restrict themselves to making short term crop loans, tied to the produce of the season. The third group of possible lenders are the cooperative or state agricultural banks. Many of these are run along inefficient, bureaucratic and conservative lines, and almost invariably they do not have sufficient funds to have a real impact on the stagnating farming economy.

For these reasons it will be necessary in many countries that the government takes an active part in supplying and directing private and public investments funds into agriculture. This has in the recent past not been the case to a sufficient degree. To the contrary "In many underdeveloped countries there has been considerable evidence of a tendency to ascribe insufficient importance to agricultural investments" [13]. It makes sense therefore, to discuss the problem of investments in agriculture in terms of a problem of allocation.

CHAPTER 3

POPULATION: OPINIONS AND FACTS

3.1. Three Points of View

The ever increasing number of people trying to live on our planet has aroused the interest of a great number of writers, especially since Robert Malthus wrote his startling books about the race between the number of people and the production of food. Several of the writers are just as concerned about this problem as Malthus was. Others are quite optimistic and lighthearted about it, but only a limited number is able to see the problem in the right perspective.

Malthus' position is probably most clearly stated in "A Summary View", published in 1830, that is 32 years after his first version of the "Essay on the Principle of Population". Malthus wrote in his "Summary View" [1] [1]: "It may be safely asserted therefore, that population, when unchecked, increases in a geometrical progression of such a nature as to double itself every twenty-five years.... If... we were to suppose that, by great attention to agriculture, its produce would be permanently increased every twenty-five years by a quantity equal to that which it at present produces, it would be allowing a rate of increase decidedly beyond any probability of realisation.... Yet this would be an arithmetical progression, and would fall short, beyond all comparison, of the natural increase of population in a geometrical progression".

We now know that Malthus was too much alarmed about the possible increase in population. Even in modern times the increase has for a large area never been close to 3% per year, which would be necessary for a doubling in 25 years. Nevertheless he stirred up a heated discussion which is still going on.

[1] A well-balanced review of the development of Malthus' viewpoint is to be found in J. K. INGRAM, *A History of Political Economy*, London 1919, p. 109 etc.

Such writers as Cook, Osborn, Pearlson, Paarlberg, Vogt, Fairchild [2] and others, all maintain that a crisis would occur if population would continue to increase, as it did in the last few decades and if men did not learn to take better care of soil and water, and natural resources in general.

There are others, however, who see no trouble ahead, at least not for the next decades or even a hundred years. Some of them take a short term look at the problem at hand, pointing to the socalled "surplusses" of agricultural commodities. So for instance Jacob Oser [3]: "The Malthusians claim that there are too many people in the world, and food supplies cannot keep up with the growing population; nature cannot provide for all of mankind. How can they reconcile this contention with the fact that many countries restricted the output of food, hampered food imports, and destroyed stocks of food?" After reviewing the situation in the United States, Oser states: "We challenge the Malthusians to reconcile crop restrictions and destructions with their forecast of overpopulation" [4]. We will see later that progress in agricultural production and an ample supply with food in Europe, Australia or North America, is not relevant to the solution of our problem, which is concentrated in Asia, Africa and Latin America.

Equally optimistic are those that point to the various unconventional ways of foodproduction that are mentioned every now and then in research reports [1]. These writers underestimate the time necessary to develop such processes into commercial production. This time is long, but it could be reduced if an urgent reason for large scale production of unconventional foods would arise, which is, however, not yet the case.

Thirdly there are writers who admit that there are great possibilities to increase foodproduction, even by conventional means, and who also realize that there is a possibility that the rate of increase in population may, in another half century or so, begin to diminish. They expect on the one hand not a dramatic crisis, but emphasize on the other hand that a long term balance between supply of food an demand for food can only be maintained under certain conditions. One of these conditions is that much attention and money will have to be allocated to the further

[1] Like synthetic production of proteins, production of edible material from algae, etc.

development of foodproduction [1]. Another condition is that some responsible action be taken to diminish the rate of growth of the population.

Dr. E. de Vries states the problem in a very sensible way as follows. He first mentions Malthus' theses with respect to growth of population and growth of production. Expressed graphically the populationline will cross the productionline upwards at some point in the future, and then there will be hunger. De Vries proceeds then to explain that there are also opposite viewpoints. For instance Pearl [2] has developed the theory that the world population will not exceed a ceiling, which Pearl puts at about 3 billion [3]. Moreover the Swedish economist Cassel has defended the viewpoint that production will increase at a long term average rate of 2.8% per annum, which is more than the average increase of population. Combining these two theses results in a picture just the opposite of the Malthusian picture. In the Pearl/Cassel case the production line climbs higher and higher over the populationline.

De Vries concludes, after discussing these viewpoints, that there is statistically not enough evidence to make a choice between them. He points out, however, that in the long run foodproduction has not increased at the average rate which Cassel defends for production as a whole [4]. His final conclusion is that the degree to which the earth will be able to accommodate and feed new billions of people is a problem of scientifically responsible use of resources, economic organisation, equitable distribution of income and the right mentality of humanity towards its natural resources [5].

This seems the correct way to approach the problem; certainly our planet is able to accommodate many more people than are living on it at present, but there are certain undeniable limits of space and cost of exploitation of resources, and for this reason a responsible way of developing and exploiting the resources must be combined with a responsible attitude towards the increase in number of population. This is also the essence of Toynbee's lecture before the F.A.O. General Assembly in Rome 1959 [6].

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[1] See: BYRON T. SHAW on p. 2, Introduction.

[2] In *The National History of Population.*

[3] This estimate is out of date now.

[4] See for this point chapter 5.

3.2. The Rate of Population Growth

A number of general statements have been made above that need substantiation. In the first place: at what rate is the population actually increasing in number? Secondly: at what rate did foodproduction increase in the recent past? This will be discussed in chapter 5.

Condensed, comprehensive figures about the growth of population have been published by the English organisation Political and Economic Planning. Its presentation is based on data collected by the U.N. and by F.A.O. [7].

TABLE 4. *The growth of the world population*

Period	Millions at end of period	Increase in period	Annual rate of increase
1850–1900	1550	459	0.7%
1900–1950	2454	904	0.9%
1950–1980	3628	1174	1.3%

The U.N. figures on which the P.E.P. presentation was based are shown in annex 3. Although recently a new, and higher estimate of the future population has been published [1], annex 3 is still of interest because it shows clearly the difference in the demographic situation in the various regions of the world. The fact that this table, published only seven years ago, is already out of date, demonstrates how quickly estimates of population growth have to be adjusted as a consequence of the increasing rate of growth. P.E.P. calculated also average annual rates of growth of the population in the various continents [8].

TABLE 5. *Annual average rate of growth of population according to P.E.P.*

	1900–1950	1948–1951
Near East [2]	0.7%	2.2%
Far East	0.7%	1.3% [3]
Africa [2]	1.0%	1.7%
North America	1.5%	1.6%
Latin America	1.9%	2.4%
Europe	0.7% [4]	0.8% [5]
Oceania	1.6%	2.8%

[1] See: chapter 4.

A somewhat more detailed and more up to date tabulation has been prepared by the United Nations Economic Commission for Asia and the Far East [9].

TABLE 6. *Annual average rate of growth of population according to Ecafe*

	1920/30	1930/40	1940/50	1950/56
World	1.1%	1.1%	1.1%	1.6%
Ecafe region	1.1%	1.2%	1.3%	1.5%
S.W. Asia	0.9%	1.1%	1.6%	2.3%
Africa	1.0%	1.0%	1.5%	1.7%
N. America	1.4%	0.8%	1.4%	1.7%
Latin America	1.8%	1.9%	2.2%	2.5%
Europe	0.8%	0.7%	0.3%	0.8%
Oceania	1.1%	1.0%	1.7%	2.3%
U.S.S.R.	1.1%	0.9%	—	—

Apparently the annual rate of growth of population increased in the course of the last century, especially in the underdeveloped areas, where healthmeasures have been taken on a large scale only recently. This phenomenon has been given the name of "population explosion" by several writers. It makes, as already stated in the introduction, the problem of the balance between population and foodproduction very urgent.

The population is increasing at the fastest rate in Latin America, closely followed by Oceania, the Near East and South West Asia. About "average" rates of increase occur in the Ecafe region as a whole, Africa and North America and below average rates in Europe and, probably, the U.S.S.R. The very important Ecafe region includes an area with a very rapidly growing population [6] and another area with a population increasing at a rate slightly below average [7].

[2] N.E. Africa is included in Africa in column 1, but in the Near East in column 2.
[3] Exclusive of China.
[4] Includes U.S.S.R.
[5] Exclusive of E. Europe and the U.S.S.R.
[6] S. W. Asia.
[7] Mainly India, 1.3%; there are indications that this percentage is too low.

The above tables give a first indication that the problem of the relation between the growth of population and the increase in foodproduction cannot sensibly be treated as a "world" problem. It might be better to treat it as a regional problem, or, if one wants to go into detail, a country by country treatment is indicated. Sir E. John Russell, formerly Director of the Rothamsted Experiment Station is correct when he states: "The solution lies in cooperation between the more advanced and the less advanced countries, but cooperation that is mutually advantageous and not hampered by restrictive conditions. Finally a sound population policy must be adopted to insure that the numbers do not outstrip food resources" [10]. If we look at the situation this way we can agree with Prof. L. Dudley Stamp when he says: "The present situation is challenging, but by no means disastrous or even as alarming as some would have us believe" [11].

CHAPTER 4

ESTIMATES OF POPULATION GROWTH

4.1. A Startling New Estimate

In this chapter and in a few others the discussion will be about what are called "long term" forecasts. The expression "long term", as used in this study, will mean a period of from two to five decades. Most of the estimates will however be focussed on the year 1980, and they will cover the twenty year period 1960–1980. Forecasts for the year 2000 would be very interesting, but speculations about such a far off year have of necessity to be very vague, and they loose in practical value what they gain in audacity.

Even estimates for a relatively speaking nearby year, as 1980, have often to be changed very considerable. Annex 3, mentioned already in chapter 3, includes some estimates about the world population in 1980, published by the United Nations in 1954. But, as indicated already, they must be considered completely out of date, and they have in fact been replaced by the United Nations [1], by a new set of figures, published in 1958 [1].

The rate of increase of population appears to be much higher than was estimated in 1954. The end-figures are consequently considerably more alarming, as the comparative table below will show.

The estimates for all the continents have been augmented, but number-wise the largest increase is in the figures for Asia. This continent accounts in the new estimates for almost two thirds of the world increase in population. It seems that the jump in figures for Asia is largely due to new information on the population of Mainland-China.

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[1] See: annex 4 A.

TABLE 7. *Increase in population from 1950–1980, according to U.N. (millions)*

	Population in 1950	Estimate for 1980 made in		Increase 1950–1980 estimated in	
		1954	1958	1954	1958
World	2,455	3,628	4,220	1,173	1,765
Africa	198	289	333	91	135
America (all)	330	535	602	205	272
N. America	168	223	254	55	86
Latin America	162	312	348	150	186
Asia (excl. USSR)	1,321	2,011	2,471	690	1,150
Europe (incl. USSR)	593	776	792	183	199
Oceania	13	17.5	22.5	4.5	9.5

The population of Asia is expected to increase by over 80% in 30 years. This is certainly an impressive increase, but percentage wise the population of Latin America will increase more (by 115%). More moderate increases are foreseen for Africa (68%) and North America (50%). A rather slow development is expected for "the old continent" Europe (33%). The population of Oceania will increase by over 70%, which is a high percentage, but it refers to a small number and a very sparsely populated continent.

These high rates of increase in population were certainly not expected by older writers on the subject. Some of them expected that the population in well-advanced countries would begin to decrease in numbers – or at least would stabilize – around the middle of the century, and that this example would be followed by the "younger" countries. This, however, did not happen, as M. K. Bennett observed; even in most older countries the population keeps on increasing [2].

4.2. Beyond 1980

Some experts have tried to look further ahead than 1980. The U.N. Secretariate expects a population of 6.25 billion in the year 2000, but a more moderate figure was mentioned by the contributors to a book called "The Next Hundred Years". They write: "if we assume... that

rates of populationgrowth in the West will fall to very low levels by 1975, that the rates of growth in Japan, Eastern Europe and Oceania will fall to low levels by the turn of the century, that Africa, South Central Asia, and most of Latin America will pass through the industrial transition in 75 years, and that a full century will be required for most of China and the Near East, then we arrive at a world population of nearly 5 billion by the year 2000, and nearly 7 billion by 2050" [3]. This estimate of 7 billion in 2050 must be considered as a minimum; it is based on the traditional assumption that the rate of growth will diminish with the progress of development, but as Dr. Bennett emphasized, there is considerable doubt about this assumption. Some writers expect a world population of 7 billion already in the year 2000.

4.3. Possible Problem Areas

It will be clear, even before we have reviewed data on the rate of growth of food production, that the above mentioned growth figures for the population may endanger the balance of supply and demand in various regions. This will be especially the case in those countries, where the population expands rapidly in number, but where agriculture lags behind. Lack of development capital, shortage of trained personnel, adverse land tenure conditions will be some of the main obstacles to a rapid development of food production in such countries. A preliminary indication of the location of the problem areas can be gleaned from the already quoted P.E.P. study [4]. It concludes that there will be no serious foodproblem in Europe as a whole for the next generation, nor in North America, Oceania or temporate South America. The U.S.S.R. is expected not to have a foodproblem before 1980 at least. But countries like India, Java, Japan and tropical Latin America are in for serious difficulties, according to P.E.P.

The situation will be even more serious than P.E.P. expected it to be, because its report was based on the 1954 estimates of population growth, which are too low.

CHAPTER 5

TRENDS IN FOODPRODUCTION

5.1. Indexnumbers of Foodproduction

In previous chapters we have already several times implied that foodproduction in some regions is barely able to keep up with the expansion of demand, which is primarily caused by an increase in numbers of consumers. It is therefore now time to supply information on this score. This will be mainly in the form of indexnumbers of total and per caput production. It is a pity that no long term series of such indexnumbers are available. This is because only a limited number of countries has reliable production figures for the inter-war period. Even at present, while the 1960 F.A.O. worldcensus is being processed, there are many countries which have never conducted a census of agriculture nor collected statistical information with the aid of scientific sampling techniques.

F.A.O. and the U.N. Secretariate have however done much to provide us with reasonably reliable world production figures for the last two decades. The statistical information on the trend in agricultural or food production is condensed in 5 tables [1].

Annex 5 is about world production of groups of commodities. Line 1 shows, if compared with line 2, that the production of "all" commodities expanded faster than agricultural production. Industry and mining apparently outstrip farming. The production of food increased at the same rate as the production of non-food-crops. Textile fibers production lagged behind the average, and the production of coffee, tea, cacao as a group forged ahead. The same is the case with oils and fats, even to a stronger degree.

World population was 2.2 billion in 1938, 2.5 billion in 1953 and 2.8

[1] Annex 5-9.

billion in 1957. That is an increase from 85 to 107 if 1953 is 100, or by 22 points. Food production increased over that period by 25 points. This might be an indication that there has been a slight improvement in the foodsituation over the last 20 years for the world as a whole. Between 1953 and 1957 foodproduction and population increased by approximately the same percentage, 7%.

In the first of these two decades, the period 1938–1948, there was only a small increase in production. This is of course due to the disruption caused by World War II. Food production increased between 1948 and 1957, or in 9 years, by 20 points, or by 2% per annum. Most of this occurred in the first half of the decade, which might be explained as a retarded recovery from war disruption. For the second half of the decade the annual increase in food production was only 1.5%.

Annex 6 shows indexnumbers of total agricultural production by regions. The term "pre-war" in this annex indicates the average production for the years 1934–1938, or 1935–1939. This average is often used as a basis for comparison. The "world" figures of annex 6 do not concur completely with those of annex 5, but there is no real contradiction. This annex suggests also that agricultural production in the first half of the present decade increased faster than population did.

The production rose faster in the Near East, the Far East and Africa than in the rest of the world. Especially in North America and Oceania the production expanded slowly. The European figure is at the world average and almost so is the figure for Latin America. This is rather alarming because the population in that continent increases faster than in any other continent. The result of this discrepancy is stepped up imports of food in some countries and diminished exports in others [1].

5.2. Production per Caput Increased but with Exceptions

Annexes 7 and 8 are about foodproduction, as distinct from overall agricultural production. In annex 7 the average production for 1952/53–1956/57 is the basis, whereas in annex 8 the basis for the indexnumbers are the "pre-war" figures. The most interesting part of these tables is the section about per caput production. These figures reflect the influence of

[1] Argentina.

the changes in the two categories: production and population. From annex 7 it appears that per caput production was in 1958/59 in West Europe 13 points higher than prewar and in North America 15 points higher than prewar, but in Oceania 5 points lower than prewar.

Oceania is in an exceptional position, which does not affect the food-supply per person. Reductions in production affect exports only, not internal supplies. Moreover the quantities produced in and exported from Oceania are relatively small and they have little influence on world figures. In West Europe and North America there was a very considerable step up in per caput production.

Quite different is the position in the underdeveloped regions. The per caput production was in 1958/59 in Latin America the same as it was prewar, but in the Far East 5 points lower than prewar. There was no improvement in per caput production in Africa but a substantial improvement of 14 points in the Near East. The figures for 1956/57 give a slightly better picture, but not substantially so.

The difference between the developed regions and the underdeveloped areas is very striking, and of importance to our study.

If we take the period 1948/49–1952/53 – in short the year 1950 – as a basis for comparison with 1958/59 we get the following picture:

TABLE 8. *Increase in per caput foodproduction since 1950*

W. Europe	plus 17 points
N. America	plus 3 points
Oceania	plus 3 points
Latin America	plus 6 points
Far East	plus 11 points
Near East	plus 14 points
Africa	0
E. Europe and USSR	plus 32 points

This picture does not give reason for cheers, because the improvements over the 1950 levels in Latin America, the Far East and the Near East are simply recoveries from poor food conditions in that year. Basically foodproduction has in the last two decades in the underdeveloped regions barely kept pace with the rise in population.

5.3. Production by Type of Food

Up till now we have discussed the production of food in general, but it is desirable to consider some specific products or groups of products. In the first place because "foodproduction" should not be a rather vague, general concept, but it should be thought of in terms of specific commodities. And secondly because the foodvalue per acre-unit varies so widely from product to product. Sir John Russell [1] gives the following figures about the quantity of nutrients produced per acre of reasonably well-farmed land.

TABLE 9. *Nutrients produced per acre*

	Dry matter in cwt/acre	Proteins equiv. cwt/acre	Million cal/acre
Cereals (grain)	18	1.7	2.92
Potatoes	43	1.5	6.67
Beans	17	3.9	2.71
Grass	25–60	1.0–4.0	2.1–5.25
Grass intensively managed			up to 8.3

These figures are of course only an illustration, but they indicate nevertheless that it may be desirable if the situation becomes tight, to shift for instance from cereals to potatoes [1] and beans, if the climate permits. In fact this was done on a large scale in Europe during the war. Grass is able to produce a large quantity of calories, but only one tenth of this quantity becomes available as human food if the grass is converted into meat or milk [2].

Annex 9 gives information about the production of some important foodstuffs. The production of grains has since 1950 increased by 2% per annum, which is more than the rate of increase in population in that period [2]. Wheat production lagged behind, but it kept up probably with the increase in number of people who consume this product primarily.

[1] More in general to rootcrops.

[2] 1.6%, chapter 3.

Very important is the fairly rapid increase in rice production [1], which outruns the increase in numbers of people in the main rice-eating regions.

The increase in production of coarse grains has probably helped in the expansion of livestockproduction. However part of this expansion is the result of better care of pastures, increases in production of foddercrops [2], and the better use of natural grazing-lands [3]. The considerable increases in the production of sugar, oilseeds, meat and milk might indicate some improvement in diets.

All in all these figures are not discouraging and they confirm the impression given by annex 7, that foodproduction since 1950 has made a small gain over the increase in population.

5.4. The Area now Being Used

The statistics on the area used for foodproduction are much less reliable than those on the volume of production. The explanation sometimes given for this phenomenon is that governments of underdeveloped countries have various ways to check on the quantity produced [4], that are not open for estimates on the area in farming. Several governments organise markets in one way or another, they are involved in storage operations, they check traffic on the roads, or they collect sales-taxes. It is of course true that many governments also collect landtaxes, but the administration of these taxes gives usually little information on the area under crops or area used for grazing. The estimates about this last item are especially very vague.

It is a pity that there is no series of figures about the farming area covering one or two decades. Such a series would give us an opportunity to detect how much of the increase in production is due to an enlargement of the area under production.

Below are given some approximate figures, which present merely an idea of the way in which the worlds land is used.

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[1] 2.9% per annum.

[2] Alfalfa.

[3] For instance because of the establishment of more watering points.

[4] Or at least quantity sold.

TABLE 10. *Use of the world's known land area*

(in billion hectares)	F.A.O. Yearbooks		Sir John Russell [1]
	about the years 1950/51	about the years 1955/58	about 1954
Total recorded area	13.50	13.70	13.4
Arable and under tree crops (cultivated land)	1.33	1.38	1.2
Meadows, pastures	2.36	2.41	2.–
Forests	3.95	3.84	4.1
Other land (deserts, rocky areas, built-up areas)	5.86	6.04	6.1

The "expansion" that seems to be revealed by the F.A.O. figures might partly be due to improved information [1]. One cannot statistically speaking be sure that the area of cultivated land increased really by 50 million hectares between 1950 and 1955, but it is the best figure available. The same is true for the figures of annex 10; some of the shown increases may be purely "statistical", at least those of parts 1 and 3. The figures in part 2 might be somewhat more reliable, because the data on some foodcrops could be checked with the information available to commodity groups. They would indicate that the area under major foodcrops increased from 1950 till 1956 by about 9% or at a rate of almost 1½% per year. The increases were largely concentrated in the underdeveloped areas. The area under major foodcrops increased in these regions from about 300 mln. hectares to about 350 mln. hectares or by 17% in 6 years, which is about 2.5% per year.

Apparently only 10% of the world's land area is cultivated. There seems, on a world basis, certainly room for expansion since with modern techniques it will be possible to turn some of the forestlands and "other" lands to productive use. Moreover part of the grazing lands may give a higher production, than in the present state, if developed as arable land, although there is in that case the danger of erosion. We will turn to this subject in chapter 8. Then we will also discuss in some detail the possibilities to improve yields per unit. It is sufficient to state here that there are

[1] Better coverage.

in principle great possibilities in this field. For instance in many regions yields of grain are less than one ton per hectare whereas other countries have crops of three tons of grain per hectare or more.

5.5. Foodproblem is not Worldwide

We have hinted already at the fact that on a world-wide basis there is no foodproblem at present, and there is not likely to be one soon. But there will be critical situations in certain regions during the next few decades. "In a very large way this [1] balance is determinable within each individual country in each aggregate", concluded Prof. D. Black, after having reviewed "Trends in Food supplies in the World" [3].

The difficulty for some countries or regions of keeping or bringing demand and supply in balance at a reasonable price level stems partly from the density of the population per unit of productive land, and also from the low yields per unit that farmers in so many countries crop.

Ecafe [4] published information on the first point.

TABLE 11. *Estimated population density in 1956 according to Ecafe*

Regions	Persons per km²		Rural population
	Total Area	Arable Land	per km² arable land
World	20	198	156
Ecafe region	69	375	325
S.W. Asia	14	146	114
Africa	7	95	86
N. America	9	81	47
Latin America	9	185	141
Europe	84	273	177
Oceania	2	60	32
U.S.S.R.	9	91	63
India	118	245	226
Pakistan	88	343	316
Mainl. China	64	568	504

[1] Population-food.

Note the large number of people per km² of arable land in such areas as the Ecafe region, Latin America, Europe, and such countries as India, Pakistan and Mainland China. Also very noticeable is the large number of rural people per km² of arable land in the same territories. In Europe there is of course a large difference between the number of people as a whole, and the number of rural people per km² of arable land.

It will also be clear that the high yields per unit achieved in most of Europe make the balance between supply and demand less precarious than the density figures would suggest.

5.6. Sharp Differences between Nations

Prof. Dudley Stamp [5] has made calculations aiming at expressing the yields of various foodcrops in one figure. He introduced the Standard Nutritional Unit, or S.N.U. [1].

TABLE 12. *Acreage per caput and food output per acre, according to Prof. Stamp* [2]

Country	Cultivated acres per caput	S.N.U. per acre
Canada	4.—	0.4
U.S.A.	3.5	0.4
Brasil	1.—	1.3
United Kingdom	0.55	0.9
France	1.8	0.6
Uganda	1.—	1.—
Pakistan	0.7	1.—
India	0.9	0.75
Japan	0.15	6.5
World	1.2	0.75

There is quite a striking difference between the large areas per caput and low yields per acre in Canada and the U.S.A., and the small acreage

[1] One unit (S.N.U.) is equivalent to one million nutritional calories consumed per year, or about 2750 per day.

[2] Period probably 1950–1955.

and high yields in Japan. Pakistan, India and the United Kingdom have each only a small acreage per caput and a rather low yield per acre barely above the world average. The United Kingdom earns however much foreign exchange by exporting industrial goods and by performing services, with which it can pay for the import of food. This is not the case with such countries as India and Pakistan.

Also Bonner [6] draws attention to the wide variation in yield per unit. He estimated that as a world average one acre produces 3800 calories of potential food per day. Japan however produces 13.000 calories per acre per day, as opposed to only 4000 calories for Asia as a whole, 7000–8000 calories for Western Europe and only 4500 calories in the U.S.A.

CHAPTER 6

THE SUPPLY OF FOOD

In previous chapters statistics and estimates on production were used and it was implied that they approximated supply figures. This of course was not quite correct. Imports and exports and changes in stock cause differences between the quantity produced in a region in a specific cropyear, and the quantity available for consumption. These differences however are for whole continents relatively small and can for this study be neglected.

6.1. World Trade in Food is Small

Contrary to expectations the quantity of food traded between nations is only a small portion of world production. "Broadly speaking, about two thirds of the world's population grows their own food, and probably about 80% live in rural areas in which the food consumed has all been grown locally. The remaining 20% – some 450 or 500 million people – are dependent to a greater or lesser extent on food transported from a distance", thus Sir John Russell [1].

This view can be substantiated by the figures of annex 11. They afford a comparison between the magnitude of worldproduction of grains and the magnitude of exports by main exporting countries. The picture would not change significantly if the lesser exporters were included. It appears that exports[1] of all grains are quite small in comparison with world-production. "Self sufficiency in foodsupply is the rule rather than the exception in most parts of the world" states Ecafe, adding that in its estimate only 7% of world food production enters in international trade [2].

The figures of annex 12 suggest however that for wheat a larger portion

[1] And consequently also imports

than 7% enters international trade. The portion of rice production entering foreign trade is however for all regions very small.

These observations are of importance because they indicate that it is likely that efforts to increase foodsupplies will have to be directed towards the regions where the great masses of consumers are living. A further indication in this direction is given in section 2 of this chapter.

6.2. Stocks and "Surplusses"

Much of the apathy towards investments in foodproduction stems from the erroneous believe that there is plenty of food produced since there is so much in the newspapers about "surplusses". Many experts have explained that the surplusses do not really indicate that there is a plentiful production. Surplusses exist under present conditions merely because production in certain countries is larger than the sum of internal sales and exportsales at existing prices through normal commercial channels. The word surplusses obscures the fact that there are at the same time in deficit countries great numbers of people who do not eat enough, because they cannot earn the money to purchase the food that is stored in major producing countries.

Annex 11 gives some information on the size of stocks of grain in major exporting countries. For reasons of comparison production figures and exportfigures are included in this annex.

The stocks of wheat [1] are roughly one third of annual world production, and about twice the volume of annual exports of the major exporters. The stocks are quite large in relation to the operations of the countries that own them, but in a world setting they are not alarmingly large.

Stocks of rice are quite small: only a fraction of worldproduction, and about half of annual exports of major exporting countries. Such a stock is really an operational stock and not a surplus in any sense of the word. If one or a few of the major rice-consuming countries have a bad crop, stocks would be hardly large enough to make up for the cropfailure.

Stocks of coarse grains [2] are considerable: about one fifth of world-production and 6 times as large as annual exports by major producing

[1] Mainly concentrated in the U.S.A. and Canada.

[2] Concentrated in the America's.

countries. However these large stocks are not very relevant to the balance of supply and demand for human food in underdeveloped countries, because little of the coarse grains is used there for that purpose. Most of the exports of coarse grains are to Europe, where the grain mainly is used for livestock-feeding and for industrial purposes.

What really counts for discussion about the balance of supply and demand for food are the stocks of wheat. Suppose that these stocks were to be used to alleviate the foodproblem in underdeveloped areas, or even the problem for one country, like India.

The wheatproduction in India is about 9 mln. tons, and the country produces also about 40 mln. tons paddy, or 27 mln. tons milled rice. The sum of those two productions is 36 mln. tons a year, a quantity of the same order as stocks of wheat in major exporting countries. India produces moreover another 30 mln. tons of other foodgrains. Suppose that the government of India would want to enlarge the supply of wheat and rice about 10% and that it came to an agreement with the exporters of wheat to purchase from them a quantity equivalent to 10% of the presently existing stocks for the next 10 years. This would mean the transportation of an extra 4 mln. tons of grain across the ocean to India, and an expenditure of some 280 mln. dollars a year [1].

It is obvious that this kind of transaction would result in quite a strain on the oceanfreight market, and that the development program for India would be seriously endangered by annual expenditure of 280 mln. dollars in foreign exchange for foodimports. Of course it is possible that some exporting countries would be willing to continue to make concessional sales at special prices and for local currency [2], but it will be clear that such arrangements – although important and valuable under certain conditions – never can be a basis for a long term solution of the foodproblem for India, or any other self respecting country.

The insignificance of the existing surplusses of wheat becomes still more clear when it is realised that there is a chance that India will have in 1965 a gap between supplies and the target of the Third Development Plan of 28 mln. tons of grain. This shortage will occur unless the rate of

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[1] If the price were set at 70 dollars per ton.

[2] Like under P. L. 480; The United States Law under which that country-interaliacan sell surplus commodities at concessional prices.

increase in grainproduction is stepped up considerably [3]. The import of such a quantity of grain would cost India the enormous sum of 1960 mln. dollars equivalent per year.

Here is another indication that a country ought to endeavour to balance the supply and demand for major foodstuffs within its own boundaries, unless it has, or can develop, large exports of industrial goods, mining products or services.

6.3. Foodsupply per Caput

Supply is the outcome of production, plus imports, minus exports, and changes in stock. F.A.O. has for years made calculations on this basis of the quantity of food available per caput in a series of countries. Annex 13 is based on such calculations. These figures should be used with caution for two reasons:

people in remote areas consume large quantities of food that are not registered by statisticians, and

people in well-to-do countries, especially the U.S.A., waste a great deal of the food that they buy and prepare.

Consequently the difference between the per caput supply in various countries is not as glaring as the figures would suggest.

Moreover it should be noted that the food requirements per caput vary somewhat from region to region. For instance "Owing to smaller stature and less body weight, the calorieneeds for Asia's population are on the average smaller than those of the population of Western countries. The fact that a large portion of Asians live in tropical or sub-tropical regions further reduces their calorie requirements" [4]. Similar observations, although to a lesser degree as far as body weight goes, could be made with respect to the people of Africa and Latin America.

Of special interest are parts b, c and d of annex 13, because they give some insight in the quality of diets in various countries. Note for instance that in the United Kingdom, the U.S.A. and Australia only about one third of the calories in the average diet comes from cereals and starchy roots, as compared with 60% in Italy and Chile, and 70% or more in Asian countries.

The differences in meat consumption per caput are really startling. More than 100 kg per year is consumed, or at least bought, by the average

Australian or Argentinian [1], as compared with 40 kg to 80 kg in European countries [2], and only 1 to 4 kg in Asia. Very large are also the variations in milkconsumption. It is over 200 kg per year per caput in the Netherlands, the United Kingdom and the U.S.A., between 100 and 200 kg in most of Europe, Argentina and Chile, where one notes a rapid improvement, but less than 50 kg in Brazil, India and Japan.

A mere comparison of calorie intake per caput in various countries, apart from the limitations mentioned above, is deficient because it does not take into account the difference in quality of diet. In many cases a low calorie intake is accompanied by a low intake of protein, and in general little use of "protective foods".

Simple statistics of food supply per caput in various countries cover up many real differences. Nevertheless, such statistics have some value, because they correct the false impression given by production and stock statistics, that the world food position is satisfactory. It is definitely not so. P.E.P. has made an estimate [3] of the number of underfed people in 1950, by placing in that category those who have less to eat than a certain number of calories. Dr. P. V. Sukhatme, Director, Statistics Division, F.A.O., has recently considered this question on the basis of newer statistics. He distinguishes between "under-nourishment" [4] and "malnutrition" [5]. According to Sukhatme a conservative estimate is that 10% of the world population is under-nourished, and over half of the world population is suffering from malnutrition [5].

6.4. Foodposition in Various Regions

Sir John Russell [6] has made an effort to classify a number of countries or regions according to characteristics of their food position. He took, in doing this, into account the area available per head, yields per acre, and type of food produced. The result of his estimates is shown below.

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[1] Which, by the way, is less than their pre-war average.

[2] However only 19 kg in Italy.

[3] See annex 14.

[4] Deficient calorie intake causes people to loose weight if they work normally.

[5] There is some lack or deficiency of one or more essential nutrients.

TABLE 13. *Food position of various regions*

Group	Acres per head	Regions	Foodproduction
I	2½ and more	N. and S. America, Australia, N. Zealand, E. Europe (except Czecho-Slov.) USSR	Surplus for export
II	1–2½	W. and Centr. Europe (except Switzerland, Holland, Belgium)	80% or more
III	about 1	Czecho-Slov., Australia, Italy, W. Germany	selfsufficient on a mixed diet
IV	below 1	on a mixed diet: U.K., Holland, Switzerland	must import food
		on a vegetarian diet: China, Japan, much of S. E. Asia, Egypt.	usually nearly selfsufficient

A classification like this has of course only a limited value, but it gives another indication of where the possible problem areas are located. It is therefore a pity, that Sir John Russell combines North and South America in one group, because this obscures very real differences. Very interesting is the distinction made in group IV between "mixed diet" and "vegetarian diet". One finds this socalled "mixed diet" in countries with a high standard of living. A considerable portion of the mixed diet consists of animal proteins and fats for the production of which large quantities of plantmaterials [1] are required. Some well-developed countries like for instance the Netherlands have an economic structure which makes it sensible to import part of their demand for carbohydrates, while using a portion of their productive capacity for the production of exportgoods.

Some information provided by Prof. L. Dudley Stamp [7] is in this connection of interest. He estimates that one acre of potatoes yields in Great Britain 4 standard nutritional units: one acre used for milk-production yields only one unit, and one acre used for meat production only 0.4 unit [2].

[1] Like coarse grains and grass.

[2] One unit (S.N.U.) is equivalent to one mln. nutritional calories consumed per year.

It will take a considerable period of time before the underdeveloped countries will have acquired a standard of living in which the mixed diet of the developed countries would fit. A transfer to this mixed diet would involve a very considerable expansion of the production of coarse grains etc. and this might be technically and economically undesirable. This transfer would be mitigated if during the period of improvement in standard of living a campaign for vegetarianism would be conducted succesfully. It is however clear that there is very little chance that the masses of underfed people in densely populated countries will be able in a foreseeable future to increase their consumption of animal products substantially. Firstly the improvement in standards of living will not come about very rapidly, and secondly there is on short notice simply not the room needed for the then necessary production of meat and milk in such countries.

This should, however, not be taken too tragically because human beings can also take in the required quantity of proteins and fats in plantform or as fish. It is therefore [1] of importance that the consumption of pulses and nuts is relatively high in Italy, Brasil and India, and that the Japanese eat a great deal of fish.

[1] See again annex 13.

CHAPTER 7

FORECASTING THE DEMAND FOR FOOD

7.1. Factors Involved

The future demand for food is not only determined by the future numbers of consumers, but also, of course, by what each of them will take. Changes in per caput consumption may occur in the next decades because of:
possible change in per caput income, which will influence buying and eating habits;
continued urbanisation which will have a similar effect;
the increasing level of general education and the dissemination of knowledge about hygiene and nutrition, which will have some influence on what and how people eat, even if their income remains constant and if their environment does not change.

As will be understood there is no statistical evidence for each of these three factors separately. What evidence is available refers to the first factor.

7.2. Consequences of an Increase in Purchasing Power

Since many years the results of studies about the relation between level of income and pattern of consumption have been published. The U.S. Bureau of Agricultural Economics published data on this subject already in the interwar period [1]. The general conclusion was that if purchasing power improves, consumption of starch decreases, and consumption of proteins, fruits and vegetables, in general "protective foods" increases. There are however two different phenomena to be observed.

One is, that in any given year, and any given country, higher income groups spend a smaller portion of their income on food than do lower income groups. Figures to illustrate this point are given in annexes 15 and 16. The first annex is based on budget investigations and it illustrates

that the portion of income spent on food is smaller with higher incomegroups than it is with lower incomegroups, even in otherwise very different conditions. Annex 16 is based on national accounts, and according to its figures the portion of income spent on food may range from 50% in underdeveloped countries, to between 30% and 40% in medium wealthy countries, to about 25% in Australia, the U.S.A. and Canada. It is also true that in general higher income groups have a "better" diet than lower income groups, but this point will be discussed in 7.3.

The second phenomenon is that foodhabits of a certain group tend to change when the per caput income of the group increases over a period of time. We are especially interested in this last mentioned phenomenon. Annex 16 can also help to illustrate this point. It will be noted that in several countries the portion of income spent on food declines from left to right, as the years progress and as standards of living improve. See for instance the figures for Denmark, Finland, Italy, Japan, Ghana, Jamaica and Puerto Rico.

In view of the conservatism, characteristic for most low income groups, and their being wrapped up in traditions, it must be expected that changes in diet will occur slowly. There will frequently be a time-lag between the improvement in income and the change in foodhabits. However, changes may occur rather quickly if the rise in income is the result of, and is accompanied by a change in living conditions, as for instance a move to a city. The effects of urbanisation on diets of rural people have however not yet recieved much attention [2].

7.3. Income Elasticity of Spending for Food

For economic discussions the measure in which spending on food reacts to changes in income is expressed in a coefficient called income-elasticity of food. It is the percentage change in expenditures for food if income increases by 1% [3]. The coefficient is usually less than unity.

In poor, underdeveloped countries like Ghana the income elasticity for food is close to 1, whereas it may drop to less than 0.5 in a rich country like Canada [4].

Relations between income and spending of food can now be expressed in the following way:
in rich countries the income elasticity coefficient for food is lower than in poor countries;

in a country, the income elasticity for food is lower with richer classes than it is with poorer classes;
in a given group [1] the income elasticity coefficient for food is lower than the coefficients for several other categories of expenditure.

An example of the third case is given by Wit [5] who investigated the budget of Dutch clerical workers with an average income of *f* 6500 a year in 1951. The income elasticity of this group for food was 0.56, that for rent of the house 0.60, for furniture 1.0, for clothes 0.93, for shoes 0.73, for health care 0.82, and for education 2.01.

Much new light on the problem of the relation between food expenditures and income has been spread by recent F.A.O. studies. Some results of this work have been published in the "State of Food and Agriculture 1957" [6]. The general conclusions of this work are:
with a rise in standard of living from a low level there is first an increase in the per caput consumption of starchy foods, but later a decrease;
the total consumption of starchy foods per nation increases however continuously, because the demand for livestockfodder and industrial uses increases;
for protective foods there is often an income elasticity of more than 1.0. That is to say an increase in consumers income of 1% may result in an increase in expenditure for protective foods of over 1%.

Two of F.A.O.'s researchworkers discussed the question of the shift in foodpattern already in 1954 [7] and they came to the following conclusion: the supply of calories does in the future not have to rise more rapidly than the rate of increase in population, but if levels of income rise, there will be a shift from cheaper to more expensive foods.

Studies published by L. Goreux [8] for Sweden, France and Germany and by R. F. Daly [9] for the U.S.A. came all to the conclusion that as incomes rise consumption of grains, grainproducts and potatoes either increases very slowly or even decreases, whereas consumption of animal products, fruits and vegetables increases rapidly.

7.4. Few Data for Underdeveloped Countries

Comprehensive studies about the behaviour of incomespenders have

[1] Except probably the very poorest.

not yet been made for underdeveloped countries. A great many figures for a series of such countries by Colin Clark [10] indicate however as a rough generalisation that if a group earns in real terms per caput twice as much as a different group, it spends about $\frac{2}{3}$ more on food. This might be interpreted as an rough indication that an 1% increase in per caput real income would result in an increase in spending for food by something like 0.6%. This conclusion is not too far from a statement by Ecafe [11] that the income elasticity for food in Asia is between 0.7 and 0.8.

It is probably conservative to use for further estimates an income elasticity coefficient of 0.6 for underdeveloped areas. This would mean that an 1% increase in per caput income would result in an 0.6% increase in foodexpenditures, or conversily that an 1% increase in food expenditures would result from a rise in per caput income by 1.7%.

7.5. F.A.O.'s First Forecast

A first attempt to estimate the world demand for food for some 25 years ahead was made by F.A.O. in its World Food Survey. The estimates were made on the basis of prewar production data, and on the assumption that the population in 1960 would be 25% higher than in 1935, and that this population would have an average diet of 2600 calories. Moreover the per caput consumption of beans, peas, fruits and vegetables, milk, eggs, fish and meat was supposed to increase. On this basis it was estimated that it would be necessary to increase foodproduction by the following percentages above the prewar level:

TABLE 14. *Necessary increases in foodproduction by 1960 over the prewar level; F.A.O. world food survey* [1]

Cereals	21	Pulses	80
Roots, tubers	27	Fruits, vegetables	163
Sugar	12	Meat	46
Fats and oils	34	Milk	100

This estimate has now of course only historical value.

[1] In percent of pre-war level.

7.6. A Revised Estimate

Two F.A.O. researchworkers, K. K. P. N. Rao and C. J. Ameral published in 1954 an estimate of the quantities of food that might be required in 1980 [12]. They used the U.N. estimates on the growth of population dated 1954, and they made their calculations for two cases:
level of per caput consumption as it was about 1950;
level of per caput consumption as accepted as target for 1960 in F.A.O.'s "Second World Food Survey". The result of their work is reproduced in annex 17, and it is summarized below. In the first case [1] the increase in requirements is of course about equal to the expected increase in population [2]. In the second case there is an important shift. The increase in requirements for cereals and sugar expressed in percent of 1949 supply are much less pronounced than the increases in the requirements for pulses, meat and milk.

TABLE 15. *Increase in food requirements by 1980 over 1949; Rao and Ameral* [3]

	Supply 1949	Increase required by 1980 at level of consumption		
		as in 1950	as in Food Survey	in % of 1949 supply
World				
Cereals	684	297	362	53
Starchy roots	332	137	134	40
Pulses	49	24	48	100
Sugar	34	16	17	50
Meat	48	22	33	70
Milk	207	90	144	70
Underdeveloped areas [4]				
Cereals	314	167	219	67
Starchy roots	115	70	73	64
Pulses	42	20	43	102
Sugar	15	9	11	73
Meat	17	12	18	106
Milk	58	37	55	95

[1] Diets remain at 1950 levels.
[2] 47% between 1950 and 1980, see annex 3.
[3] Mln. metric tons.
[4] Far East, Near East, Africa and Latin America.

7.7. Assumptions for a Forecast of Fooddemand

In this paragraph an outline may be given of the method we use to make a forecast of fooddemand.

Any forecast of fooddemand has of course to be made on the basis of a reasonable set of assumptions about the general course of the economy.

It must for instance be assumed, that there will be no major war, or large scale preparations for war. Also there should be the assumption that there will be no major depression, and that the process of economic development will proceed, maybe at a somewhat faster rate than in the decade 1950–1960. Consequently per caput income will increase. As for population it is assumed that the medium forecast of the United Nations Secretariate is correct [13]. These assumptions are partly based on a study by Ioanes, made for the 85th Congress of U.S.A. [14].

The assumption about economic development and per caput income has consequences for per caput consumption of food. These consequences might differ for the developed regions and the underdeveloped ones. One could for the developed regions imagine that the per caput consumption of cereals and starchy roots would in 1980 be the same as in 1960, that the consumption of sugar might over that period increase by 5%, the consumption of oilseeds, pulses and milk by 10%, and the consumption of meat by 15%. The budget and diet studies made for the developed countries would give some ground for such estimates.

However, there are not sufficient studies about behaviour of consumers in underdeveloped regions to justify a differentation between the consumption increases for various foodstuffs over the next 20 or 30 years. The result of research, now in hand at F.A.O. headquarters, will throw light on this question.

For the purpose of this study it has been assumed that per caput consumption of all foodstuffs in underdeveloped countries will increase by 10% between 1950 and 1980. This assumption is based on the following grounds. It seems reasonable to expect per caput real income to improve by 0.5% per annum. This improvement in income per caput could be achieved under the following conditions. It can be expected that population in the underdeveloped areas will increase at the rate of 1.9% per

year [1]. If the capital/output ratio in these areas is 4:1 [2], then an increase in per caput income can be achieved if 9.6% of income is invested in new means of production [3].

$$S = \frac{K}{Y} \times (\Delta N + \Delta H)$$
$$= 4 \times (1.9 + 0.5)$$
$$= 4 \times 2.4 = 9.6$$

A net investment activity of this order seems reasonable. As we mentioned in chapter 1.5, some South American countries achieve a net investment of 10% of national income. There may be countries where it will be difficult to realize a net investment of that level, but including the possibility of international- and other aid-programs, we believe to have reason for some optimism. An improvement of per caput real income by 0.5% means compounded an improvement by 17% over the 30-year period. If the income elasticity coefficient for food in underdeveloped areas [4] is 0.6, then an increase in income by 17% would result in an increase in food consumption by 10%.

7.8. A Simple Check-Estimate

This estimate is based on the assumptions set out above. According to U.N. estimates [5], the population will increase as follows:

TABLE 16. *Increase in population from 1950–1980*

	1950 (mln)	1980 (mln)	1980 in % of 1950	Annual rate of increase
Underdevel. areas [6]	1,742	3,151	180%	1.9%
Underdevel. areas excl. China	1,192	2,145	180%	1.9%
Dev. areas (incl. USSR)	755	1,069	140%	1.2%
World (incl. China)	2,497	4,220	170%	1.8%
World (excl. China)	1,947	3,214	165%	1.7%

[1] Annex 4 and table 16.
[2] See chapter 1.2.

The required supply for the underdeveloped areas for the year 1980 can be found by multiplying the supply [7] for 1949 with a factor for the increase in number of consumers [8], and a factor for the increase per caput consumption [9]. The calculations are shown in annex 18, of which the main figures are summarized below.

TABLE 17. *Required food supply in 1980* [10]

	Supply 1949	Estimated Supply 1960	Required Supply 1980	Increase 1960–1980
Cereals [11]	314	397	622	255
Roots	115	145	228	83
Pulses	42	53	83	30
Sugar	15	19	30	11
Meat	17.6	22	35	13
Milk	58.6	74	116	42

The required increase in supply for the underdeveloped areas is about 100% for the 30-year period 1949–1980. That is a growthrate of 2.31% per year. For the period 1960–1980 the increase is about 55% [12] in 20 years, or again 2.3% per annum compounded.

Since intercontinental trade is and will be small as was demonstrated in chapter 6, one does not make a great mistake by stating that the increase in supply has to be produced in or close to the areas where the food is to be consumed. Moreover an attempt to estimate probable changes in volume of trade would require an extensive analysis of price relations between distinct regions, which is quite beyond the scope of this study.

[3] See chapter 1.3, formula.
[4] See chapter 7.4.
[5] See annex 4.
[6] Corrections for China made by author.
[7] Is production.
[8] 1.8.
[9] 1.1.
[10] In million tons.
[11] Cereals include bread grains, rice and coarse grains.
[12] In percent of 1960 figures.

7.9. Estimates Compared

A comparison between the figures for the underdeveloped areas produced by Rao and Amaral in 1954 and our estimates works out as follows:

TABLE 18. *Comparison of estimates of required increases in foodsupplies 1949–1980* [1]

	Rao and Ameral		Our estimates
	at recent diets	at F.A.O. diets	
Cereals	167	219	308
Roots	70	73	113
Pulses	20	42.5	41
Sugar	8.9	11.3	15
Meat	11.6	17.7	17.1
Milk	37	54.7	57.4

It is not surprising that the figures in the third column are higher than those in the second column, since the third is based on more recent higher estimates of population growth, and because it is based on the assumption of a slight increase in per caput consumption. The second and third column show for pulses, sugar, meat and milk almost identical figures. This similarity obscures however two counteracting differences: the third is based on higher population figures than the second, but the second is based on a more substantial improvement in diet than the third. The high figures in the third column for cereals and roots are the result of our assumption that the per caput consumption of these foodstuffs would increase at the same rate as that of the other foodstuffs. This is believed to be a reasonable, and practical assumption in view of the moderate improvement in standard of living that is assumed in this study. It might however be believed that the consumption of animal products might, to a small degree, increase more than the consumption of grains and roots. This would not perceptably change the basic figures. In this case part of the grains and roots would have to be fed to animals, in order to produce meat and milk, but the relative importance of this change would be too small to effect the overall conclusion.

[1] Million tons.

The principal difference between the estimates of the F.A.O. experts and those of this study ought to be stressed. Our estimate, as it intends to be an economic one, is not based on a theoretical "desirable" diet, but on an increase in consumption which would be the consequence of the expected and assumed improvement in per caput income. This concept eliminates the question whether the consumers will have the purchasing power to buy an improved diet, by assuming, as a precondition, that purchasing power will improve and will be a main cause of an increase in demand. If purchasing power does not increase for some reason, per caput demand will also not increase.

7.10. Increase in Requirements per Continent

The estimate of required increase in supplies given in 7.8 must be distributed over the three continents on the basis of the expected increase in population per continent. The increase to be expected between 1960 and 1980 has been intrapolated from the U.N. estimates about the growth of population as given in annex 4.

In the second place the expected increase in per caput consumption had to be taken into account. It has been assumed before that the per caput consumption would increase by 10% in 30 years. This increase had to be reduced for the 20-year period 1960–1980 to 7%. We arrive then at the following percentagewise increases in requirements per continent:

TABLE 19. *Required increase in foodsupply by continent*

Continent	Population [1]		1980 in % of 1960	Consumption in 1980 in % of 1960	
	1960	1980		per caput	total
Asia (excl. USSR)	1,700	2,471	145	107	155
Asia (excl. USSR and China [2])	980	1,465	150	107	160
L. America	219	348	159	107	170
Africa	240	333	139	107	149 (150)

[1] Millions.

[2] Correction for China made by author.

It seems that we must aim for 1980 at an increase in foodproduction in Asia [1] by 60%, in Africa by 50% and in Latin America by 70% over the level of 1960. This increase can be brought about of course by an increase in yields per unit [2] or by an expansion of the farmarea, or a combination of these two means. In the following chapter an attempt will be made to gauge how much of the required increase can be allocated to each of these two means.

[1] Exclusive China.

[2] Say acre or hectare.

CHAPTER 8

THE SCOPE FOR AN INCREASE IN PRODUCTION

8.1. Two Ways to Increase Production

There are of course two ways in which production of food can be expanded: by an improvement in yields per unit, or by an expansion of the farmarea. A combination of these two will nearly always be used. It is however for our estimates of required investments of importance to discuss how much each of these two ways possibly can and will contribute, because there may be a large difference in the costs to create the facilities for the production of an extra ton of wheat by improving yields as compared with those of extending the wheatarea for the production of an extra-ton.

There are a number of unconventional ways to increase foodproduction. Most of these methods are still in the experimental stage and applying them at a large scale in the next 20 years would probably result in higher costs per unit of food than would a better application of conventional farming methods. However, as said before, this study does not enter into a discussion of unorthodox ways of producing food. It should also be remembered that this study is based on the assumption, that relative foodprices will not change.

8.2. Long Term Rate of Increase in Foodproduction

Reliable figures about the long term rate of growth of foodproduction are hard to find. Variations in crop from year to year make any comparison between volumes of production 5 or 10 years apart hazardous. If one takes a longer period however one will usually find in that period a major disturbance which makes the series unreliable. This is for instance true for a comparison between the average production of 1935–39 and any postwar period.

The figures discussed in chapter 5 suggest however that in the past foodproduction in larger areas and over longer periods has increased at rates between 1% and 2% per annum. Since 1950 the rate of growth seems to have been slightly higher than 2%. The already mentioned P.E.P. report [1] also concludes that over any larger period increases in agricultural production have seldom been over 2% per annum. Even in the U.S.A. agricultural output has increased at the rate of only 1.65% per annum since 1920 [2]. In Western Europe there seems to have been a long run increase in production of 2% per annum [3].

Since it is expected [1] that demand will in the period 1960–1980 increase at a rate of 2.3% per annum it is obvious that measures must be designed to ensure that production continues to increase at the post 1950 rate, or maybe even somewhat faster.

8.3. Past Improvements in Yields

Reliable figures about improvements in yield over a longer period are even rarer than growth rates for food production as a whole. There are, however, a number of indications that give some guidance [2]. They show clearly that yields have, in general, improved at a very low rate [3], but also that there are wide variations from year to year, crop to crop, and region to region.

James Bonner [4], after comparing for several countries rates of increase in agricultural production defined as production per acre-unit states, that the rate was usually roughly 2% per year. A large effort by the Rockefeller Foundation and the Government of Mexico resulted in an exceptional figure of 4% in that country; in India the rate seems in recent years to have been 3%. Bonner concludes that we may expect a rate of 2% in the future if a "sufficiently skilled effort is put up". If an "exceptional effort" is staged a rate of 4% can be expected.

Salter published in 1948, figures concerning the improvement in yield considered attainable by 1960, expressed in percent of the yields for the period 1935/39 [5]. Salter expected that on a world wide basis yields of

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[1] See chapter 7.

[2] See for instance annexes 19 and 20.

[3] Usually between 1% and 2% per year.

cereals would increase by 20%, those of roots and tubers by 50%, sugar 15%, fats and oilseeds 20%, pulses and nuts 20%, fruits and vegetables 35%, and meat and milk 20%. Assuming that Salter had in mind a period of about 12 years his estimates, or rather goals, are in the range of 1% to 2% per year, except for root crops, where he expects a rate of about 4%.

Data on increases in yield per hectare in the six countries of the European Economic Community indicate that [1] for the period 1948/52 to 1953/57 the range of increase was from 1.7% for sugar beets to 3.8% per year for barley. The milk production per cow increased by 2.1% per year, and meat output per animal by 2.3% [6]. These are rates for what is probably the most progressive region in the world.

There need not to be any fear that it will be difficult to improve yields further because they might be close to a physical or biological ceiling. Yields in most areas are still so low, that fairly simple measures may be expected to give substantial results. On the other hand one should not expect rapid increases in yields to a level that is considered technically achievable. Statements like those made by Oser in his book "Must Man Starve" [7], implying that it would be fairly easy to increase yields in "backward" areas to the European level, thereby doubling production, must be looked at with suspicion. They are overoptimistic because they do not take sufficiently into account the financial, institutional and educational difficulties that stand in the way of such an improvement. James Bonner [8] is probably right when he writes that it will take 30–50 years to raise farmproductivity [2] to twice the present level [3]. He adds that it will require an investment of 500 billion dollars.

8.4. Future Improvements in Yield

Taking all these indications into consideration it is proposed to use for further calculations the following improvements in yields per annum, for the period 1960–1980 for three important groups of crops.

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[1] At compounded rates of growth.

[2] Yield per acre.

[3] This is consistent with Bonner's statement that we can expect an increase of about 2% per year. Prof. Ir. G. J. TERRA expects however a rate of improvement of yields per unit of less than 1% per year (Economie, Tilburg, June 1956, p. 422).

TABLE 20. *Assumed improvements in yield*

	% per year	period 1960–1980
Cereals:		
S. America	1.5	30
Asia	2.–	40
Africa	1.5	30
Root crops:		
S. America	1.–	20
Asia	3.–	60
Africa	1.–	20
Pulses:		
Asia	1.–	20
Africa	1.–	20

The assumption for the 20 years period is derived by simple multiplication, since the basis for the annual rates is so uncertain that there seems no reason to apply the compound interest formula.

The F.A.O. statistics give no easy indication about the increase in yield for sugarcane, partly because the growing period of cane varies considerably from country to country. In general cane-yields have increased rapidly in countries where efficiently run estates are in operation. In Peru for instance yields increased by 2.7% a year over the period 1934/38 to 1954/56. In countries where cane is grown by peasants yields increase very slowly. In view of the uncertain future of estate-production it has been found prudent to assume an improvement in yields of sugar per average unit of 0.5% per annum.

No rate of increase for yields of oilseeds has been set, because there are so many of them, and also because some of the oilseeds are "by-products", like linseed and cottonseed. Moreover others grow as trees, like oilpalm and cocaonut, sometimes in a semi-wild state.

Special consideration must be given to the possible increase in per unit production of animal products like meat and milk. Here we have to deal with two factors: the productivity of the animal and the productivity of the land used for fodderproduction.

As far as the possible increase in fodderproduction is concerned the problem is analogous to that of the improvement in yields of crops in

general. There is no reason why unit yields of foddercrops could not increase by say 1–1.5% per annum, if one accepts such rates of increase for crops in general. As for pastures there are also several ways in which production per unit could be improved [1]. General experience makes it likely that improved techniques will be applied to a larger degree in cropproduction than with respect to pastures. In general it seems however reasonable to expect an overall improvement of yields of land used for fodderproduction by 1% per annum.

Regarding improvements in productivity per animal-unit [2] there are of course such factors as better breeding, the introduction of better races, better feeding practices, higher rates of culling. But progress will probably be slow, also because in general cattle-owners are more conservative than cropproducers.

F.A.O. statistics show that in Australia and Europe milkproduction per cow improved by only 1% per annum in the period 1934/38 to 1957. In North America the rate of improvement was close to 2% [9]. One can probably not expect more than a 0.5% per year improvement for the underdeveloped areas during the next 20 years. If one considers that a denser animal population may result from improved land use, and that the capacity per animal will be increased, then one can estimate, using the above mentioned percentages, a total increase in production of meat and milk per unit of land of 1% plus 0.5% or 1.5% per annum or 30% in 20 years.

Some consider the possibility to improve the productivity of animal husbandry much larger than that of cropproduction, probably because in most countries so little has been done yet to improve animal husbandry. For instance Pawley [10] claims that the resources and the technical basis exist for a level of production of livestock products of certainly not less than 5 times the present world output. This may be true for some regions, but it is unlikely to be applicable to the densely populated underdeveloped areas, with which this study is concerned.

8.5. Increase in Area

A comparison between the expected percentagewise improvement in

[1] Fertilization, planting of improved pastureplants, controlled watersupply, fencing, rotational grazing, etc.

[2] Milk and meat.

yields and the expected increase in demand will show that only part of the latter can be satisfied by improvements in yields. The possibilities to enlarge the agricultural area must therefore now be discussed.

A number of experts seem to be of the opinion that it will be possible without employing extra ordinary methods to enlarge the farmarea by one billion acres or 410 million hectares. James Bonner remarks however that most of the available land is to be found in the Americas and least in Asia [11]. Kellog, quoted by Black, believes that most of the available land is to be found in the tropics. He also mentiones a figure of one billion acres [12]. Salter of the U.S. Agricultural Research Service went in 1948 somewhat further [13]. He believes that in the tropics alone one billion acres land could be brought under cultivation. Moreover the cultivated area in the cool regions of the U.S.S.R., Canada and the U.S.A. could, according to Salter, be expanded by 300 million acres. The total possible increase in cultivated area is estimated by Salter at 1.3 billion acres [1].

Also Sir John Russell [14] sees possibilities for a considerable extension of the agricultural area, especially in the Americas. The possibilities in Asia are according to him much smaller. He does however not make an overall estimate.

According to the figures given in chapter 5 table 10 a total of 3.790 million hectares is now used for agriculture [2]. Compared with these figures the possibilities for expansion [3] are limited. This limit will however not yet be felt in the next few decades. There will be sufficient area of land available for expansion in the period 1960–1980 under consideration in this study.

It should however be realised that much of the available tropical land has poor soils. Terra remarks correctly about the tropics: "The soil is by nature very little productive, except in young volcanic and in alluvial delta-areas" [15].

8.6. Problems of Meeting Future Demand

It seems apparent that it will be technically possible to increase production by conventional means sufficiently to meet the demand of 1980. However,

[1] 530 million hectares.

[2] 1.380 million hectares for crops, and 2.410 million hectares for pastures.

[3] 1 billion acres or say 400 million hectares.

as Bonner points out, "the mere fact that it is theoretically possible to increase food production, should not blind us to the magnitude of the task. It is immense". We should also remember that as a rule "each successive increment in foodsupply may be expected to be a more costly one" [16].

This last admonition of Bonner refers to the wellknown Law of Diminishing Returns. This law was formulated as follows by Alfred Marshall: "Whatever may be the future development of the arts of agriculture a continued increase in the application of capital and labour to land must ultimately result in a diminution of the extra produce which can be obtained by a given extra amount of capital and labour" [17]. This wording is now considered to put things in a too absolute way. The theory of growth has taught us that capital formulation comes to a standstill during a period of unchanging techniques, that is to say, when the production function remains the same. It taught us also that economic growth emplies a continuous stream of inventions. This means that there is at any moment a given production function, but that this function changes continuously. The ratio between capital [1] and income remains, however, fairly constant as an average [2]. In this connection, the term "neutrality of inventions" is sometimes used. Some writers consider this phenomenon as a matter of chance, but Kaldor [18] states that the economic process itself in developed countries is the cause of this neutrality.

Oser denies that the Law of Diminishing Returns still applies and he draws attention to the increasing output per harvested acre of six important crops in the U.S.A. He concludes that the Law looses its significance in a dynamic developing country [19]. Oser has obviously been influenced too much by the economic environment in his country, that is, the environment of a growing economy in which technical improvements are adopted rapidly. A comparison between developed and underdeveloped countries discloses that there is in the developed countries the need for developing and applying new techniques in order to keep the economy growing, whereas the underdeveloped countries can manage for many years to apply technical processes which have been applied already to a considerable degree in the developed economies.

[1] Inclusive land.

[2] Apart from annual and seasonal fluctuations.

In this train of thought, the problem of meeting the future demand for food in the underdeveloped areas is not primarily a problem of inventing new techniques. Establishment of new research centers is not a matter of first priority. Prime consideration should be given to influencing the people by education and propaganda, to changes in the institutional framework and to supplying the funds required for the realization of improvements used already elsewhere. Development in those areas is, therefore, primarily a problem of economics, organization and education. Application of proven technical processes to the generally worn out lands in the underdeveloped areas will cost increasing amounts of capital. Most likely the Law of Diminishing Returns will apply to successive amounts of capital used to improve yields of lands already in production in Asia, Africa and Latin America.

Horace Belshaw, who knows the problems of underdeveloped areas very well, puts it this way: "Over a shorter period of a few decades there is no need to be alarmist over the possibility of increasing world food production at a sufficient rate...." But likewise there is no ground for optimism over the prospect of increasing consumption at current rates of growth in underdeveloped countries."... It is not simply a problem of population growth, or density of population. It should be defined in terms of relationship between size of population and the resources which can be utilized with existing capital at existing levels of technology, as effected by... economic and social structure and organisation" [20].

Jacob Oser seems very superficial and naive when he states: "a very conservative estimate would be that crop output could be doubled for the whole world on existing acreages. This is not a far-fetched goal. By using all the best agricultural methods which are already known, the world could reach that level of output. Fertilizers, manures, irrigation, drainage, better varieties of plants, erosion control, better tillage with machinery, the control of insects and diseases – these and other improvements could raise world yields per acre to the West-European level" [21]. Oser is of course right in stating that yields "could" reach the West-European level, if.... But that is exactly the point and the problem: how to finance and organize all the things that have to be done to transform the technical potentialities into reality.

8.7. How much to Expect from Each Factor?

In the beginning of this chapter it was stated that, so long one uses conventional methods of foodproduction, an increase in this production had to result from an improvement in yields, or in expansion of area or both. The question arises now how much can be expected from each factor.

The U.S. Department of State claims that 80% of the postwar increase in wheat production is due to improved yields, and that the same is true for 60% of the increase in rice production [22]. These estimates can however not be applied to future foodproduction as a whole.

In annex 21 some calculations are given based on assumptions earlier developed in this study. Line 1 of each of the three parts of the annex gives estimates of the necessary increase in supply based on the figures developed in chapter 7, tables 17 and 19. Line 2 gives figures about possible improvements in yields as estimated in 8.4, table 20. The difference between required increase in supply and what can be expected from improvements in yields has to be acquired by extension of the area. These quantities are indicated in line 3. The rest follows logically, and the results of the calculation can be summarised as follows:

TABLE 21. *Required increase in agricultural area over the period 1960–1980*

	Million hectares		
	Arable	Pastures	Total
Asia (excl. China and USSR)	21.2	41.5	62.7
Africa	7.3	6.6	13.9
Latin America	12.1	29.8	41.9
Total	40.6	77.9	118.5

The rest of this study will discuss how much capital will have to be invested to assure [1] that yields will improve as expected, and that the farmarea will expand as estimated above.

[1] Provided that the non-financial problems will be solved.

8.8. What Beyond 1980?

The interesting book "the Next Hundred Years", of which James Bonner is one of the authors gives some rather reassuring estimates about the relation between supply and demand for food for the coming century. The book estimates that the world's population will reach the 7 billion mark by 2050. It has already been stated that it would be technically possible to double the present volume of agricultural production. This would feed 4–5 billion people. If productivity later on could be raised to the Japanese level in Asia and to the European level in other continents the world could feed 6.5 billion people at a diet of 3000 calories a day, or 7–8 billion people at 2500 calories a day. Bonner concludes: "Conventional agriculture will apparently suffice to feed 7 to 8 billion people, although only at standards of living lower than those of the best fed people to day" [23]. This seems rather reassuring, although it should be realized that the above mentioned tight situation will probably occur after only one more century!!

CHAPTER 9

TYPE AND LEVEL OF INVESTMENTS

9.1. Public and Private Investments

Already in chapter 2 a distinction was made between public and private investments, because investment-decisions for each of these categories are governed by different sets of considerations. In this chapter the distinction is made, because each category comprises a different type of works. Public investments are usually made for the larger primary works, that can serve a large group of farms, whereas private investments are usually made in order to improve or enlarge one particular farm or a small number of farms.

One could also say that the private investments and public investments are complementary to each other. A significant improvement in farming conditions requires usually a certain amount of public investments, but these investments can bear fruit only if simultaneously additional investments are made by private people or groups of private people.

Public investments are as a rule made for projects that cannot or not easily be exploited on a commercial basis [1]. Further there are many projects that aim at the improvement of the agricultural situation in a region [2]. These can only be executed with a government subsidy, and the government will want to play a rôle in the execution of such projects in order to protect the general good. Then there are projects which can give benefits only after a considerable initial period, like irrigation-projects, or which are in the nature of pioneering. As a rule the government will have to tackle such projects, in one way or another. The government may plan

[1] As for instance roads.

[2] Like reallocation of land, consolidation of farms, assigning formerly tribally owned land to specific farmers.

to own and manage such projects permanently, or only for the initial period, or she may give certain guarantees or help in financing such projects [1] [1].

Examples of public investments are:

a. construction of transportfacilities, like ports, railways or roads, especially farm to market roads, but part of the investment in "general roads", ports and railways is also for agriculture.

b. construction of large landimprovementworks, such as clearing, irrigation, drainage, leveling; these works serve to open new land for farming, or to improve land already in use.

c. construction of plants for processing and storage, or facilities for marketing; these works are sometimes financed by groups of farmers [2].

d. acquisition of machinery for "pool" operations.

e. addition to funds of agricultural banks.

f. investments in government installations, such as for instance demonstration farms, experiment stations, equipment for field services.

Examples of private investments are:

a. small farmland improvement works, as clearing, leveling, deepplowing, liming, supplying basic fertilizer stock, farmroads.

b. investments in farmbuildings, stables, silo's, barns.

c. improving watermanagement by digging wells, installing irrigation or drainage pumps, digging of irrigation- or drainageditches.

d. investments in equipment.

e. increasing the livestock of the farms.

f. increasing stocks in general.

g. participating in co-operative undertakings [3].

h. investments in schooling and training.

9.2. Collecting Information on Investments

It is usually possible to collect fairly complete information on past or future public investments in agriculture. The authorities which compose national income statistics for a country have usually the basic information

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[1] Cheap loans or a contribution to capital.

[2] See g under "private".

[3] See c under "public".

on hand. Most of the estimates for future investments can be collected from the Ministries of Agriculture, Public Works and Finance and from the Agricultural Banks, Planning Offices and similar institutions.

Much more difficult is it to collect information on private investments. Here again the offices which compile national accounts are a good source of information, but even they will soon admit that their knowledge of the subject of private investments in the farmsector is very limited. Some of the reasons for the limits of this kind of knowledge are obvious: the large number of small firms; usually no bookkeeping records; little urge to make information available, etc. There is however a more fundamental reason: the fact that such a great part of the investments on the farm occurs without money transactions.

"Irrespective of the general approach to measuring investment in construction, it is extremely unlikely that the bulk of own account construction by farmers will be covered without special efforts", states Abraham in his article on investment estimates in underdeveloped countries [2]. "Since improvements to their farms made by farmers may account for a sizeable fraction of the gross investment in the agricultural sectors of the less industrialized countries, the omission of such investment may well limit the usefulness of capital formation statistics for many purposes, especially where policies are being pursued to develop agriculture, where the agricultural population is growing rapidly, etc.". "Direct improvements to farms may take many forms, including the construction of barns, fences, roads, the digging of wells and irrigation ditches, and terracing lands. Not many countries make adequate allowance for these capital improvements, probably because of their preoccupation with investment in heavy industry and because of the statistical difficulties involved. These difficulties are of two kinds. In the first place, the extent of such construction activity must be determined. Secondly, a suitable basis for valuing the construction must be found" [2]. Abraham also mentions in his article the difficulties of evaluating changes in stocks.

9.3. Overall Figures on Investments in Agriculture

In annex 22 are listed estimates on total [1] gross investments in the

[1] Public plus private.

agricultural sector in 1952, 1953 and for some countries a recent year. These estimates are based on national accounts, as found in various publications. The totals have been expressed per unit of population connected with agriculture, per hectare of arable land, and per hectare of agricultural land [1]. The most significant figures are probably those pertaining to investments per hectare of arable land and per hectare of agricultural land. The amounts per hectare of arable land have been calculated by dividing the total by the number of hectares of arable land. This implies the hypothesis that no investments were made on pasture land, which is obviously incorrect for countries like the Netherlands and Denmark. However, this procedure comes closer to reality in underdeveloped countries. The two series of figures [2] have to be considered as indications of the limits within which investments per hectare arable land have been made. In underdeveloped countries the truth will be closer to the figures in column 5, and in more developed countries it will be closer to the figures in column 6.

Annex 23 gives similar information based on sets of National Accounts published by the United Nations Secretariate. The totals, converted in US dollars, have been expressed per unit of agricultural population and per hectare of arable land.

These over-all figures have only a very limited value, but they give us an opportunity to find some indications about the historic level of investment. The figures include investments for the production of raw materials [3] and possibly for fishing and forestry. These "impurities" cannot be eliminated but they do not seriously distort the over-all picture. Another problem is that the estimates for the agricultural sector include allocated amounts spent on multipurpose projects. Such allocations are often made on other than economic grounds. Here again it is at this stage of the research impossible to correct the over-all estimates for this factor.

There are some striking differences of level in the figures in the column "dollar per unit of agricultural people" in annexes 22 and 23.

The countries can be grouped in four classes:

a. Investments very high; over 100 dollars per head: Canada, U.S.A., Norway, Israel.

[1] Arable and pastures.

[2] Investments per hectare agricultural land and per hectare arable land.

[3] Fibers, rubber.

b. Investments high; between 40 and 80 dollars: Austria, Denmark, the Netherlands, Finland, Sweden, Mexico, O.E.E.C. countries as a whole.
c. Investments medium; between 10 and 20 dollars: Italy, United Kingdom, Chile.
d. Investments low; less than 10 dollars: Portugal, Turkey, Greece.

The amounts in the column "dollar per hectare arable land" are also spread over a wide range, from about 100 dollars per hectare in Norway and Israel to only 0.4 dollars per hectare in Turkey [1]. Here too the countries can be grouped in a few classes:

a. Extraordinarily high investments; about 100 dollars or more per hectare: Norway and Israel.
b. Very high investments; 30 dollars or more per hectare: Austria, the Netherlands, Italy, Finland, United Kingdom recently, Sweden, Taiwan, and the O.E.E.C. countries as a whole.
c. High investments; 12 to 25 dollars per hectare: Denmark, Finland, United Kingdom, 1952 and 1953, U.S.A., Canada, Ecuador, Honduras.
d. Medium investments; 3.5 to 10 dollars per hectare: Ireland, Greece, Portugal, Mexico, Chile, Argentina.
e. Low investments; 1 dollar or less per hectare: Turkey, Burma.

A comparison between the investmentsfigures and the indexfigures of volume of production reveals no clear relation between level of investment and rate of growth of foodproduction. This is true for the figures per head of agricultural population as well as for the figures per hectare. A first reason for this lack of relation is that the data are too crude for the detection of a relation between growth of production and investments, which would actually be the determination of ICOR for agriculture. For such determination one ought to have series of data for a number of years, and one ought to account for the time-lag between investment and increase in production. Moreover the influence of the socalled autonomous improvement of labour-productivity, or area-productivity should be eliminated. Even if such calculations would give reasonable results, there would be probably considerable differences in ICOR from country to country. Some countries are able to attain a certain increase in production with but little investments per average hectare. Others have to spend

[1] Since 1952/53 investments in Turkish agriculture have increased very substantially.

much money to attain a similar increase. This may be so because of adverse physical conditions like in Norway, or because all the cheap improvements have already been established long ago, like in the Netherlands and Italy or a combination of these two factors.

It is however quite likely that there will be a rather close relation between level of investments and increase of production for a whole continent or even more so for the three continents, Asia, Africa and Latin America together.

Despite these difficulties it seems possible to detect from the figures of annexes 22 and 23 some indication of the amounts that are under present conditions to be invested per hectare in order to achieve an increase in production of one percent. The annexes include figures of only a few more or less underdeveloped countries. This is not surprising, because the statistical data necessary for the composition of national income accounts are seldom available in such countries. Especially data on investments will be rare. Nevertheless there are figures about 8 more or less underdeveloped countries in these tables, and these figures are reproduced below.

TABLE 22. *Level of investment and increase in production*

Country	Gross Investment in Agriculture [1]		Increase of production per year in percent of base year
	per ha. arable land in dlrs.	per ha. agric. land in dlrs.	
Turkey	0.4	0.2	5
Greece	3.5	1.4	2
Mexico	9.7	2.1	4
Chile	5.8	5.3	3
Argentina	5.–	1.1	1.5
Ecuador	16.–	5.5	2 [2]
Honduras	14.–	4.7	— [2]
Taiwan	55.–	54.–	4 [2]

The investment figures for Turkey are certainly too low; they increased very much in later years; those for Taiwan are probably higher

[1] Public and private.

[2] Author's own estimate.

than normal. The figures about the 6 other countries give an indication that with an annual investment of less than 5 dollars [1] per hectare agricultural land an increase in production of about 2% per year could be originated.

9.4. Levels of Programmed Investments

In annex 24 are shown for a number of socalled underdeveloped countries the figures for programmed investments in the agricultural sector as recommended by Surveymissions sponsored by the Worldbank. These missions made their recommendations in different years, with different pricelevels. This carries however not much weight since all the missions occurred between 1950 and 1958, and since these estimates are so approximate that the differences in pricelevel do not matter.

The figures of annex 24 are not comparable with those of annexes 22 and 23 because the missions were usually not in a position to recommend or to forecast a level of total gross investments in agriculture [2]. What they did, more or less completely, was to indicate what, according to their overall program, should be invested in certain projects or programs. The figures are almost exclusively about public investments and they come in this respect closer to what this study aims to estimate.

For only a few of the countries in annex 24 are census data available about the agricultural population. The amounts per head of the population are rather high [3] in British Guiana, Jordan, Syria and Iraq. They are estimated at between 1 and 2 dollars in Ceylon and Jamaica and at less than 1 dollar per head in Turkey, Guatemala, Malaya and Nigeria. If one excludes British Guiana, where the thin population creates special problems, one could perhaps say that the programmed investments tend to be rather high in dry, arid countries, but generally low in humid tropical countries.

If one assumed, that the agricultural population is about one half of the total population of the countries mentioned in annex 24 [4], it could be said that programmed investments are between 1 and 13 dollars per head of the agricultural population. This would bring the countries of

[1] Average about 3 dollars.

[2] Public plus private.

[3] 3–10 dollars.

[4] Again excluding British Guiana.

annex 24 in the range of the countries with medium investments per head of agricultural people of annex 22, allowing roughly for the fact that the programmed investments in general include only public investments.

The programmed investments per hectare arable land are high in Ceylon and Jamaica [1]. They are substantial in British Guiana, Jordan, Syria and Iraq [2] and they are low in Turkey, Guatemala, Malaya and Nigeria [3]. These groups, again allowing for the fact that the programmed investments in general include only public investments, are in the same range as the groups with high, medium and low investments, per hectare arable land of annex 22.

Annex 25 gives for a number of countries in Africa and Asia figures about investments in agriculture as presented in their national development programmes. It can safely be assumed that these figures are mainly about investments in new public works, as in the case of the data of annex 24.

Taiwan shows again as in annex 23 abnormally high figures. Those of the African territories are on the other hand very low. If one excludes Taiwan, one finds for the remaining set a range of investments per hectare arable land from 0.2 to 15 dollars, and per hectare agricultural land from 0.15 to 10 dollars. These figures are of the same order of magnitude as those of annex 24.

9.5. The Range of Total Investment

In annexes 22 and 23 are included the figures of 8 more or less underdeveloped countries [4]. If one excludes Turkey [5] and Taiwan [6], then it appears that in the remaining 6 countries gross investments per ha arable land range between 3 and 16 dollars per annum, with an average of 9 dollars. Investments per hectare agricultural land range from 1.5 to 5.5. dollars per annum with an average of about 3 dollars.

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[1] Over 10 dollars per hectare arable land.

[2] Between 3 and 6 dollars per hectare arable land.

[3] Around 1 dollar per hectare arable land.

[4] See 9.3, table 22.

[5] Because the figures are abnormally low.

[6] Because the figures are abnormally high.

The figures of annex 24 about programmed [1] investments work out at an average of 4.7 dollars per hectare arable land, resp. 2.7 dollars per hectare agricultural land. Those of annex 25 give an average of 6.7 dollars per hectare arable land, or 4.6 dollars if Taiwan is excluded.

These two sets of figures are not contradictory; they can be reconciled. In the first place do the figures of annexes 22 and 23 represent historic gross investments on a national account basis. They should therefore include public and private investments and in both categories investments for replacements as well as investments for renewal and extension. On the other hand the figures of annexes 24 and 25 include mainly estimates for public investments for new projects. It should be realized that new projects are usually in part replacement of existing facilities, and in sofar do the here mentioned figures for public investment include an element of "replacements". This represents however only part of total necessary investments for replacements. In general public investments for replacements and private investments are insufficiently represented in these figures.

On the basis of experience with a number of agricultural projects, it can be estimated preliminarely that each amount of public investment requires almost an equal amount of private investment in order to bring the established works into full production. Conversely one can say that the amounts of gross overall investments include about equal amounts of public and private investments.

The following figures are therefore probably not too far off.

TABLE 23. *Level of investment per hectare* [2]

		Investments		
		Public	Private	Total
Historic figures	per ha. arable land	4.5	4.5	9
	per ha. agricul. land	2.–	1.5	3.5
Programm. figures	per ha. arable land	4.7 [3] (rounded off to 5)		
	per ha. agricul. land	2.7 (say 2.75)		

[1] Mainly public.

[2] In dollars per hectare.

[3] Excluding the figures for Taiwan.

The three continents in which this study is interested include in total [1] about 760 million hectare arable land and 1400 million hectare pastures, in total 2160 million hectare agricultural land. Using the above historic figures as averages it seems that in the decade 1950–1960 per year about 6.8 billion dollars were spent on improvements and extension of arable land, and in total 7.6 billion dollars on all agricultural land.

This investment helped to bring about an increase in production of about 2% per annum [2]. This figure compares very well with the overall figures on increase in production given in 5.1. It has been estimated in 7.8 that foodproduction will have to increase by 2.3% per annum in the next two decades. Such an increase might require an investment of about 10% more than the level in the decade 1950–1960, or about 10 dollars per hectare arable land resp. 4 dollars per hectare agricultural land. If this is acceptable then we can complete the figures on programmed public investments as in tables 24 and 25. The distribution of total investments between "public" and "private" has been changed from the almost fifty-fifty pattern, because the figures of the lower part of table 23 indicate that the figures for "public" investments per hectare agricultural land should be 2.5 dollars rather than 2 dollars.

TABLE 24. *Level of required annual investment based on the historic figures of table 23, plus 10%*

	Investments			Million hectares	Totals in billion dollars
	Public	Private	Total		
Arable land	5	5	10	760	7.6
Agricul. land	2.5	1.5	4	2,160	8.6

The totals for public investments alone would be:

[1] See annex 29.
[2] See 9.3.

TABLE 25. *Level of required annual public investments based on the programmed figures of table 23*

	Dollars per hectare	Million hectare	Totals in billion dollars
Arable land	5	760	3.8
Agricul. land	2.5	2,160	5.4

These figures are of course very rough, and they are only intended to give a first idea of the magnitude of the amounts involved.

CHAPTER 10

INVESTMENTS FOR NEW LAND AND FOR LANDIMPROVEMENTS

10.1 Introduction

In this chapter an attempt will be made to estimate seperately what investments should be made for the extension of the agricultural area, and what sums should be invested in the improvement of land already in farms. The first estimate will be made on the basis of data for specific projects. The second estimate had to be made on the basis of the general figures found in chapter 9.

10.2. The Costs of Projects of Various Types

In annex 26 data have been collected about a great number of projects in four important fields of agricultural development: irrigation, reclamation [1], settlement projects, and storage works. The data are culled from two main sources: reports about projects which have been under consideration for financing by the International Bank for Reconstruction and Development [2] and the already mentioned series of I.B.R.D. reports about the "Economic Development of..." [3]. Two other sources are mentioned in the first column of the annex. Some information about the location and the character of the projects is also included. The most important column for the purpose of this study is of course the last one, which indicates the estimated investment per hectare [4]. All figures are about the costs of public works, unless otherwise indicated.

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[1] In a broad sense.

[2] Marked "project".

[3] Marked "bank".

[4] Or per ton static capacity for the storage projects.

At first glance it seems that there is no order at all in these figures. However after closer scrutiny some ranges of costs can be detected. For instance:

a. irrigation works, which need a high dam, and detailed distribution works may cost about 1500 dollars per hectare.
b. irrigation projects, using a high dam, but in which only the main canals are included in the public costs: between 750 and 1000 dollars per hectare.
c. irrigation projects, which need only a diversion dam, and main canals: 500 dollars per hectare.
d. irrigation projects, which divert water out of a main river as supplementary irrigation; only main canals: 300 dollars per hectare.
e. pumping schemes, and small works: 300 dollars per hectare.
f. drainage of low coastal areas: 300 dollars per hectare.
g. drainage of low inland areas: 100 dollars per hectare.
h. reclaiming formerly used land: 30 dollars per hectare.
i. light jungle clearing: 50 dollars per hectare.
j. heavy jungle clearing: 100 dollars per hectare.
k. land leveling: 10 dollars per hectare.
l. cost of settling farmers on large farms: 250 dollars per hectare.
m. cost of settling small farmers: 500 dollars per hectare.
n. private investment to develop irrigated land: 500 dollars per hectare.
o. private investment to develop irrigated orchards: 1000 dollars per hectare.
p. simple storage facilities of local material: 5 dollars per static ton.
q. permanent warehouses for long time storage: 50 dollars per static ton.
r. modern silo's, with moving equipment, per static ton 100 dollars.

All these figures are of course very rough, and in any specific case the costfigures may vary widely from the above. Especially these figures should not be used to judge whether a specific project is expensive or cheap. The economic evaluation of a project should never be based on costfigures alone but always on a comparison of costs and benefits [1].

10.3. Hypothetical Program for Landdevelopment and Its Costs

The figures of 10.2 have been used for an estimate of the costs of public

works necessary to develop the areas of new land mentioned in chapter 8.7. The calculations are shown in annex 27.

For each of the three continents a hypothetical land development program has been drawn up; in the composition attention has been paid to the particular conditions in the area concerned. It has been assumed that a large part of the required area of new arable land ought to be irrigated, and that the greater part of this land will need clearing of brush or trees and leveling. Many hectares will therefore require a succession of works, like irrigation, clearing and leveling.

It is also expected that the governments will want to settle the farmers in the new areas so, that they will be able to produce well after a short time. This is a costly operation in terms of investment, but if it is neglected to do this it will take a long time to bring the new land into full production and the economics of the operations will be adversely affected. Also in that case, more land would be required to meet the foodbill of 1980. The cost of settlement could conceivably partly be met by way of farm-credits, to be repaid by the settlers, but even so initially this work has to be financed from public funds.

Although the landdevelopment programs are purely hypothetical and although there is much uncertainty about the investments per hectare, there is nevertheless a good chance that the totals indicate properly the order of magnitude of the amounts of public investments required for the development of new land. Summarized the figures are:

TABLE 26. *Public investments to develop 118.5 million hectare new land* [1]

	Asia	Africa	Latin-America	Total
Arable land	15.5	4.4	9.5	29.4
Storage	2.5	0.35	0.9	3.75
Pastures	13.–	2.05	3.7	18.75
Total	31.–	6.8	14.1	51.9

The average investment per hectare agricultural land would be 438 dollars.

[1] In billion dollars.

These amounts should be spent during the next 20 years, so that the annual amount should be in total 2.6 billion dollars [1].

It should be noted that the above amounts do not cover all types of public investments required to develop new lands. For instance nothing is included for additional agricultural services [2], marketing-, processing-, nor transportfacilities. The estimate is purely for public investments in the development of new land untill readiness for production and for storage of the harvested crops.

As pointed out already earlier a very large amount of private investments will be involved in the further development, and the initiation of the exploitation of these new lands. These private investments might be almost as high as the public investments. It depends very much on the particular conditions of the area and on the type of farming to be practised on it. But it should always be remembered that a great deal of these private investments will be made in kind [3] and not in money.

10.4. Investments for Improvement

In annex 21 estimates have been made about the total required increase in supply of a number of important foodstuffs, and about which part of the total could reasonably be expected from increases in yield. The rest would have to be produced on new land.

The question is now: what investments will have to be made in order to realize the expected improvements in yield of land already in farms? No direct information is available on this score. However, an idea of the order of magnitude can be derived from the investment figures developed in chapter 9.5. It was estimated there that probably in the decade 1950–1960 a sum of 7.6 billion dollars was invested per year in agriculture; $\frac{4}{7}$ of this total or about 4.3 billion dollars would have been public investments. It has also shown in annex 10 that in the period 1950–1956 only 80.000 hectares new arable land has been developed. This is a very small area compared with the estimated requirement [4] of 40.600.000 hectares

[1] For Asia 1.55 billion, for Africa 0.35 billion, and for Latin America 0.7 billion dollars.

[2] Experiment stations, etc.

[3] Labour, materials, increase in livestock.

[4] See chapter 8.7.

new arable land. In chapter 10.3 it has been estimated that the development of 40.6 million hectares new arable land would cost 29.4 billion dollars in the form of public investments; that is 720 dollars per hectare. Using this figure [1] for the period 1950–1956 it appears that the development of 80.000 hectares may have cost 57.6 million dollars in 7 years or about 8 million dollars per year. In addition some million of dollars will have been spent on extension of the pasture-area. Any way it is clear that out of the public investments in agriculture of 4.3 billion dollars roughly 4 billion dollars will have been used for the improvement of land already in farms. This is at a farmarea of 2.160 million hectares [2] almost 2 dollar per hectare per annum.

With this investment has been realized an increase in production of about 2% per year. For the decades 1960–1980 a 15% greater increase is required. The amount necessary to improve land already in farms might therefore be put at roughly 2 dollars per hectare per annum. This investment per average hectare farmland would result in a total per annum of 2160 million times 2, or 4.3 billion dollars in public investments.

10.5. The Estimate of Total Public Investments

Total public investment required for satisfying the estimated increase in demand will be:

	per annum	period 1960–1980
for new land	2.6 billion dollars	51.9 billion dollars
for improvement	4.3 billion dollars	86.– billion dollars
	6.9 billion dollars	137.9 billion dollars

The total can be distributed over the three continents in the following way: (See table 27)

The annual total of roughly 6.9 billion dollars in public investments compares with the "historic" figure of chapter 9.5 of 4.3 billion dollars, and the figure of "required" investments of the same paragraph of 5.9

[1] Changes in costs of construction have been neglected since the figure is too approximate for such adjustments.

[2] See annex 29.

TABLE 27. *Public investments, per continent and in total*

Continent	Required new land mln. ha.	Costs per ha. in dlrs.	Total a in bln. dlrs.	Land to be improved min. ha.	Costs per ha [1] in dlrs.	Total b in bln. dlrs.
Asia	62.7	438	27.5	994	40	39.7
Africa	13.9	438	6.1	695	40	27.8
Latin America	41.9	438	18.3	470	40	18.8
Total	118.5	438	51.9	2159	40	86.3

Continent	Total a + b in bln. dlrs.	
	20 years	per year
Asia	67.2	3.4
Africa	33.9	1.7
Latin America	37.1	1.8
Total	138.2	6.9

billion dollars [2]. It is over 50% above the historic figure, mainly because it will be necessary to develop new land at a much higher rate than has been done in the past. If this for some reason is found to be undesirable, or technically speaking not feasible [3], then more attention will have to be paid to more intensive improvements of land already in farms. In other words in that case less money will be spent on new land but more on "old" land. Such a shift would influence the total figure considerably, because a more rapid improvement of yields per unit, than foreseen in chapter 8, table 20, would require rapidly increasing amounts per hectare. This is according to the Law of Diminishing Returns as discussed in chapter 8.6. It is improbable that the productivity of the land already in production can be improved rapidly without a considerable increase in costs. In that case the development would not be conform the desideratum that production should be increased without a relative increase in prices.

[1] Twenty times the costs per annum of 2 dollars.

[2] See for a summary annex 28.

[3] For instance because not enough projects have been prepared in enough detail to permit opening of contractnegotiations.

10.6. The Foreign Exchange Component

The foreign exchange component for the investments estimated above will vary very much with the type of project and with the state of development of the country in which the project will be located. For instance the foreign exchange costs of a simple irrigationproject, consisting of an earthdam and a number of unlined canals with gates made of timber will be low, especially if most of the work is done by human and animal labour [1]. On the other hand: an irrigation project requiring a high concrete dam, lined canals, steelgates and some pumpingplants may require a large percentage of total costs to be spent in foreign exchange.

Also: leveling operations using pairs of oxen and simple scoops will cost little foreign exchange: the introduction of motorized equipment would increase the foreign exchange component very much.

With respect to countries the following examples can be given. Refined and complicated irrigation projects in Italy cost that country very little foreign exchange, because almost all the equipment, materials, and structures are produced in that country. Raw materials for the production of machinery and structures form almost the only item of import.

A similar project to be executed in a country that does not possess its own industry of cement, steel and machinery, and does not educate enough engineers and other technicians in its own schools, may have a foreign exchange component of over 50% of total public investments.

As a general average, based on experience and on the figures quoted in chapter 1.10, one might say that 30% of the public investments in land-development works would be in foreign exchange. The percentage might be lower for projects in India and certain Latin-America republics, but higher for most African and Near Eastern Countries.

[1] As is sometimes the case in India.

CHAPTER 11

COMPARISON WITH OTHER ESTIMATES

11.1. The U.N. Estimate

The attempt made in this study to estimate the amount of investments required to help accomplish an adequate rate of development in agriculture is certainly not the first one ever made.

Already in 1951 the United Nations Secretariate published a study about the level of investments that would be required in order to achieve a certain rate of development in the underdeveloped countries [1]. This study is based on the thesis that a transfer of workers from agriculture to other occupations would be required in order to achieve a perceptable increase in per caput income. However the report discusses also an estimate of the amounts thought to be required for agriculture. The table op page 76 of the U.N. report shows estimates of investments required for two purposes: a. to increase national income by transferring workers out of agriculture into non-farms occupations; and b. to increase yields in agriculture [1]. It is assumed that it would be necessary in order to achieve a certain rate of development, to transfer per year 7% of the working population. The report estimates that an investment of 2500 dollars per person would be involved in this operation. For agriculture, the report assumed that the underdeveloped countries should spend 1% of their national income on extension services and research, and that a further 3% of national income should be invested in agricultural capital goods on and off farms. It is not quite clear whether these assumptions refer to all types of investments [2]. It is most likely that the U.N. assumption refers mostly to public and private monetised investments, since the

[1] Not production, but yield per acre, page 78.

[2] Public and private, monetised and non-monetised.

assumption refers to national income. Subsistence non-monetised-peasantagriculture is usually insufficiently represented in estimates of national income. It is a pity that the basis for the rule that 3% of national income should be invested in agriculture is not disclosed. There is doubt whether this percentage is based on actual investmentfigures.

The combined effect of the investments made at the level indicated by the U.N. assumption would be a rise in national income by 2% per year and an average increase in the yield per acre of 2½% per annum over the next 10 to 20 years.

The table in the U.N. report includes the below mentioned amounts of required annual investment for agriculture per region, to which we added in order to facilitate a comparison our estimates as discussed in chapter 10.

TABLE 28. *Comparison of estimates of required investments in agriculture* [1]

	U.N. Report	This Study	
		for improvement	total
Latin America	960 million dlrs.	0.9 bill. dlrs.	1.8 bill. dlrs.
Africa, excl. Egypt	528 million dlrs.	1.4 bill. dlrs.	1.7 bill dlrs.
Near East + Egypt	360 million dlrs.		
S.O. Centr. Asia [2]	960 million dlrs.		
Far East, excl. Japan	1.056 million dlrs.		
Asia	2.376 million dlrs.	2.– bill. dlrs.	3.4 bill. dlrs.
	3.864 million dlrs.	4.3 bill. dlrs.	6.9 bill. dlrs.

Since the U.N. estimate is obviously only for improvements of yields, it should be compared with our estimate for that purpose. Both estimates are made on a simple basis: the U.N. estimate on the assumption that 4% of national income should be applied for this purpose; the figure of this study on the estimate that it would take on average 2 dollars per hectare of farmland to bring about the average required improvement in yields.

The different bases of the estimates account for the variety in figures for the separate regions. For instance, the U.N. figure for Africa is very low because national income is low; while the estimate for that continent in this study is much higher because of the large area of agricultural land to

[1] Amounts per annum.

[2] India, Pakistan, Ceylon, Maldive Islands.

be improved. The basis for the estimate of this study, which ties investments to the area to be improved, seems more logical than the U.N. assumptions.

It seems that the U.N. estimate in total is almost at the same level as the present estimate for improvement of land already in farms.

This is however in fact not so, because the present estimate refers only to public investments, whereas the U.N. estimate probably also includes monetised private investments.

Dr. E. de Vries [2] has revised the U.N. estimates, and he came to the conclusion that it would be necessary to allocate 5% of national income to the development of agriculture in order to increase agricultural production by 0.75% per annum more than the expected annual increase in population. Dr. de Vries' figures are:

TABLE 29. *Required investments in agriculture according to Dr. E. de Vries*

Latin America	1.200 million dollars per annum
Africa	570 million dollars per annum
Asia	2.350 million dollars per annum
Total	4.120 million dollars per annum

The total is almost equal to the present estimate for landimprovement, but lower than the present total estimate. This discrepancy appears to be quite large if it is remembered that the figures of Dr. de Vries probably refer, as the U.N. figures do, to public and private monetised investment.

11.2. Some Further Estimates

Dr. Abbas [3] made some estimates of the investments required to develop a group of 7 Asian countries [1]. These countries include the bulk of the population of Asia [2] and Dr. Abbas' figures can therefore be compared with the present estimate for Asia. Dr. Abbas based his estimates, as did the U.N. Secretariate, on the thesis that national income can be increased by transferring workers from agriculture to other

[1] Ceylon, India, Indonesia, Burma, Thailand, Pakistan and the Philippines.

[2] Excluding mainland China.

sectors of the economy [1]. He used the rule of thumb that 25% of national investments should be allocated to agriculture. The figures shown in annex 2 indicate that in really underdeveloped countries more than 30% of gross domestic capital formation is invested in agriculture. This percentage diminishes as the country develops and diversifies its economy. A percentage of 25 seems however not too far off as a general average.

On this basis Dr. Abbas works out three cases, which can be presented in a condensed way as follows:

TABLE 30. *Estimated annual investments for 7 Asian countries*

	Total	For Agriculture
a. Per caput income constant	1,493 mill. dlrs.	373 mill. dlrs.
b. Per caput income increases by 1 dollar per annum	6,341 mill. dlrs.	1,568 mill. dlrs.
c. Full employment and 2 million workers per annum transferred to non-agricultural jobs	12,998 mill. dlrs.	3,249 mill. dlrs.

The estimate of case c. is of the order of the present estimate for Asia [2]. However, Dr. Abbas' estimate suffers from the same deficiency as the U.N. estimate: there is no clear independent basis for the estimates on agricultural investments.

Ecafe has recently published an interesting study on the development of its region [4]. The study states, that if fertility of human beings does not change in the next decades, minimum caloric requirements would increase by a range of from 90% to 140% above the 1955-levels of food supply by 1980, dependent on the increase in per caput income. If fertility would decline by 2% per annum, food supplies would have to increase by 70%–110%. Ecafe uses, in order to arrive at an estimate of required investments, the same method as the U.N. study of 1951, but the figures are different. Instead of the U.N. figure of 2500 dollars investment required to establish a farm worker in a non-farm job, Ecafe uses a figure of 1500 dollars, after having examined various development plans of Asiatic countries. The annual capital requirement for the Ecafe

[1] Industry.

[2] 3.4 billion dollars.

region is estimated on this basis at 13.5 billion dollars, or 14% of the aggregate income of this area, or 10 dollars per caput. If we apply the rule of thumb that 25% of total investments should be for agriculture, investment for this sector would be 3.4 billion dollars in total, or 3.5% of aggregate income or 2.50 dollars per person per annum. If one assumes that the area for agricultural land in the Ecafe region is about equal to the area for the Far East as shown in annex 29 [1], then it appears that Ecafe's estimate for required investments in agriculture is about equal to 5 dollars per hectare per annum. Ecafe's estimates for investments for agriculture is at the same level as the present estimate [2], but again it should be remembered that the present estimate is for public investments only, whereas the Ecafe estimate probably includes also monetised private investments.

Takashi Ihara [5] compared four estimates of investments required for the development of South East Asia. These four estimates include the already discussed studies of the U.N. Secretariate and of Dr. Abbas, and furthermore an estimate made in 1949 by F.A.O. and one made by Mr. Singer.

Ihara uses also the rule of thumb that 25% of investments should be allocated to agriculture. This rule has already been applied by the U.N. Secretariate and by Dr. Abbas, and Ihara applies it to the two other estimates as well.

The following table is derived from Ihara's article:

TABLE 31. *Funds required for the economic development of South Eeast Asia* [3]

	Rate of Pop. Growth	Amount per Annum bln. dlrs.	Funds for Agriculture		
			Total biln. dlrs.	Dollar per Head	Dollar per hectare Arable
U.N. 1951	1.25%	6.5	1.6	3.–	4.5
F.A.O. 1949	1.5	4.9	1.2	2.6	3.2
Singer	1.25	11.3	2.8	5.1	7.7
Abbas 1956	1.33	6.3	1.6	3.–	4.2

[1] 636 million hectares.
[2] 3.4 billion dollars.
[3] Exclusive China.

All estimates are well below the present estimate for Asia [1] as could be expected from the previous discussion of the estimates of the United Nations and of Dr. Abbas.

The important difference between our estimates and the others mentioned in this chapter is, that the others use an indirect method for estimating investmentrequirements for agriculture. They estimate overall investment requirements and apply then the 25% rule. Our method is a direct one. We base our estimate on figures about growth in population and improvements in standard of living, and estimate then the increase in demand for food. Next we estimate in how far this increase in demand can be satisfied by an improvement in productivity or an extension of farmarea. Finally we estimate the amounts required to achieve these goals, limiting ourselves to public investments.

[1] 3.4 billion dollars.

CHAPTER 12

AN OUTLINE OF REQUIRED RESEARCH

It was already indicated in the Introduction that this study raises more questions than it answers. Especially in the last few chapters it was clear that not enough basic knowledge is available for estimating reliably the required level of investments.

Research about probable increases in population is well in hand at the U.N. Secretariate and some private institutions. The results of these investigations can be used profitably, but they should be adjusted periodically. It is nowadays also possible to make reasonable assumptions regarding the future improvement in per caput income on the basis of research work now in progress at various institutions. But from there on research will have to be done extensively if it is desired to make an estimate of required investments in foodproduction that is accurate enough for use as a direct guide for policy. Such an estimate would have to include figures for specific regions and specific methods of increasing the production of food. Our study is only a reconnaissance survey and can point only to the importance of the problem. It does not give a basis for action in specific cases.

More ought to be investigated about the effect of increases in income and changes in social environment [1] on the pattern of consumption and the composition and quantity of diet of people in underdeveloped areas. The possibility of influencing the pattern of consumption, in order to achieve a "cheaper" diet, should also be investigated. On this basis a more concise estimate of the development of demand should be made. F.A.O. is paying attention to this subject.

Much research will have to be done in order to estimate what improvement in yield per unit reasonably can be expected taking into account the

[1] In short: economic development.

physical characteristics of soil and climate, the human factor, socio-political factors, and available techniques of education and propaganda.

Many investigations are also needed to find out in some detail where the farmarea suitably can be extended and how, and what production could reasonably be expected from such new land.

The costs of realising the improvement in yield and extensions of area ought to be investigated and to be expressed per unit of diet. It is possible that one Standard Nutrional Unit [1] can be much cheaper produced on the basis of rootcrops than on the basis of rice. Therefore a few alternative ways of meeting the increase in demand should be investigated and compared.

On the basis of this information a tentative decision can be made about the portions of the expected increase in demand that could be met from improvement in yields and from extension of areas. Thereafter a program for both types of actions can be drafted, and the social, organisational and economic problems involved in the realisation of the program can be studied. In the process of formulating the program account should be taken of the differences in quantities of materials and number of trained technicians required for various projects. It is possible that one way to increase the production by one million S.N.U.'s would require more technicians than a different way to achieve the same goal. If, as can be expected, technicians will be in short supply the second way to achieve the goal would be preferable, although it might cost more money. Also at this stage various alternatives ought to be investigated.

Simultaneously the investments to be made for the realisation of the program should be estimated; a distinction should be made between monetised and non-monetised investment; public and private works; and between foreign exchange and local currency requirements.

Finally a study can be made about how to finance the program; in this study attention should be paid to the question of how much the countries concerned can finance themselves, and for what amounts foreign aid [2] would be required.

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[1] S.N.U., see chapter 6.4.

[2] A distinction should be made between loans on commercial terms ("hard" loans), loan on concessional terms ("soft" loans) and grants.

It is obvious that only a large research organisation with an extensive international network of contacts will be able to tackle this research-program satisfactorily. It is however believed, that, in view of the rapidly increasing population, the problem of how to feed the population reasonably, is important enough to warrant work of the type outlined above.

SUMMARY

It may at this point be convenient for the reader to recapitulate briefly how our figures have been built up.

First it has been assumed that the population of the three underdeveloped continents will increase between 1950 and 1980 by 1.9% per year, or by 80% in the 30-year period.

Secondly it has been deemed probable that per caput real income would improve by 0.5% per annum, which would mean a 17% improvement in 30 years. Using an income elasticity coefficient for food of 0.6 the above improvement in income would result in an increase in spending for food by 10%. The combination of these two factors would lead to an increase in the demand for food by almost 100% in 30 years, or 55% in the 20-year period 1960–80 or by 2.3% per annum. Per continent the increase in demand is estimated in the 20-year period 1960–80 at 60% for Asia, exclusive U.S.S.R. and China, 70% for Latin America and 50% for Africa.

Attention is then called to how production probably will increase, and a distinction is made between improvements in yield per unit and an expansion of the agricultural area. This leads to an estimate of the number of hectares of new land required in the three continents. The totals are for the period 1960–80: 40.6 million hectares arable land and 77.9 million hectares of pastures, or together 118.5 million hectares agricultural land.

Figures about investments required to bring about the assumed improvements in yield, and the assumed expansion of area are collected mainly from three sources: national accounts, over-all development plans and specific projects. There are indications that past increases in production of about 2% per year have been brought about by means of an average investment of 9 dollars per hectare arable land or 3.5 dollars per annum per hectare agricultural land. A review of development plans for a

number of countries leads to the conclusion that a public investment of 5 dollars per hectare arable land, or 2.5 dollars per hectare agricultural land was recommended in such plans. These indications lead to the conclusion that in the decade 1950–60 about 7.6 billion dollars per year was invested in agriculture in the three continents together. Probably close to half of this was private investment.

As it is our opinion that production in the period 1960–80 has to increase about 10% faster than it did in the past decade, the required investments have, as a first approximation, been increased to 10 dollars per hectare arable land, or 4 dollars per hectare agricultural land. These figures are used as a first rough guide to a total of required investments for the period 1960–80. This estimate results in a total for the three continents of 8.6 billion dollars per annum, of which 5.9 billion dollars in public investments.

An attempt is then made to consider this figure in some detail, and to separate what is needed for the preparation of new land from what is needed for the improvement of land already in use. This is done with the aid of a review of a large number of individual projets. "Rule of thumb"-figures for various types of investment works are used in three hypothetic land development plans, one for each continent. It appears then that it would cost 51.9 billion dollars in public investments to open and equip 118.5 million hectares of new land or 438 dollars per hectare. This operation would require 2.6 billion dollars per year. On top of this 4.3 billion dollars would have to be spent by public authorities per year for further improvements on existing agricultural land, on the basis of 2 dollars per hectare. The annual total of public investments would on this basis be 6.9 billion dollars, or 138 billion dollars for the 20-year period. About 30% of this total would be in foreign exchange.

ANNEXES

ANNEX 1. *Industrial origin of gross domestic product % of Agriculture, Forestry and Fishing in total*

			1950	1955	1956	1957
Europe & USA	Netherlands	g	14		11	12
	W. Germany	g	11		9	9
	U. Kingdom	g	6		4	4
	U.S.A.	n	7		5	5
Latin America	Argentina	g	15		18	19
	Brazil	n	29	30	27	28
	Colombia	n	40	38	36	37
	Peru	g	38	29	25	
Asia	Burma	g	46 ('51)		41	42
	Ceylon	g	55		49	47
	India	n	51	45	50	
	Japan	n	26		20	19
	Pakistan	n	60		57	56
	Thailand	g	57	45	44	
	Turkey	g	49		42	43
Africa	Belgian Congo	g	30		26	28
	Egypt	n	44	35 ('54)	33	
	Kenya	n	50		39	38
	Tanganyika	g			64	64
	U. of S. Africa	n	18	14	14	15

g = gross domestic product
n = net

Source: *UN Monthly Bulletin of Statistics*, January 1959, and *Yearbook of National Account Statistics* 1958.

ANNEX 2. *Portion of gross domestic capital formation allocated to agriculture, forestry and fisheries (in % of total)*

	1950	1951	1952	1953	1954	1955	1956	1957
U.S.	8	8	7	7	6	6	5	5
U.K.	5	5	5	4	4	4	3	3
Canada	13	13	12	10	8	8	7	6
Austria	12	11	17	15	13	14	15	14
Denmark	9	10	10	9	8	6	7	6
Finland	16	15	14	14	13	12	10.5	10
Greece	10	12	8	7	7	6	5	8
Ireland	6	8	7.5	8	10	9	5	11
Italy	—	—	13	14	14	13	12	12
Norway	—	—	10	10	10	10	10	9
Portugal	—	—	13	11	13	12	11	9.5
Taiwan	—	34	23	27	26	24	22	16
Ecuador	33	28	25	31	24	22	—	—
Honduras	31	34	34	42	30	28	—	—
Israel	16	18	18	25	28	20	19	20
Netherlands	—	6	8	7	6	6	5	5

Source: *Yearbook of National Account Statistics*, 1957 and 1958, New York.

ANNEX 3. *World population (millions)*

	1920	1930	1940	1950	1953	Medium estmate for 1980	Density in number per km² 1953
World	1,813	1,987	2,213	2,455	2,547	3,628 [4]	19
Africa	140	155	172	198	208	289	7
America (all)	208	244	277	330	351	535	8
North America	117	135	146	168		223	
Latin America [1]	90	109	131	162		312	
Asia (excl. USSR)	970	1,047	1,176	1,321	1,364 [2]	2,011	51
Europe (incl. USSR)	486	531	576	593		776	
Europe (excl. USSR)	328	355	380	393	402	450 [3]	82
Oceania	9	10	11	13	14	17.5	2

[1] South of U.S.A.
[2] Includes a number of 500 mln. Chinese.
[3] Author's estimate.
[4] Is 47% higher than the population of 1950.

Source 1: *UN Statistical Yearbook*, 1954 Table 1A; figures are mid-points of ranges of highest and lowest estimates.
Source 2: The past and future population of the World and its continents, *UN Population Division* in *the Proceedings of the World Population Conference*, 1954. Volume III, p. 256.

ANNEX 4. *UN estimate of the population until 2000 (in millions)* [4]

A.	Year	World	Africa	North America [1]	Latin America [2]	Asia	Europe [3]	Oceania
	1900	1,550	120	81	63	857	423	6
	1925	1,907	147	126	99	1,020	505	10
	1950	2,497	199	168	163	1,380	574	13
	1975	3,828	303	240	303	2,210	751	21
	1980	4,220	333	254	348	2,471	792	22.5
	2000	6,267	517	312	592	3,870	947	29
B.	Estimated percentage increases per quarter century							
	1900–1925	23	22	56	57	19	19	57
	1925–1950	31	35	33	65	35	14	36
	1950–1975	53	52	43	86	60	31	59
	1975–2000	64	71	30	95	75	26	40

[1] N. of Mexico.
[2] S. of Mexico.
[3] Including U.S.S.R.
[4] Based on tables 5, 6 and I(B) of *The future growth of World Population*, UN New York 1958; figures based on medium assumptions.

ANNEX 5. *Development of world production in the last two decades (1953 = 100)*

	1938	1948	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
Industry, incl. mining	—	—	—	—	—	100	—	—	117	121	118	130
All commodities	77	86	89	93	97	100	101	105	109	109	—	—
Agricultural products	81	87	90	93	97	100	101	105	108	106	107	113
Food	81	86	90	91	96	100	101	104	107	106	108	114
Cereals	79	91	86	86	95	100	95	100	104	101	—	—
Coffee, tea, cacao	94	89	90	95	99	100	104	115	109	119	—	—
Non-food crops	80	89	90	99	99	100	103	107	110	106	—	—
Fats and oils	62	77	83	99	92	100	103	104	119	117	—	—
Textile fibers	85	82	80	92	99	100	99	104	104	99	—	—

Source: *UN Monthly Bulletin of Statistics*, March 1959, p. VIII and August 1961, p. VI.

ANNEX 6. *Volume of agricultural production by regions*

	Average 1948/49–1952/53 = 100							Average ann. increase 48/49–52/53 to 56/57	
	Prewar	53/54	54/55	55/56	56/57 [2]	58/59 [3]	1959/60 [3] preliminary	Production	Population
Western Europe	93	115	115	116	118	123	127	2.7	0.75
N. America	73	107	104	108	112	112	114	2.–	1.8
Oceania	88	108	108	115	114	119	119	2.1	2.4
Subtotal	82	110	109	112	115			2.3	1.2
Latin America	82	108	113	116	119	126	129	2.9	2.3
Far East (excl. China)	97	110	113	117	119	121	124	3.–	1.4
Near East	83	119	119	121	125	128	128	3.8	2.2
Africa	78	113	117	116	120	120	120	3.1	1.9
Subtotal	88	111	114	117	120			3.1	1.7
All above regions	85	111	111	114	117			2.7	1.5
World [1]		110	111	114	117	121	123	2.7	1.5

[1] Includes USSR, China and E. Europe.
[2] Preliminary.
[3] Estimated on the basis of indexnumbers for which 1952/53–1956/57 was equal to 100.

Source: *State of Food and Agriculture*, 1957, F.A.O., p. 12 and *Monthly Bulletin F.A.O.*, July 1959, and the *State of Food and Agriculture*, 1960, p. 11.

ANNEX 7. *Volume of total and per caput food production by regions (1952/53–1956/57 = 100)*

	Total foodproduction				Per caput			
	Prewar [1]	1948/49–1952/53	56/57	58/59	Prewar [1]	48/49–52/53	56/57	58/59
W. Europe	82	86	103	109	93	89	102	106
N. America	68	92	104	110	87	99	101	102
Oceania	83	93	99	115	110	102	95	105
Lat. America	70	88	108	114	103	97	103	103
Far East (excl. China)	85	86	107	109	108	92	104	103
Near East	72	84	109	115	95	91	105	105
Africa	72	89	105	105	96	96	101	96
E. Europe and USSR	83	86	115	130	85	91	112	123
All above regions	77	88	107	114	95	94	104	107

[1] "Prewar" means for most countries 1934–38, for others 1936–39.

Source: *The State of Food and Agriculture*, 1960, F.A.O., p. 11 and 13.

ANNEX 8. *Volume of total and per caput food production by regions (Prewar = 100)*

	Total		Per caput	
	1948/49–1952/53	prelim. 1956/57	1948/49–1952/53	prelim. 1956/57
W. Europe	108	126	98	110
N. America	140	160	118	120
Latin America	125	150	93	97
Oceania	112	122	93	88
Far East (excl. China)	104	122	86	93
Near East	120	150	98	108
Africa	127	151	104	111
All above regions	118	139	99	106
World [1]	110	117	100	107

[1] Includes USSR, E. Europe, China.

Source: *Monthly Bulletin of Agricultural Economics and Statistics* May 1957, F.A.O., p. 8/9.

ANNEX 9. *World*[1] *production of major foodstuffs (in million tons)*

	1948/52	1956/57	1957/58	average 56/57–57/58	56/57–57/58 in percent of 1948/52	Increase per annum
Wheat	114	123	122	122	107	1.–%
Coarse grains [2]	198	233	228	230	116	2.3
Rice (milled)	75	92	88	90	120	2.9
Total	387	448	438	442	114	2.–
Centrifugal sugar	26	34	36	35	134	4.9
Oilseeds (as oil)	12	14.7	14.9	14.8	124	3.4
Milk	206	234	242	238	115	2.2
Meat	31	39	39	39	126	3.7

[1] Excluding USSR, Eastern Europe and China
[2] Barley, Oats, Maize.

Source: *State of Food and Agriculture*, F.A.O., 1958, p. 199.

N.B. Preliminary figures for the production in 1959/60 seem to show that the annual increase in production of cereals and sugar has been somewhat faster; however, the production of oilseeds, milk and meat has been developing at a slower pace in the last two years.

ANNEX 10. *Area of arable land*

1. Arable land by regions

(Mln. Hectares)	About 1950	About 1956
Europe	150	152
N. America	233	229
S. America	90	102
Oceania	21	25
Far East	304	364
Near East	70	75
Africa	219	222
Total (excl. USSR)	1.087	1.169

2. Area under major food crops [1] by continents

(Mln. Hectares)	1948/52	1955/57	1948/52 = 100
Europe	55.9	57.5	103
N. America	90.3	76.3	84
S. America	36.3	43.1	110
Oceania	4.9	3.8	78
Far East	223.1	261.–	117
Near East	17.6	22.8	130
Africa	22.6	25.2	112
Total (excl. USSR)	456.4	497.4	109

3. Arable land in selected countries

(Mln. Hectares)	About 1950	About 1956
Japan	5	5
India	131	158
Pakistan	24	25
Argentina	30	30
Brazil	19	19
Thailand and Burma	13	16

[1] Wheat, rice, corn, pulses, oilseeds, potatoes.

Source: F.A.O. data, compiled by U.S. Dept. of Stat, Intelligence Report 8148.

ANNEX 11. *Estimated stocks of some commodities (million metric tons)*

	World production		Stocks held by major exporters at beginning of the season			Gross exports by major exporters	
	1956/57	1958/59	56/57	58/59	1960 [1]	1957	1958
Wheat	123.6	138.2	47.8	42.7	52.9	23.–	19.5
Rice	91.6	—	1.7	0.9	—	4.1	3.1
Coarse grains	272.8	293.5	43.4	58.5	73.7	7.8	9.5

[1] Forecast.

Source: *State of Food and Agriculture*, 1957, F.A.O. pp. 31 and 149 and 1960, p. 33 and *Monthly Bulletin of Agricultural Economics and Statistics*, F.A.O. July 1959.

ANNEX 12. *Supplies of wheat and rice by regions (1955/57 Av. in 1000 tons)*

		Production	Import	Export	Available quantity
WHEAT:	Lat. America	10,600	3,365	3,580	10,385
	Far East	25,500	100	3,750	21,850
	S. Asia	14,500	5	2,160	12,345
	S.W. Asia	12,100	395	1,310	11,185
	Africa	5,500	430	1,580	4,350
RICE:	Lat. America	4,065	180	250	3,995
	Far East	94,180	4,155	2,510	95,825
	S. Asia	38,150	150	1,255	37,045
	S.W. Asia	1,225	40	205	1,060
	Africa	2,970	290	385	2,875

Derived from F.A.O./U.S. Dept. of State, Intelligence Report 8148.

ANNEX 13. *Trends in per caput food supply*

	A Average calorie supply per day			B % calories from cereals and starchy roots		
	Prewar	48/49–50/51	53/54–54/55	Prewar	48/49–50/51	53/54–54/55
West Germany	3,040	2,680	2,930	47	55	43
France	2,870	2,790	2,830	51	51	47
Italy [2]	2,510	2,380	2,570	65	65	60
Netherlands	2,840	2,940	2,940	44	43	37
United Kingdom [3]	3,110	3,080	3,210	35	39	33
United States	3,150	3,160	3,080	32	27	26
Australia	3,300	3,230	3,120	34	33	31
Argentina	2,730	3,210	2,840	44	45	41
Brazil [1]	2,150	2,340	2,350	48	49	52
Chile	2,240	2,380	2,490	61	62	59
India [1]	1,970	1,620	1,850	69	67	69
Pakistan		2,150	2,130		72	79
Japan [3]	2,180	2,050	2,200	77	78	71

	C Meat in kg per year			D Milk [4] in kg per year		
	Prewar	48/49–50/51	54/55	Prewar	49/50	54/55
West Germany	53	29	45	160	136	170
France	61	62	75	150	150	167
Italy [2]	20	15	19	74	79	106
Netherlands	38	28	38	200	—	220
United Kingdom [3]	68	53	66	152	212	206
United States	71	84	88	204	249	237
Australia	120	111	108	164	195	180
Argentina	107	116	104	163	165	155
Brazil [1]	—	39	27	—	79	30
Chile	38	38	32	54	78	100
India [1]	3	2	1	65	43	46
Pakistan		4	4		—	—
Japan [3]	4	2	3	4	4	10

[1] Per caput consumption of pulses and nuts high.

[2] Per caput consumption of pulses and nuts high but decreasing.

[3] Per caput consumption of fish high.

[4] In terms of liquid milk; dairy products included.

Prewar: either the average for the years 1935–1939 or for the years 1934–1938.

Source: *State of Food and Agriculture*, 1957, F.A.O. pp. 166 and 167.

ANNEX 14. *Estimate of population underfed*

	Population 1950 mln.	Numbers underfed mln.	People underfed in percent of	
			World population	Population per continent
Europe [1]	393	178	7	46
U.S.S.R.	200	—	—	—
N. America	168	—	—	—
Latin America	162	126	6	78
Asia	1,320	1299	53	98
Africa	198	184	7	93
Oceania	13	3	negligible	23
World	2,454	1797	73	—

[1] Including E. Europe.

Source: *World population and resources*, 1955, P.E.P., p. 44.

ANNEX 15. *Food expenditures in % of total expenditures for consumption*

	Java Estates	Java Djakarta	Ghana	Netherlands
Year of investigation	1939/40	1937	1953	1951
Total expenditure per month [a]	*f* 5.49	*f* 10.24	sh. 167	*f* 239.67
Expenditure for food in % [a]	75.–	60.5	58.9	39.3
Total expenditure per month [b]	*f* 16.12	*f* 31.67	sh. 480	*f* 778.58
Expenditure for food in % [b]	58.3	51.8	53.7	19.7

Source: L. H. HUIZINGA, *The Needs of the Native Farmer in the Tropics and the Raising of his Standards of Living*. Netherlands Journal of Agricultural Science, February 1959, p. 57.

ANNEX 16. *Portion of expenditures on food in private consumption expenditure (in % of total)*

	1950	1951	1952	1953	1954	1955	1956	1957
Australia	25	26	27	26	26	26	26	25
U.S.A.	26	28	28	27	27	26	27	23
Canada	23	24	23	23	22	22	21	23
U.K.	29	29	30	31	31	31	31	31
Austria	36	37	40	39	37	36	36	35
Belgium	31	31	32	32	32	—	—	28
Denmark	30	28	28	28	28	28	28	27
Finland	42	38	39	40	39	38	38	37
Ireland	—	—	35	37	37	37	37	36
Italy	49	48	48	46	47	47	46	45
Netherlands	36	36	38	38	38	38	37	37
Norway	—	—	31	31	31	31	31	31
Sweden	29	29	31	30	30	30	30	28
Ceylon	51	50	50	50	50	50	50	50
Israel	31	28	35	35	35	—	—	—
Japan [1]	62	60	57	56	55	54	52	50
Ghana	64	63	59	56	58	54	57	56
Chile	38	39	39	36	39	—	—	—
Ecuador	47	48	50	50	49	48	49	—
Honduras	48	48	46	49	47	50	—	—
Jamaica	44	44	45	43	42	41	39	—
Panama	42	42	41	41	44	41	42	—
Puerto Rico	46	47	47	45	44	44	43	43

[1] Includes food, beverages and tobacco.

Source: *Yearbooks of National Account Statistics*, 1957 and 1958, U.N. New York, 1958 and 1959.

ANNEX 17. *Food supplies (gross) required to feed the world's population by the year 1980 at recent levels of consumption (1946–49) and also at slightly improved levels (second world food survey targets)*

Region	Year	Consumption Levels	Cereals	Starchy roots	Pulses	Sugar	Fats	Fruit	Vegetables	Meat	Eggs	Fish	Milk
			(million metric tons)										
Far East	1949		227.3	54.1	34.6	7.6	—	—	—	7.–	1.–	7.9	25.4
	1980	recent	333.1	78,9	50.4	11.1	—	—	—	10.2	1.4	11.5	37.1
	1980	improved	369.–	83.2	68.–	13.7	—	—	—	13.7	2.9	17.5	44.6
Near East	1949		32.1	1.5	1.7	1.1	0.4	11.8	7.2	1.5	0.3	0.3	11.4
	1980	recent	50.9	2.4	2.7	1.7	0.7	18.7	11.4	2.4	0.4	0.5	18.–
	1980	improved	57.–	3.4	3.8	1.7	1.1	27.2	21.3	3.–	0.6	0.7	20.6
Asia	1949		260	56	36	9	—	—	—	8.5	—	8.2	37
Africa	1949		25.1	33.6	3.1	1.–	—	—	—	2.4	0.2	0.4	7.5
	1980	recent	41.6	55.5	5.2	1.7	—	—	—	4.–	0.4	0.6	12.4
	1980	improved	48.1	56.–	6.6	1.9	—	—	—	4.6	0.5	0.9	15.2
Lat. America	1949		30.1	24.7	2.3	5.3	—	—	—	6.7	0.5	0.8	14.3
	1980	recent	56.8	46.7	4.4	9.9	—	—	—	12.6	1.–	1.5	27.–
	1980	improved	59.3	45.–	6.2	9.1	—	26.–	23.1	13.7	1.3	1.6	31.1
Europe	1949		130.1	117.–	2.7	8.–	6.4	18.9	32.3	11.8	2.4	5.4	49.3
	1980	recent	153.9	138.5	3.2	9.5	7.6	22.4	38.2	14.–	2.8	6.4	58.3
	1980	improved	165.6	155.8	4.6	9.4	8.2	30.9	49.–	16.–	3.4	6.6	68.6
N. America +	1949		132.2	15.3	2.–	8.3	3.2	15.3	19.9	14.3	3.8	0.9	68.5
Oceania	1980	recent	192.1	22.3	2.9	12.1	4.7	22.2	28.8	20.8	5.5	1.3	99.6
	1980	improved	195.5	17.–	2.9	11.6	4.3	27.1	33.9	21.9	5.5	1.4	109.9

ANNEX 17. *(cont.)*

Region	Year	Consumption Levels	Cereals	Starchy roots	Pulses	Sugar	Fats	Fruit	Vegetables	Meat	Eggs	Fish	Milk
			(million metric tons)										
U.S.S.R.	1949		107.–	86.–	2.9	3.–	1.9	16.3		4.3	0.2	1.4	31.–
	1980	recent	154.7	124.4	4.2	4.3	2.7	23.6		6.2	0.3	2.–	44.8
	1980	improved	151.5	105.6	4.5	4.1	3.1	47.2		8.1	0.5	3.6	60.9
World Total	1949		684	332	49	34	—	—	—	48	8.3	17	207
	1980	recent	981	469	73	50	—	—	—	70	11.8	24	297
	1980	improved	1,046	466	97	51	—	—	—	81	14.7	32	351
Asia excl. Mainland China	1948/52		148.2	27.–	7.–	7.4	—	—	—	7.7	—	—	34.7

Source: *World Population Conference*, 1954, Volume 5, p. 488.

ANNEX 18. *Estimates of required increases in supply*

	Supply in 1949 mill. tons	Coefficient for increase in per capita consumption	Coefficient for increase in population	Requirements in 1980 million tons	Required increase 1949–1980	Assumed require increase [1] 1960–1980
Developed areas						
Cereals	369	1.–	1.4	517	148	100
Roots	218	1.–	1.4	305	87	60
Pulses	7.6	1.1	1.4	11.7	4.1	3
Sugar	19.3	1.05	1.4	28.3	9	6
Meat	30.4	1.15	1.4	48.9	18.5	12
Milk	149	1.1	1.4	230	81	54
Underdeveloped areas						
Cereals	314	1.1	1.8	622	308	225
Roots	115	1.1	1.8	228	113	83
Pulses	42	1.1	1.8	83	41	30
Sugar	15	1.1	1.8	30	15	11
Meat	17.6	1.1	1.8	34.7	17.1	13
Milk	58.6	1.1	1.8	116	57.4	42

[1] Increase for 1960–1980 derived pro rata from required increase for 1949–1980, taking into consideration actual increases until 1957/58, and rate of growth of population. Estimated supply in 1960 in million tons: cereals 391; roots 145; pulses 53; sugar 19; meat 22; milk 74.

Source: Supply in 1949 derived from annex 17

ANNEX 19. *Increases in yield per hectare*

Crop	Production in metric tons per hectare			Increase of production in t/hectare		Increase [1] in percent per annum	
	1934/38	1948/52	1955/57	34/38–48/52	48/52–55/57	34/38–48/52	48/52–55/57
Wheat							
Europe	1.42	1.48	1.68	0.06	0.2	0.3	2.–
N. + C. America [2]	0.82	1.16	1.41	0.32	0.25	2.8	3.1
S. America	0.96	1.07	1.15	0.11	0.08	0.8	1.0
Asia	0.95	0.76	0.87	—0.19	0.09	—	—[3]
Africa	0.69	0.72	0.79	0.03	0.07	0.3	1.4
Oceania	1.13	1.13	1.08	—	—0.05	—	—
Rice (paddy)							
Europe	5.18	4.3	4.3	—0.88	—	—	—
N.- + C. America [2]	2.19	2.2	2.55	0.01	0.35	0.03	2.5
S. America	1.53	1.7	1.7	0.17	—	0.8	—
Asia	1.77	1.58	1.84	—0.19	0.26	—	1.7[3]
Africa	1.19	1.23	1.45	0.04	0.22	0.25	3.–
Maize							
Europe	1.48	1.21	1.79	—0.27	0.58	—	6.5
N. + C. America [2]	1.33	2.20	2.43	0.87	0.23	4.6	4.–
S. America	1.53	1.26	1.39	—0.27	0.13	—	1.6
Asia	1.13	1.02	1.16	—0.11	0.14	—	—[3]
Africa	0.81	0.83	0.92	0.02	0.09	0.2	1.5
Broad beans							
Europe	1.10	0.85	0.93	—0.25	0.08	—	1.5
S. America	—	0.78	—	—	—	—	—

ANNEX 19. *(cont.)*

	Production in metric tons per hectare			Increase of production in t/hectare		Increase [1] in percent per annum	
	1934/38	1948/52	1955/57	34/38–48/52	48/52–55/57	34/38–48/52	48/52–55/57
Asia	1.07	1.–	1.–	—0.07	—	—	—
Africa	1.12	1.12	—	—	—	—	—
Chick peas							
Europe	0.46	0.43	0.54	—0.03	0.11	—	3.7
Asia	0.55	0.53	0.59	—0.02	0.06	—	2.–
Africa	0.39	0.53	—	0.14	—	2.6	—
Sweet potatoes and jams							
Europe	16	14.5	11.8	—1.5	—2.7	—	—
N. + C. America	4.5	4.5	4.68	—	0.15	—	0.5
S. America	7.5	7.7	8.38	0.2	0.68	0.2	1.5
Asia	7.9	8.9	10.2	1.–	1.3	0.9	2.5
Africa	6.2	6.9	7.25	0.7	0.35	0.8	0.9
Potatoes							
Europe	13.8	15.1	—	—	1.3	—	1.3
N. + C. America	14.1	17.2	—	—	3.1	—	3.1
S. America	5.3	5.7	—	—	0.4	—	1.2
Asia	5.3	7.–	—	—	1.7	—	5.4
Africa	6.–	7.9	—	—	1.9	—	5.4

[1] Increase expressed in percent of crop in first period.

[2] The U.S.A., Canada and Mexico are of course the dominating countries in this area.

[3] Figure unreliable because of low yield in 1948/52.

Source: F.A.O. Yearbooks on production.

ANNEX 20. *Indices of yields per hectare by region*

(1955–1957 averages; 1948–1952 = 100)

	Wheat	Rice	Corn	Pulses	Oilseeds	Potatoes[2]
Europe [1]	115	98	143	114	114	109
N. America	122	137	114	106	137	121
S. America	113	96	103	99	116	105
Oceania	96	109	102	—	—	126
Far East	117	116	103	99	103	118
Near East	108	121	106	100	94	120
Africa	105	109	112	100	—	105
Total [1]	111	116	109	100	110	107

[1] Excl. USSR.

[2] Includes sweet potatoes and yams.

Area Definitions

Far East: from Japan through Pakistan, incl. Comm. China.

Near East: from Afghanistan to Mediterranean, Libya, Sudan, Egypt.

Source: U.S. Department of State, Intelligence Report 8148, *World Food Production and Requirements.*

ANNEX 21. *Estimate of required increase in area. Period 1960–1980*

Continent	Category	Cereals	Root-crops	Pulses	Sugar	Meat	Milk	Required increase in area in million hectares		
								arable	pasture	total
Asia (excl. China)	1. Required increase in supply	60%	60%	60%	60%	60%	60%			
	2. Gain from improved yields	40%	60%	20%	10%	30%	30%			
	3. Gain from increased area	20%	—%	40%	50%	30%	30%			
	4. Supply in 1960 (mln. t.)	190	40	11	12	12	39			
	5. Supply in 1980 (mln. t.)	304	64	18	19	19	63			
	6. Increase in supply (mln. t.)	114	24	7	7	7	24			
	7. Portion of 6 to be gained from 3	38	—	4.6	5.9	3.5	12			
	8. Yield per hectare (ton) [1]	2.6	16	0.9	4	0.2	0.5			
	9. Hectares required (mln.)	14.6	—	5.1	1.5	17.5	24	21.2	41.5	62.7
Africa	1. Required increase in supply	50%	50%	50%	50%	50%	50%			
	2. Gain from improved yields	30%	20%	20%	10%	30%	30%			
	3. Gain from increased area	20%	30%	30%	40%	20%	20%			
	4. Supply in 1960 (mln. t.)	30	40	4	1.2	2.9	9			
	5. Supply in 1980 (mln. t.)	45	60	6	1.8	4.4	13.5			
	6. Increase in supply (mln. t.)	15	20	2	0.6	1.5	4.5			
	7. Portion of 6 to be gained from 3	6	12	1.2	0.48	0.6	1.8			
	8. Yield per hectare (ton) [1]	1.2	8.8	1.0	4	0.2	0.5			
	9. Hectares required (mln.)	4.6	1.4	1.2	0.12	3.–	3.6	7.3	6.6	13.9
S. America	1. Required increase in supply	70%	70%	70%	70%	70%	70%			
	2. Gain from improved yields	30%	20%	20%	10%	30%	30%			
	3. Gain from increased area	40%	50%	50%	60%	40%	40%			
	4. Supply in 1960 (mln. t.)	36	30	3	6.5	8	17			
	5. Supply in 1980 (mln. t.)	61	51	5.1	11.1	13.6	29			
	6. Increase in supply (mln. t.)	25	21	2.1	4.6	5.6	12			
	7. Portion of 6 to be gained from 3	14.3	15	1.5	3.9	3.2	6.9			
	8. Yields per hectare (ton) [1]	1.7	10	1.–	5	0.2	0.5			
	9. Hectares required (mln.)	8.4	1.4	1.5	0.78	16.–	13.8	12.1	29.8	41.9
								40.6	77.9	118.5

[1] The yields figures have been found by multiplying the latest available statistical figure with the expected percentagewise increase (chapter 8, table 29).

ANNEX 22. *Gross capital formation in agriculture*

		Total mln. dollars	Dollars per head of agric. pop.	Dollars per ha. arable land	Dollars per ha. agric. land	Prewar = 100 Index foodprod. 1955/56
Turkey	1952	10.2	0.75	0.4	0.19	170
	1953	8.1	0.65	0.35	0.16	
Denmark	1952	48	48	17.8	15.5	132
	1953	50	50	18.5	16.1	
	recent	65	65	24.–	21.–	
Netherlands	1952	71	51	64.–	29.5	137
	1953	65	46.5	59.–	27.–	
Italy	1952	420	21	26.5	20.–	135
	1953	510	25.5	32.–	24.5	
Greece	1953	12	3.1	3.5	1.4	132
Finland	1951	58	41	22.5	20.–	132
	1952	61	43.5	23.5	21.–	
United Kingdom	1952	174	17.4	24.5	9.–	131
	1953	171	17.1	24.–	8.9	
	recent	280	28	40.–	14.6	
Norway	1952	67	112	84.–	67.–	123
	1953	69	115	86.–	69.–	
	recent	77	128	96.–	77.–	

ANNEX 22. *(cont.)*

		Total mln. dollars	Dollars per head of agric. pop.	Dollars per ha. arable land	Dollars per ha. agric. land	Prewar = 100 Index foodprod. 1955/56
Sweden	1952	122	76	32.–	27.–	103
	1953	127	79	33.5	28.–	(114) 54/55
Mexico	1951	104	—	5.6	1.2	166
	recent	180	49	9.7	2.1	
Chile	1951	32	17	5.8	5.3	141
Argentina	1951	176	—	5.8	1.2	121
	1952	133	—	4.5	0.93	
U.S.A.	1952 [1]	3,100	140	16.5	7.–	150
	1953	2,800	126	15.–	6.–	
Canada	1952	490	175	12.6	8.–	152
	1953	469	168	12.–	7.6	
Burma	1952	10	—	1.16	1.16	87
	1953	8	—	0.9	0.9	
OEEC region	recent	34,000	46	36.5	19.7	

[1] Private only.

Sources: *International Journal of Agricultural Affairs*, July 1957.
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ANNEX 23. *Amount of investments in agriculture*

Based on estimates of: "Gross domestic capital formation", expressed in current prices.

		1950	1951	1952	1953	1954	1955	1956
Europe								
Austria	a)	42.5	57.5	96.–	85.–	93.–	120.–	139.–
	b)	28	38	63	56	61	86	91
	c)	24	32.5	55	47	52.5	74	79
Denmark	a)	45	59	65	59	61.5	44	50.5
	b)	45	59	65	59	61.5	44	50.5
	c)	16.5	21.5	24	21.5	22.5	16	18.5
Finland	a)	83	110	125	88	115	120	128
	b)	61	80	91	64	84	88	94
	c)	32	42.5	48.5	34.5	44.5	46.5	49.5
Ireland	a)	9.2	14.5	14.5	16	20.8	18.2	11.2
	b)	6.3	9.9	9.9	11	14.2	12.5	7.7
	c)	6.5	10.4	10.4	11.4	14.8	13.–	8.–
Italy	a)	—	—	430	495	540	600	600
	b)	—	—	21.5	24.7	27.–	30.–	30.–
	c)	—	—	27	31.5	34.–	38.–	38.–
Norway	a)	—	—	79	81	91	93	95
	b)	—	—	127	130	147	150	153
	c)	—	—	95	97	110	112	114
Portugal	a)	—	—	28.5	26.5	31.5	31.–	30.5
	b)	—	—	8.2	7.6	9.–	8.9	8.8
	c)	—	—	8.4	7.8	9.3	9.2	9.–

ANNEX 23. *(cont.)*

		1950	1951	1952	1953	1954	1955	1956
Other countries								
Canada	a)	507	573	594	580	434	489	569
	b)	192	220	225	220	165	187	215
	c)	12.5	14.–	14.6	14.2	10.7	12.–	14.–
Ecuador	a)	13.5	16.2	13.5	20.5	21.5	22.–	—
	b)	—	—	—	—	—	—	—
	c)	12.–	14.4	12.–	18.2	19.2	19.7	—
Honduras	a)	7.6	10.5	14.3	19.9	10.8	11.5	—
	b)	—	—	—	—	—	—	—
	c)	7.6	10.5	14.3	19.9	10.8	11.5	—
Israel	a)	11.4	19.1	29.–	44.5	62.–	60.–	64.5
	b)	52	87	132	200	280	272	295
	c)	30	50	76.5	117	163	158	270
Taiwan	a)	—	29.5	37.5	45.5	47.–	56.5	58.–
	b)	—	—	—	—	—	—	—
	c)	—	33.5	43.–	51.5	53.–	63.–	66.–

a) In million dollars.
b) Per unit of agricultural population, dollars.
c) Per hectare of arable land, dollars.

Source: *National Accounts*, published by the U.N. Secretariate (Yearbooks of National Account Statistics).

ANNEX 24. *Programmed investments in the agricultural sector*

	Mln. dollars per year	Dollars per head of pop.	Dollars per head of agricul. pop.	Dollars per ha. arable land	Dollars per ha. agricult. land
Br. Guiana	5	10	—	3.55	—
Ceylon	16	1.8	—	10.75	—
Jordan	4.8	3.2	—	5.30	3.00
Jamaica	2.5	1.56	3.6	14.70	6.25
Turkey	19.6	0.8	1.45	0.80	0.36
Syria	15.8	3.95	—	3.40	1.34
Guatemala	1.6	0.485	0.94	1.10	0.76
Malaya	3.3	0.52	—	1.50	—
Iraq	31.–	6.5	—	5.60	4.80
Nigeria	16.8	0.53	—	0.75	—

Source: IBRD Reports, *The Economic Development of* .....

ANNEX 25. *Investments in agriculture according to national plans*

	Expenditure per year in mln. dlrs.	Per hectare arable land	Per hectare agricult. land	Expected annual increase in production in %
B. Congo [1]	7.7	0.16	0.15	—
Ruanda Urundi [1]	0.8	0.46	0.2	—
Liberia	1.2	0.6	0.5	—
Ceylon	23.8	15.6	—	11
Taiwan	22.7	26.–	24.3	4.2
India	442.6	2.8	2.6	4.4
Japan	15.2	3.–	2.4	2
Indonesia	47.9	2.7	—	3.1
Pakistan	111.6	4.6	—	2.5
Philippines	85.–	11.6	10.–	1.6

Source: 1. for African countries *State of Food and Agriculture*, 1958, F.A.O., p. 150.
Source: 2. for Asian countries; *Economic Survey of Asia and the Far East* 1956, U.N. 1957, p. 51.

[1] In the plan of the Congo for 1950/59 and the plan for Ruanda Urundi only 7% of total expenditure was allocated to agriculture. In more balanced plans this percentage is between 25% and 33%. Belgium intended to more than double the amount for investments in agriculture in the plan for the Congo for 1960/69.

ANNEX 26. *Investments in specific projects*

Source	Country	Type of work	Investment dlrs. per ha.
A. *Irrigation-Works*			
Bank	Br. Guiana	Boarasarie, simple diversion, some drainage work	200
		Corentyne, ditto, but some pumping	320
Bank	Colombia	General figure, no large dams or pumps	300–600
Project	Sudan	Managil, simple diversion	310
J. of Farm Ec.	Iraq	Tigris, Euphrates, diversion project	500
		Adham canal, diversion project	395
Bank	Ceylon	Gal Oya, high dam, includes distribution work	585
Project	Thailand	Chao Phya and Yan Hee, high dam, diversion work but only main canals	124
Project	Peru	Quiroz, earth dam, distribution work	710
Bank	Syria	Ghab, high dam, some drainage work	740
Project	Japan	Aichi, high dam, distribution works	1,800
Project	India	DVC, several dams, main canals only	180
Project	Turkey	Seyhan, dam, distribution works, some drainage works	330
Project	Lebanon	Litani, dam, public works only	510
Project	Italy	Vulturno, diversion, detailed distribution	1,200
Project	Italy	Fortore, high dam, detailed distribution	900
Project	Italy	Flumendosa, high dam, detailed distribution	1,700
Project	Italy	Catania, high dam, detailed distribution	1,580
Bank	Jamaica	Several small schemes, gravity	325
Bank	Syria	Three schemes, no details	500–1,000
Bank	Ceylon	General program figure	470
Bank	Colombia	General figure, no large dams or pumps	300–600
Bank	Syria	Nine gravity projects	320
Bank	Syria	Four other gravity projects	225–460
Bank	Malaya	Average program estimate	82.5–104
B. *Reclamation work*			
Bank	Br. Guiana	Drainage of tidal land	about 300
Bank	Suriname	Nickerie polder, construction costs only	300

ANNEX 26. *(cont.)*

Source	Country	Type of work	Investment dlrs. per ha.
Bank	Suriname	Wageningen polder, includes settlement social costs	1,340
Bank	Suriname	General program, various works	330
Bank	Jamaica	Reclamation of low coastal areas	200
Bank	Iraq	Drainage of river area	11.2
Bank	Colombia	Drainage of river area	80–160
Bank	Nigeria	Water control works river area	49–350
Project	Pakistan	Reclaiming dry land	31.5
Project	India	Reclaiming kans grass infested land, deep plowing	27.5
Project	India	Jungle clearance	68.5
Project	Peru	Leveling, or light clearing	10
Bank	Ceylon	Developing land for irrigation	300–600
Bank	Malaya	Developing new land for paddy	40
Bank	Colombia	Land clearing	40–240
Bank	Colombia	Land clearing, including roads	80–360
C. *Settlement Projects*			
Bank	Br. Guiana	Small mixed farms	625 up
Bank	Br. Guiana	40-hectare farms	250
Bank	Ceylon	4–5 acre farms on new irrigated land	1,600
Bank	Syria	Dry farming non-mechanized per family	1,400
Bank	Syria	Dry farming mechanized per family	1,850
Bank	Syria	Irrigated farming	950
Project	Japan	Kamikita 5 hectare farm, per hectare	440
Project	Japan	Konsen, 14-hectare farm per hectare	280
Project	Italy	Volturno, private investment in irrigation	550
Project	Italy	Fortore, private investment in irrigation	500
Project	Italy	Flumendosa, private investment in irrigation [1]	900
Project	Italy	Catania, private investment in irrigation [1]	1,080

[1] With orchards.

ANNEX 26. *(cont.)*

Source	Country	Type of work	Investment dlrs. per ha.
D. *Storage Works*			Investment per ton static; dlrs.
Bank	Nigeria	Famine stock warehouses, 4.000 tons each	21
Bank	Nigeria	Simple warehouses, 4.000 tons each	35
Project	Turkey	Modern concrete warehouses	60
Project	Nicaragua	Modern warehouses	110
Project	Panama	Modern warehouses	85
FAO Bulletin	S.E. Asia	Thatched godowns	4
FAO Bulletin	N. Africa	Port silo	94
FAO Bulletin	N. Africa	Metal with concrete base, rural storage	82
FAO Bulletin	S.E. Asia	First class one story buildings	26
FAO Bulletin	S.E. Asia	Temporary structures	9

ANNEX 27. *Investments to develop new land by continent*

Asia		Million hectares	Investment dollars per hectare	Total million dollars
Arable land		21.2		
irrigation	b	1.2	850	1,020
irrigation	c	5	500	2,500
irrigation	d	5	300	1,500
pumping schemes	e	3	300	900
coastal drainage	f	2	300	600
inland drainage	g	5	100	500
reclamation	h	3	30	90
light clearing	i	5	50	250
heavy clearing	j	5	100	500
leveling	k	15	10	150
settling costs	l	10	250	2,500
settling costs	m	10	500	5,000
				15,510
		Million tons	Per ton	
Storage				
simple	p	100	5	500
permanent	q	20	50	1,000
silos	r	10	100	1,000
				2,500
Grand Total Arable				18,010
		Million hectares	Investment dollars per hectare	
Pastures		41.5		
light clearing	i	30	50	1,500
inland drainage	g	11.5	100	1,150
settling costs	l	41.5	250	10,375
				13,025
Overall Total (rounded off)				31,000

The letters refer to the categories mentioned in chapter 10, par. 2.

ANNEX 27. *(cont.)*

Explanation

1. No high dam irrigation works, with refined distribution systems have been included.
2. The total area in the various categories of cost combined is larger than 21.2 million hectare, because much land will need more than one kind of operation (some land will need clearing, irrigation, leveling and settling, etc.).
3. It is assumed that the governments will care to settle farmers well on almost all the new land.
4. Simple storage is included for most of the grains and pulses to be grown on the new land; smaller quantities will be stored in permanent warehouses and silos.
5. Only land covered with light bush is to be cleared for pasture plus some swampy land along rivers.

Latin America		Million hectares	Investment dollars per hectare	Total million dollars
Arable land		12.1		
irrigation	b	3	850	2,550
irrigation	c	2	500	1,000
pump irrigation	e	1	300	300
jungle clearing	j	7	100	700
coastal drainage	f	1	300	300
leveling	k	10	10	100
settling costs	l	6	250	1,500
settling costs	m	6	500	3,000
				9,450
		Million tons	Per ton	
Storage				
simple	p	20	5	100
permanent	q	8	50	400
silos	r	4	100	400
				900
Grand Total Arable				10,350

ANNEX 27. *(cont.)*

		Million hectares	Investment dollars per hectare	
Pastures		29.8		
Light clearing	i	15	50	750
heavy clearing	j	15	100	1,500
drainage	g	7	100	700
settling	l	3	250	750
				3,700
Overall Total (rounded off)				14,000

Explanation

1. No very expensive or very low-cost irrigation works are envisaged. Most of the land will have to be cleared from the heavy Amazon jungle. Much land will require leveling.
2. Governments are supposed to assist farmers in settling well on the new land.
3. Part of the pastures can be reclaimed from land on lower Andean mountain slopes and savannahs, which is covered with light brush. Some pasture land will require drainage into rivers, for instance in Andean valleys, or low pampas.

Africa		Million hectares	Investment dollars per hectare	Total million dollars
Arable land		7.3		
irrigation	b	2.–	850	1,700
irrigation	d and e	3	300	900
clearing	i and j	4	75	300
leveling	k	2	10	20
settling costs	l	2	250	500
settling costs	m	2	500	1,000
				4,420

ANNEX 27. *(cont.)*

		Million tons	Per ton	
Storage				
simple	p	10	5	50
permanent	q	4	50	200
silos	r	1	100	100
				350
Grand Total Arable				4,770
		Million hectares	Investment dollars per hectare	
Pastures		6.6		
clearing	i	4	50	200
clearing	j	2.6	100	260
drainage	g	1	100	100
settling costs	l	6	250	1,500
				2,060
Overall Total (rounded off)				6,800

Explanation

1. Some of the required irrigation works in Africa will need high dams, but some of the cheaper development is also possible, especially along the Nile and other large rivers. It is assumed that equal parts of light and heavy jungle will have to be cleared.
2. Pastures will mainly be located in areas with light shrub vegetation, but some heavy jungle clearing and some swamp drainage will also be necessary.
3. It is again assumed that the government will want to settle farmers on the new land properly.

ANNEX 28. *Summary of investment figures*

Source:	Type of figure	Type of land	Dollar per ha			Million hectares	Total in billion dollars		
			public	private	total		public	private	total
Chap. 9 par 5,	historic	arable	4.5	4.5	9	760	3.4	3.4	6.8
tables 22, 23	historic	agricl.	2.–	1.5	3.5	2160	4.3	3.3	7.6
Chap. 9 par. 5,	Programmed	arable	4.7 (5)			760	3.8		
table 23		agricl.	2.7 (2.5)			2160	5.4		
Chap. 9 par. 5,	"required"	arable	5	5	10	760	3.8	3.8	7.6
tables 24, 25		agricl.	2.5	1.5	4	2160	5.4	3.2	8.6
Chap. 10 par. 5,	estimated	"New"land	438			5.9	2.6 } 6.9		
table 27	estimated	improve-ments	2.–			2160	4.3 }		

ANNEX 29. *Areas of agricultural land*

	Arable	Permanent meadows and pastures	Total
	million hectares		
Europe excl. USSR	151	85	236
North America	229	279	508
Latin America	102	368	470
Near East	87	271	358
Far East	363	273	636
Africa	208	487	695
Oceania	24	377	401
World excl. USSR	1,164	2,140	3,304
World incl. USSR	1,384	2,407	3,791

760 (Near East, Far East, Africa); 1,399 (Latin America, Near East, Far East, Africa); 2,159 (Latin America, Near East, Far East, Africa)

Source: *Yearbook* 1957, F.A.O.

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