CAPITAL REQUIREMENTS FOR AGRICULTURE IN DEVELOPING COUNTRIES TO 2050[1]

Josef Schmidhuber, Jelle Bruinsma and Gerold Boedeker[2]

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[1] Paper presented at the FAO Expert Meeting on "How to Feed the World in 2050", 24-26 June 2009, Rome.
[2] Global Perspective Studies Unit, FAO.

SUMMARY AND CONCLUSIONS

Cumulative gross investment requirements for developing countries' agriculture add up to a total of nearly US$9.2 trillion over the next 44 years (2005/07-2050). This amount would be necessary to remain consistent with FAO's long-term outlook for global agriculture (World agriculture: towards 2030/50).

Broken down by type of investment, more than US$5.5 trillion or 60 percent of the total would be required to replace the existing capital stock (or new capital items that are being added and subsequently depreciated over the 44 year period to 2050); the rest, i.e. about US$3.6 trillion would need to be added to the existing capital stock to increase (nearly double) output and raise productivity. Broken down by activity, primary agriculture accounts for about US$5.2 trillion of the total, while the remaining US$4.0 trillion is absorbed by downstream needs (processing, transportation, storage, etc.). Within primary agriculture, mechanization accounts for the single biggest investment item (25 percent) followed by expansion and improvement of irrigation (nearly 20 percent). Broken down into annual amounts, the cumulative investments result in yearly averages of about US$210 billion gross and US$83 billion net, respectively. All estimates, gross and net, cumulative and annual, are in constant 2009 dollars.

A striking feature of the outlook is that the annual net additions to the capital stock (growth investments) exhibit a noticeable decline over time, which results in a slow-down in the annual net capital requirement. These net investments account for 55 percent of the total at the beginning of the projection period and for merely 30 percent towards 2050. The change in net investments reflects a number of different factors. First and obviously, incremental production needs to decline alongside declining incremental needs. Partly offsetting this decline is a shift towards more capital-intensive forms of production with a growing replacement of labour by capital. A third, factor, again supporting the declining net capital needs is a somewhat higher overall efficiency of input use in the future.

Growth accounting results suggests that overall growth will be characterised by a growing substitution of labour with capital and moderate total factor productivity growth. There are, however, marked regional differences. In Latin America, for instance, growth will be capital and productivity-based, with negative labour contributions. In sub-Saharan Africa, by contrast, growth will be heavily labour and moderately capital based, with limited efficiency gains.

The analysis of performance indicators suggests that there are marked regional differences in the capacity of agriculture to generate incomes and reduce poverty. Projections for the gross value of production for instance suggest that revenues generated by an agricultural labourer in sub-Saharan Africa will rise only by 50 percent over the next four decades. The expected growth in food markets will not suffice to lift revenues significantly.

The analysis of expected revenues, capital stocks and land available per labourer suggests that too many people in sub-Saharan Africa will remain dependent on a labour-intensive, capital-saving form of small-scale agriculture, in which too many farmers will have too few resources and revenues to share. The poverty reduction potential in the projected revenue/capital stock trajectory in sub-Saharan Africa should thus be limited.

This poses questions as to what alternative income sources could be tapped. Emerging options include new opportunities that arise from higher energy prices and a production of bioenergy feedstocks; income opportunities from the provision of environmental services; or a greater export orientation of production. All three growth options call for a know-how and a capital-intensive form of agriculture and thus run counter to the factor endowment that characterises Africa's smallholder structure. One option to overcome these constraints would be through increased investments in resource-pooling institutions.

The available capital stock per worker was identified as an important explanatory variable for inter-regional differences in performance. A farmer in Latin America has on average 10 times more capital available than his colleague in sub-Saharan Africa. Behind the abstract aggregate of capital per farmer are a large range of tools and equipment that make agriculture in Latin America so much more productive than in Africa. It includes more and better mechanization, tractors, tillers and combines, irrigation, storage and processing plants, and other elements of an efficient downstream sector. Moreover, Latin American farmers have multiples of support capital in better infrastructure, research institutions, available roads, or electricity. Rural roads per hectare for instance amount to 0.017 km in Latin America compared to 0.007 km, i.e. less than half that distance in sub-Saharan Africa. Likewise, rural electricity supplies per worker are 50 times higher in Latin America compared to sub-Saharan Africa.

INTRODUCTION

This paper is an interim report on ongoing work at FAO to estimate investment requirements in developing countries' agriculture. The estimates presented in the paper are far from final and the narrative of future trends and developments is far from complete. Estimates cover most capital items, without however singling out areas for public involvement, neither of domestic nor of foreign funding sources.

Nor has any attempt been made to gauge incremental investment needs required to attain certain development goals such as MDG-1 or the target set by the World Food Summit. This also means that important investment areas such as agricultural research or rural infrastructure are excluded. These will be covered in later work. Likewise, an item of major concern to public investment, namely 'ensuring access to food for the most needy' (e.g. through social safety nets)[3] is not dealt with here.

Instead, the estimates presented in this paper embody a broad range of capital items needed to achieve the 2030 and 2050 crop and livestock production levels in developing countries as foreseen in the baseline outlook of the latest FAO perspective study (FAO, 2006a). The majority of these capital items relate to primary agriculture. In addition, a number of activities covered relate to downstream industries of primary agriculture, notably various forms of processing, storage and marketing.

The net additions to and replacement of obsolete capital stocks make up total investment requirements. Traditionally, the lion's share of capital needs was covered by private farmers and by entrepreneurs in the related upstream and downstream industries (including capital outlays in non-monetized forms). Some capital items such as irrigation development, rural infrastructure and agricultural research, will require public intervention. However, no effort has been made to measure the needed or desired level of public sector engagement. This can vary widely across capital items and countries, and any quantitative assessment would need to start from a detailed and disaggregated basis. One such assessment is planned as a follow-up to this assessment. It will be based on the investment assessment and the baseline projections underlying this paper and will gauge the incremental public capital requirements needed to reach a more ambitious outcome/development goal, such as a complete eradication of hunger within a shorter time span.

METHODOLOGY AND MEASUREMENT: WHAT HAS BEEN MEASURED, WHAT NOT, AND HOW

Imputed versus actual

The basic goal of this assessment was to gauge the amount of capital that will be required to produce the total amounts of crops and livestock products projected in FAO's long-term outlook to 2030 and 2050, i.e. the hectares of land to be developed, to be irrigated, to be put under permanent crops; the numbers of tractors, combines, implements or merely handtools, the increases in livestock herds, sheds, etc. This means that all investments are imputed estimates, not necessarily actual investments. Likewise, capital stocks are imputed and not necessarily actual, ditto for changes in capital stocks, i.e. net investments and depreciation.

[3] Accounting for over a fifth of the incremental annual public investment as estimated in the FAO (2003) Anti-Hunger Programme.

Box 1: Past FAO estimates of investment requirements

The 1981 publication "Agriculture: Toward 2000" (FAO, 1981) gave an estimate of average annual gross investment over the 20 year period 1980-2000 for 90 developing countries (excluding China) of US$69 billion in 1975 dollars, US$47 billion for investment in primary agriculture (of which about a third for investment in replacement) and US$22 billion for investment in supporting capital stock. Separate estimates are given for (net) investment in forestry and fisheries. These investment estimates refer to total investment required, i.e. the sum of private and public investment.

The 1988 FAO study "World agriculture: toward 2000" is an update of the 1981 study and follows the same methodology. For 93 developing countries (excluding China) the estimate of annual (average over the 17 year period 1982/84-2000) gross investment amounts to US$88 billion in 1980 dollars. Investments in primary agriculture are estimated at US$50 billion (nearly 60 percent for investment in replacement), and investment in supporting capital stock at US$38 billion. No estimates are given for investment in forestry and fisheries.

The investment estimates of the Technical Background document No 10 for the 1995 World Food Summit, "Investment in agriculture: evolution and prospects", were based on the FAO study Alexandratos, N. (1995), "World agriculture: toward 2010". The estimates given in this publication refer to the group of 93 developing countries and are those needed to achieve the production projections of the latter publication (i.e. the WFS target is not considered and 637 million people are left undernourished in 2010).

The estimate for annual (average over 1993-2013) gross investment in 1993 dollars is US$ 129 billion, of which US$86 billion in primary agriculture (US$61 billion for replacement) and US$43 billion in support (or post-production) investment. To this are added US$37 billion worth of investments in public support services (mainly technology generation and transfer) and rural infrastructure, two categories not covered in earlier studies. The total then amounts to US$166 billion of which about three-quarters (US$125 billion) is private and one-quarter (US$41 billion) is public investment.

The next FAO exercise giving investment estimates (of a slightly different nature) was: FAO (1999), "Investment in agriculture for food security: Situation and resource requirements to reach the World Food Summit objectives", CFS:99/Inf 7[4].

The estimates are an update of the 1995 estimates (still for developing countries only) but this time refer to what is needed to reach the WFS target of halving the number of undernourished people in 2015. They are: an annual (average over 2000-2015) gross investment in 1995 dollars of US$140 billion, of which US$93 billion (US$66 billion for replacement) in primary agriculture and US$47 billion in support (or post-production) investment. To this is added an US$40 billion of investment in public support services and rural infrastructure. The total amounts to US$180 billion.

The latest FAO publication giving investment estimates is FAO's (2003), "Anti-Hunger Programme". The estimates given refer to what is needed to reach the WFS target in 2015. They cover only investment incremental to expected future public investment. Annual (average over 2003-2015) investment in 2002 dollars of US$23.8 billion of which US$2.3 billion for productivity improvements, US$7.4 billion for natural resource development, US$7.8 billion for rural infrastructure, US$1.1 billion for knowledge generation and US$5.2 billion for ensuring access to food.

These imputed investments and capital stocks can differ from actual investments and capital stocks for a number of reasons. If, for instance, farmers work with excessively depreciated capital stocks (old tractors, tillers, threshers, sheds, etc.), actual capital stocks would be lower than the imputed ones and vice versa. Conversely, some investments may not entirely or not always translate into monetary expenditures. For instance, when a farmer builds a storage facility for his cereal crop or a shed for his grazing animals, these activities may not or not fully be reflected in the actual value of the capital stocks; they are, however, part of

[4] Also reported in: FAO (2001), "Mobilizing resources to fight hunger," CFS:2001/Inf. 7.

the imputed capital as they absorb resources with positive opportunity costs and reflect a shift away from consumption into investment.

As a consequence, the estimated investment numbers and capital stocks may not or not always correspond to those from other sources such as national accounts. While this means that deviations from actual capital stocks are unavoidable in the short-run, imputed and actual capital stocks and investment requirements should converge in the longer-run, at the latest after one full depreciation period of the item with the longest lifespan. The outlook to 2050 should thus be sufficiently long to ensure convergence. At any rate, the advantage of the calculation of imputed capital stocks is that the results are comparable across countries and over time.

Investment areas and unit costs

In order to derive capital needs from production projections, changes in agricultural outputs were linked to 26 different capital items. For every capital item, specific unit costs and a specific lifetime and thus depreciation periods were chosen. The imputed values are obtained by multiplying the physical quantities (hectares, numbers, etc. in the base year and the years 2030 and 2050) with an average unit cost expressed in constant 2009 US dollars. While the calculations have been undertaken on the basis of 93 individual developing countries, specificity for unit costs and depreciation periods has been limited to regional averages. Of the 26 capital items, 14 relate to primary agriculture (including some non-conventional ones such as "establishment of permanent crops", "herd increases" and "working capital") and 12 related to the agricultural downstream sector (see Box 2 for a listing of the capital items).

Investment in agricultural downstream activities covers storage, processing and marketing of agricultural products. They are included for the sake of completeness although they may not always or entirely be attributable to agriculture and agricultural development. Not covered are investments related to manufacturing and distribution of agricultural inputs such as fertilizer. Likewise, expenditures in agricultural research could not be estimated as part of the investment requirements. For all investment items, both primary and downstream sectors, unit costs have been identified. Obviously, the absolute levels of the investment requirements are contingent on factors such as the assumed unit costs, the capital (input) absorbed per unit of agricultural activity or the assumed lifespan of a capital item[5].

Depreciation and gross investment

The additions in the capital stocks between the base year (2005/07) and the years 2030 and 2050 amount to the cumulative net investment requirements over the projection periods. Subsequently, requirements for replacement investment are derived for the capital goods which must be replaced periodically. For each capital item a specific lifetime has been identified. For example, permanent crops are assumed to have a life span of 25 years, tractors one of 15 years, and so on. For many capital items replacement investments exceed net investments. Estimates for replacement investment are added to the net requirements to obtain estimates of gross investment (see Box 3 for a summary explanation).

Box 2: List of capital items included

Crop production:

- Development of arable land under crops
- Soil and water conservation
- Flood control
- Expansion and improvement of irrigation
- Establishment of permanent crops (citrus, other fruit, oil palm, coconuts, cocoa, coffee, tea and rubber)
- Mechanization (tractors and equipment)
- Other power sources and equipment (increase in number of draft animals; equipment for draft animals; handtools)
- Working capital (50 percent of the increase in the cost of fertilizer and seed)

[5] Investments in physical units are, in general, more robust than those in monetary terms as it proves difficult to assemble appropriate unit value costs for the various investment items.

Livestock production:

- Increase in livestock numbers (cattle and buffaloes, sheep and goat, pigs, poultry)
- Housing and equipment for commercial production of pigs and poultry
- Development of grazing land

Downstream support services:

- Investment in milk production, processing
- Investment in meat production, processing
- Dry storage (cereals, pulses, oilseeds, cocoa, coffee, tea, tobacco and sugar)
- Cold storage (bananas, fruits and vegetables, livestock products)
- Rural marketing facilities
- Assembly and wholesale markets for fruits and vegetables
- Milling of cereals
- Processing of oilseeds, sugar crops, fruits and vegetables
- Ginning of seed cotton
- Other processing

Country coverage

Capital stock and investment calculations are performed for the 93 developing countries covered in the FAO 2006 study (see the list of countries in Annex 1; note that countries in transition in Central Asia are not included).

Endogeneity and technology shifts

The projections of future investment needs are linked to and derived from the projections of 40 individual agricultural production activities, assuming certain technologies and/or complete technology packages (frontiers). Over an outlook horizon of more than 40 years, investments requirements will not only be defined by a given, current stage of technology, but also encompass shifts to new frontiers. Depending on factors such as the farm size or opportunity costs of farm labour, farmers will shift to new technology levels. While important, these shifts have not been taken into account in an explicit manner. Instead, links have been established indirectly by associating output levels (e.g. crop yields) with a certain package of input requirements; in many cases, this is done in a step-wise linear manner and is meant to emulate the shifts in technology. To make assumption more transparent and these technology shifts more explicit, future revisions therefore will attempt to include such frontier shifts directly, with links to changes in the overall level of development and/or farm size.

Box 3: Derivation of investment requirement estimates

The projections to 2050 cover 40 agricultural production activities (34 relating to crop production and 6 related to livestock production) in 93 developing countries. Each activity draws on a certain amount of current inputs and capital stock services.

For each of the 26 capital items distinguished, the value of capital stock, CS, is calculated for each year covered in the model (t = 2005/07, 2010, 2015, 2030 and 2050) multiplying the physical quantity, Q (hectares, numbers, etc.) with an average unit cost, P, expressed in 2009 US dollars.

For each capital item, the net investment in any year, I_t^n, is defined as the net increase in the value of capital stock over that year, or as the growth of capital stock, g, times capital stock, CS, at the beginning of the year. The growth rate is estimated as the annual growth of capital stock over the period preceding the year in question (except for the base year):

$$I_t^n = g_t \cdot CS_t \quad (1)$$

Replacement investment in any year t is equal to the gross annual investment of L years earlier, where L is the economic life of the capital good in question. Gross annual investment, I_t^g, is defined as the sum of net annual investment and replacement investment in the same year:

$$I_t^g = I_t^n + I_{t-L}^g \quad (2)$$

Equation (2) can be approximated as:

$$I_t^g = \frac{I_t^n}{1-(1+g_t)^{-L}} \quad (3)$$

Cumulative net investment CI_t^n over any of the periods distinguished in the model (2005/07 to 2010, 2010 to 2015, 2015 to 2030 ad 2030 to 2050) is defined (and calculated) as the net increase in capital stock over that period:

$$CI_t^n = CS_t - CS_{t-1} \quad (4)$$

Cumulative gross investment is defined (and calculated) in a manner similar to annual gross investment:

$$CI_t^g = \frac{CI_t^n}{1-(1+g_t)^{-L}} \quad (5)$$

Total annual and cumulative net and gross investments are simply derived by adding up over the 26 capital items.

Public and/or private

No distinction has been made with respect to the potential source of the required capital. Therefore, the amounts include all potential sources; that is private and public both of foreign and domestic provenance. The way capital stocks are financed currently suggests that the largest part of total investments comes from private domestic sources. And the selection of capital items in this assessment suggests that private sources (domestic and foreign) would be the prime source of capital, at least if it is assumed that public investments should be limited to activities where public goods are produced (hunger and poverty reduction, environmental sustainability, social cohesion, etc.). The public hand can play a role either in funding these investments directly or by helping link, pool and promote private flows. Typically, such investments include the creation and maintenance of infrastructure, large-scale irrigation schemes, or research and development of new crop varieties and animal breeds. Depending on the level of public engagement, these investments can help attract further private flows (crowding in) or, if too massive, replace private engagement (crowding out effects). Private public partnerships would aim at maximising the former and minimising the latter.

THE RESULTS

Projected capital stocks and investment needs

Provisional results for investment requirements for primary agriculture and its downstream industries in developing countries show that the total over the 44-year period 2005/07 to 2050 could amount to almost US$ 9.2 trillion (2009 dollars), 57 percent of which for primary agriculture and the remainder for support services (Table 1). Within primary agriculture, about a quarter of all capital needs stem from projected mechanization needs and almost a fifth (18.5 percent) from a further expansion and improvement of irrigation.

Table 1: Cumulative investment over 2005/07 to 2050 in billion 2009 US$

	net	depreciation	gross
Total for 93 developing countries	**3636**	**5538**	**9174**
total investment in primary production	**2378**	**2809**	**5187**
of which in crop production	**864**	**2641**	**3505**
Land development, soil conservation and flood control	139	22	161
Expansion and improvement of irrigation	158	803	960
Permanent crops establishment	84	411	495
Mechanization	356	956	1312
Other power sources and equipment	33	449	482
Working capital	94	0	94
of which in livestock production	**1514**	**168**	**1683**
Herd increases	413	0	413
Meat and milk production	1101	168	1269
total investment in downstream support services	**1257**	**2729**	**3986**
Cold and dry storage	277	520	797
Rural and wholesale market facilities	410	548	959
First stage processing	570	1661	2231

Broken down by type of investment, 60 percent or US$5.5 trillion will be needed to replace existing capital stocks, the other 40 percent or US$3.7 trillion would be growth investments and thus net additions to the existing capital stock. A detailed account of sector-specific investment projections is available in Annex 2.

The share of investments in primary agriculture is expected to fall in all regions, again at considerably different rates. Investments in downstream activities in turn rise in all regions. Perhaps surprisingly at first sight, the fastest growth in downstream activities is expected for sub-Saharan Africa, albeit from a relatively low absolute level. The region's food system is the least mature and growth reflects a gradual move away from a heavy reliance on primary production only. East Asia, by contrast, already has the most mature system, higher levels of grain, sugar, meat and milk processing and thus exhibits the smallest growth in non-primary growth, but at much higher absolute levels (Figure 1).

Figure 1: Capital stocks in primary agriculture and downstream industries, sub-Saharan Africa and East Asia

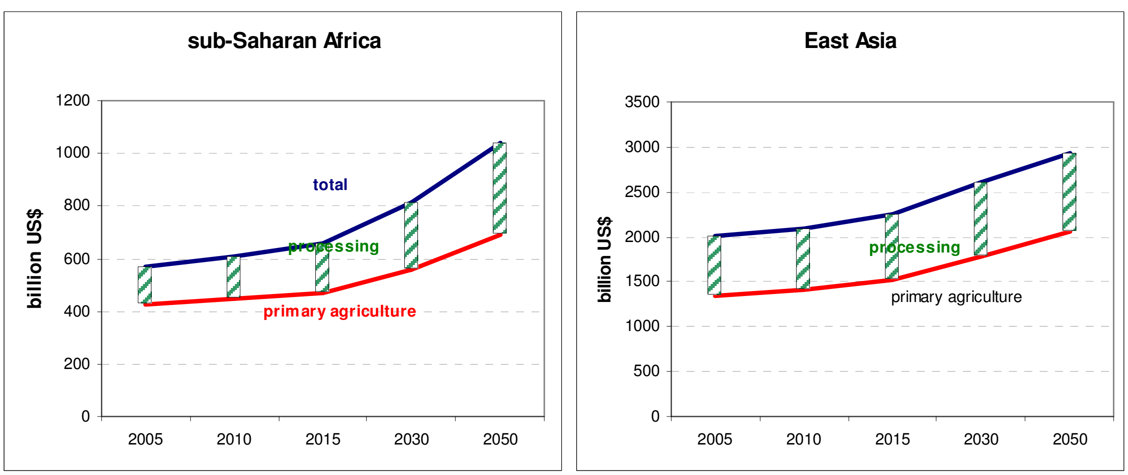
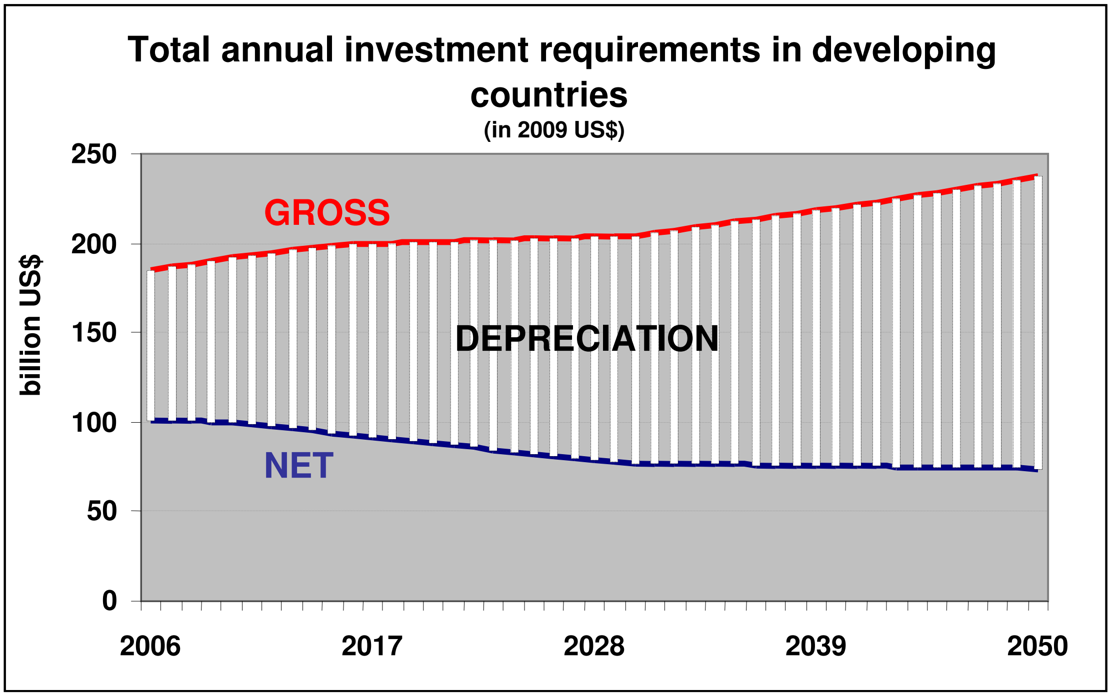


Figure 2: Total annual (public and private) investment requirements in developing countries



A striking feature of the outlook is that the annual net additions to the capital stock (growth investments) exhibit a noticeable decline over time and result in a slow-down in the annual net capital requirement. "Growth" investments account for 55 percent of the total at the beginning of the projection period and for merely 30 percent towards 2050 (Figure 2). For the aggregate of the developing countries as a whole, this reflects a number of different factors.

First, and obviously, a declining incremental production need (Table 2), driven by declining population growth and growing satiation levels of per capita consumption for food and fibre, also drive down incremental investment needs. For developing countries as a whole, overall agricultural production grew at a rate of 3.5 percent over the last 46 years and is expected to grow at a rate of less than half that level over the next 44 years. While the decline in production dynamics supports the projected slow-down in capital needs, there will be a countervailing shift towards more capital-intensive forms of production and a growing replacement of labour by capital. This explains the more moderate decline in incremental capital needs than is suggested by the expected levelling of output growth. And third, there is the impact of a change in the overall efficiency of input use, or total factor productivity (TFP). This is derived as the residual element of output growth that cannot be explained by growing input use, i.e. neither by changes in labour nor by changes in capital and land. While no TFP accounting is available for the past, future TFP growth is expected to be moderately positive for developing countries as a whole, albeit at rates of considerable difference across regions.

Table 2: Growth rates of agricultural production, percent p.a.

	1961-2007	1981-2007	1991-2007	2005/07-2030	2030-50	2005/07-2050
Developing countries	3.5	3.6	3.5	1.8	1.1	1.5
idem, excl. China and India	3.0	3.0	3.1	2.1	1.4	1.8
sub-Saharan Africa	2.6	3.3	3.1	2.7	1.9	2.3
Near East/North Africa	3.0	2.7	2.5	2.1	1.3	1.7
Latin America and Caribbean	3.0	3.0	3.4	2.1	1.2	1.7
South Asia	2.8	2.8	2.4	2.0	1.3	1.6
East Asia	4.3	4.5	4.3	1.3	0.6	1.0

For the aggregate of all developing countries, the relative importance of these factors (from 2005 to 2050), renders the following shares: (net) change in capital: +71 percent, in agricultural labour: -16 percent, in land use: +25 percent, and in total factor productivity: +20 percent6. This suggests a moderate decline in the role of labour inputs and an equally moderate replacement of labour with capital. Obviously, the aggregate hides vastly divergent developments in the various regions and for instance a much larger capital/labour substitution in Latin America (capital: +62 percent, labour: -73 percent, land: +49 percent, TFP: +62 percent) and no such shift at all in sub-Saharan Africa (capital: +48 percent, labour: +59 percent, land: +28 percent, TFP: -35 percent). Colloquially put, sub-Saharan Africa would continue to grow by "transpiration", while Latin America could further grow by efficiency gains or "inspiration".

A breakdown by region suggests that Asia would account for the largest part of global investment needs (57 percent); China and India alone account for some 40 percent. Latin America would absorb about 20 percent and sub-Saharan Africa and the Near East and North Africa region for the remaining 23 percent of capital needs (Table 3). Asia's high share reflects the region's large agricultural base, its high overall output and its relatively capital-intensive forms of agricultural production (irrigation, mechanization, terracing, etc.). Growth rates for Asia, however, would be more modest. This is in stark contrast to sub-Saharan Africa, where the overall level of investment requirements is expected to be relatively modest, reflecting the region's generally labour-intensive, capital-saving forms of production, while growth rates are projected to be higher, reflecting a very gradual shift to a more capital-intensive form of agriculture and moderately rising per capita production levels driven by a doubling of its population and consumer base.

Table 3: Cumulative investment over 2005/07 to 2050 by region

	net	depreciation	gross				
			crop production	livestock production	support services	total	share in total
	billion 2009US$						%
93 developing countries	3636	5538	3505	1683	3986	9174	100
excl. China and India	2427	3169	2184	966	2447	5596	61
sub-Saharan Africa	479	462	319	178	444	940	10
Latin America /Caribbean	842	962	528	316	960	1804	20
Near East / North Africa	451	742	619	152	422	1193	13
South Asia	843	1444	1024	368	894	2286	25
East Asia	1022	1928	1015	669	1266	2950	32

Broken down into annual instalments over the 44-year outlook period, the total gross needs of US$9.2 trillion amount to annual capital requirements of nearly US$210 billion. Over time, a larger share of the net investment requirements would occur in the early years and decades of the outlook, reflecting, inter alia, higher incremental investment needs in these years. Thereafter the slowdown in production growth would also be reflected in a levelling-off of incremental investment needs. This "frontloading" effect could have important policy implications and lend itself to important policy messages.

As indicated, this assessment does not provide an assessment of public vs. private financing, neither from domestic nor from foreign sources. If current private/public shares were to be applied to the projections,

[6] The underlying growth accounting approach applied here assumes a uniform, constant real wage across all income strata.

70 percent or US$150 billion of the US$210 billion would come from private sources, the remaining 30 percent or US$60 billion would have to be provided by public sources, both foreign (ODA) and domestic.

HOW RESOURCES WILL BE PUT TO WORK: PERFORMANCE INDICATORS FOR AGRICULTURAL PRODUCTION, CAPITAL STOCKS, LABOUR AND LAND

How much will be produced by whom?

In 2005, East Asia alone accounted for nearly half of the developing world's agricultural output. Measured in ICPs[7], US$554 billion dollars came from that region and it was followed by Latin America and South Asia which produced an annual agricultural output of US$210-15 billion each and the Near East/North Africa region and sub-Saharan Africa with a mere US$95 billion and US$98 billion respectively per year (Table 4).

A look at the long-term growth path to 2050 suggests a dynamic that is quite different from the current rates and levels. Sub-Saharan Africa, currently the region with about lowest agricultural output, is expected to show the fastest growth and could nearly triple its production to US$263 billion by 2050. East Asia, by contrast, currently the largest producer, will see an increase in output by merely 53 percent (Table 4). By large measure, this reflects the fact that sub-Saharan Africa has to meet the food needs for the largest population increase of all regions and will do so from its own agricultural production base. East Asia by contrast will only see a very modest overall growth in its population to 2050 falling to zero growth between 2030 and 2050. Moreover, the region has already attained relatively high per capita consumption levels (2870 kcal/person/day in 2000) which will rise only moderately to levels somewhat above 3200 kcal/person/day. It will, just like sub-Saharan Africa, feed its population from its own agricultural resources, with self-sufficiency declining only very moderately; in fact, the only region that is expected to step up production significantly beyond its own needs is Latin America with self-sufficiency rates projected to rise from 118 percent to 130 percent; Latin America will thus cover the moderately growing deficits of all other regions.

Table 4: Gross value of agricultural production by region (billion 2004/06 ICP$)

	2005	2030	2050	2050/2005
Developing countries	1172	1784	2207	1.88
sub-Saharan Africa	98	182	263	2.69
Latin America and Caribbean	210	343	436	2.08
Near East / North Africa	95	155	200	2.11
South Asia	216	356	459	2.12
East Asia	554	748	848	1.53

In order to meet these production increases, the various regions will have to put more money to work in agriculture, mobilize more capital, land and labour. How much more resources the various regions will commit, what role incremental capital, land and labour will play will be discussed in the next section. The starting point for this analysis is the expected output per person which will serve as the basis for the discussion of how efficiently land, labour and capital will be used. The latter will be based on an outlook for labour and capital intensity of production and explore the scope and limits of agriculture to create incomes and help reduce poverty.

[7] ICP or "international commodity prices" are used in order to avoid the use of exchange rates for obtaining country aggregates and to facilitate international comparative analysis of productivity. These "international prices", expressed in so-called "international dollars", are derived using a Geary-Khamis formula for the agricultural sector. This method assigns a single "price" to each commodity. For example, one metric ton of wheat has the same price regardless of the country where it was produced.

How much output per person?

Probably the most important indicator[8] from a developmental perspective is the evolution of agricultural output per person employed in agriculture (per capita gross value of production, AgGVP/PC). It is a first proxy for how much revenue people employed in agriculture generate and how revenues will evolve over the long-run to 2050. It can also provide hints as to how big the contribution of agriculture to overall poverty reduction will be and how rapid the agricultural transformation is likely to evolve.

A first inspection of the levels and trends of output per labourer across regions reveals vastly divergent trends (Table 5). In 2005, by far the highest level of agricultural output per person was attained in Latin America and, despite the high initial levels, no slowdown in growth per agricultural labourer is expected for the region. On the contrary, agricultural output per person is projected to rise faster than in any other region and nearly quadruple to US$18,173 per person by 2050. On the other end of the spectrum is sub-Saharan Africa, where output per agricultural labourer is the lowest today and will remain the lowest by far over the next decades. In fact the gap to all other regions is even expected to widen as AgGVP/PC is expected to grow by less then 50 percent in 45 years.

Table 5: Gross value of production per agricultural labourer (2004/06 ICP$ per person)

	2005	**2030**	**2050**	**2050/2005**
Developing countries	882	1319	1844	2.09
sub-Saharan Africa	475	587	700	1.47
Latin America and Caribbean	4993	10405	18173	3.64
Near East / North Africa	1827	3157	4888	2.68
South Asia	575	836	1230	2.14
East Asia	845	1398	2221	2.63

This raises the question as to what forces drive these divergent regional trends and what the different paths mean for poverty reduction through agriculture. The first question can only be answered by analysing the trends in the underlying variables. The two factors involved are obviously trends in the overall value of output on the one hand and the evolution of the agricultural labour force on the other.

Table 6: Aggregate self-sufficiency ratios (in percent) by region

	2005	2050
Developing countries	99	99
sub-Saharan Africa	97	95
Latin America and Caribbean	118	130
Near East / North Africa	79	78
South Asia	99	98
East Asia	94	91

Growth in overall agricultural output will be the highest in sub-Saharan Africa. As discussed above, this reflects high growth in consumption and the fact that much of the added needs are expected to be met by domestic production. Self-sufficiency will decline only moderately from 97 percent in 2005 to 95 percent in 2050 (Table 6). Output will also rise in Latin America, albeit less rapidly and predominantly for export markets to make up for the slightly rising deficits of other regions. That means that the difference in the growth of output per worker is almost entirely due to the second factor, i.e. the changes in the agricultural labour force. In fact, the agricultural labour force of sub-Saharan Africa is projected to nearly double to 2050, while it will fall to nearly half in Latin America to 24 million (Table 7).

The mere numerical description of these trends does not allow to draw any inferences on the desirability of the associated development paths. What can be said, however, is that even the near tripling of agricultural output in sub-Saharan Africa will not suffice to make a significant difference in revenues per person left working in agriculture. When combined with the outlook for capital stocks (Table 8) and the land available per labourer (Table 9), it can also be said that too many people will remain dependent on a labour-intensive,

[8] Ideally, performance should be measured as gross margins (returns on variable costs) or net margins (returns on total costs) of production; this however would require a complete accounting for variable and fixed costs of production.

capital-saving form[9] of small-scale agriculture. The poverty reduction potential of this form of agriculture should remain limited by the very virtue that too many farmers will have too few revenues to share.

Table 7: Agricultural labour force (millions) by region

	2005	2030	2050	2050/2005
Developing countries	1,330	1,353	1,197	0.90
sub-Saharan Africa	206	310	376	1.83
Latin America and Caribbean	42	33	24	0.58
Near East / North Africa	52	49	41	0.79
South Asia	376	426	373	0.99
East Asia	655	535	382	0.58

Source: FAO Statistics Division

This is not to suggest that poverty reduction efforts and strategies should ignore small-scale agriculture. On the contrary, the fact that more than 70 percent of the poor reside in rural areas and most depend on small-scale agriculture suggests that poverty reduction strategies have to start from and fully embrace small scale farmers; but while a smallholder structure is the starting point for poverty reduction, it cannot be an objective in its own right, particularly in sub-Saharan Africa. For one thing, the expected growth in its domestic food markets is too limited to engender much improved incomes for a growing number of farmers; for another, agricultural export markets would remain elusive for an under-capitalised form of small-scale agriculture. If the market potential is limited to the food needs, new markets (e.g. energy markets), new non-market income possibilities (payments carbon offsets, climate change mitigation programmes, payment schemes for environmental services) or strategies for a complete exit from agriculture need to be found to generate income possibilities for its young and rapidly growing labour force.

But neither will the poverty reduction potential be significant in Latin America's large scale agriculture, at least in absolute terms. There are simply too few people remaining in the sector today to be brought out of poverty in the future. Those remaining in agriculture, however, will produce agricultural output large enough to make a living from it. In tandem with the rising output per person, Latin America will continue to pursue its current export-orientation. The overall rate of self-sufficiency is expected to rise from 118 percent to 130 percent by 2050 (Table 6). The region will continue and even expand its role as the world's agricultural power house and make up for the less dynamic growth in other regions.

An alternative way of attaining higher incomes and ensuring livelihoods, though not covered in this outlook, would be to raise revenues not covered in agricultural production. Options include revenues that could be raised through the provision of environmental services and in particular contributions to Green House Gas (GHG) abatement and the entry into the carbon market. It is important to note in this context that agriculture is, with a share of over 30 percent (including deforestation), not only one of the main sources of global GHG emissions but would also provide a significant potential for climate change mitigation. These funds could help farmers adopt carbon-saving production technologies, reduce carbon footprints of traditional technologies and, at the same time, increase productivity and profitability of agricultural production. Promising options include a shift to no-till and conservation agriculture, more efficient milk and ruminant meat production systems (FAO, 2006b) or a transition from paddy to upland rice production.

Another income alternative could arise from an increased production of agricultural feedstocks for the energy market. The energy market is so large that it would not be subject to demand constraints and would allow more farmers to draw revenues from otherwise increasingly saturated markets. For small scale farmers, bioenergy could help overcome the on farm power constraint, the factor that often limits agricultural productivity growth the most. For larger scale farmers, bioenergy offers a new potential to produce for a market that is in essence characterized by perfectly elastic demand and a market that will absorb any incremental production as long as agricultural feedstocks are competitive as input into the energy market, i.e. as long as energy prices are above parity prices in the energy market. In essence this necessitates high energy

[9] The capital stock available per worker will not increase in sub-Saharan Africa, while it will triple in Latin America (Table 8).

prices. The perfectly elastic demand also means that food prices will be determined by energy prices and that poor food consumers could be priced out of the food markets by less elastic energy consumers.

The success of such a diversification into new areas of agricultural activities will be contingent on whether smallholder agriculture has a comparative advantage for these new markets. Typically, smallholder agriculture is labour-intensive and capital-saving and in particular know-how deficient. Many of the emerging income options, by contrast, require know-how and capital and seldom unskilled labour. Tapping into carbon offset schemes under the "Clean Development Mechanism" (CDM), for instance, is mostly limited to large projects and large farmers and a large share of these CDM projects was granted to the large holdings or outright agricultural industries in Latin America. The administrative hurdles of such schemes are simply to onerous for smallholders to meet. Likewise, commercial bioenergy production is highly know-how and capital intensive; Brazilian ethanol production for instance has become more profitable as it became more labour-saving. The discrepancy between factor needs and factor endowments of smallholders means that they are unlikely to have a comparative advantage for these alternative income sources; in fact, their factor endowment is precisely the opposite of the factor requirements needed for such activities.

Options to overcome a lack of capital and know-how exist. One option would be to improve or create the institutional setting that allows a pooling of smallholder resources and create enough human and financial capital to overcome the resource limits. Co-operatives can play an important role in pooling resources; public investments can support and foster these efforts. There are numerous examples for successful resource pooling, particularly for new bioenergy projects. In Thailand, for instance, 4000 farmers have pooled resources in a co-operative to set-up a cassava based bio-ethanol project in the Chok Chai district of Nakhon Ratchasima; through the country's Agricultural Co-operative Federation they even established a joint-venture with a US-based energy company to overcome remaining capital constraints and attract the necessary know-how to operate a large-scale ethanol plant.

These examples suggest that the comparative disadvantage of small-scale farming for new market opportunities can be overcome and that the new markets could be tapped by small scale operators if their resources can be pooled. In turn this will require a strengthening of rural institutions and thus public investments. The greatest needs but also the greatest potentials for institutional improvements lie in sub-Saharan Africa. The quantitative assessments of the institution-related investments requirements will be provided in the companion paper to this assessment at a later stage.

Why will outcomes be so different? The correlates of success

An important factor that helps explain difference in the output per worker is the ***capital stock per*** labourer available. Taking again the two extreme cases of Latin America and sub-Saharan Africa, the estimates summarized in Table 8 suggest that a farm worker in the former region has on average 10 times more capital available than his colleague in the latter. Behind the abstract aggregate of capital per farmer are a large range of tools and equipment that make agriculture in Latin America so much more productive than in Africa. It includes more and better mechanization, tractors, tillers and combines, irrigation, storage and processing plants, and other elements of an efficient downstream sector. And, while not included in the estimates, Latin American farmers have multiples of support capital in better infrastructure, research institutions, available roads and electricity. Equally important is reliability of these supplies, rendering fewer off-hours in terms of electricity supplies or irrigation water availability. Rural roads per hectare for instance amount to 0.017 km in Latin America compared to 0.007 km, i.e. less than half that distance in sub-Saharan Africa. Likewise, rural electricity supplies per worker are 50 times higher in Latin America compared to sub-Saharan Africa.

Table 8: Capital stock per worker (in 2009 US$1000 per person)

	2005	2030	2050	2050/2005
Developing countries	4.28	5.72	7.68	1.79
sub-Saharan Africa	2.78	2.62	2.77	1.00
Latin America and Caribbean	25.24	45.70	77.77	3.08
Near East / North Africa	11.61	17.33	25.41	2.19
South Asia	3.88	4.59	6.10	1.57
East Asia	3.06	4.87	7.67	2.51

The outlook to 2050 suggests that the inter-regional differences in capital stocks per worker are likely to become more pronounced. Capital stocks per worker will roughly double in East Asia, South Asia and the Near East and North Africa region while they will triple in Latin America and completely stagnate in sub-Saharan Africa. That means that by 2050 a worker in Latin America will have 28 times the capital available compared to his colleague in sub-Saharan Africa. These huge differences in capital intensity are at the heart of differences in the current output per worker and the divergent growth paths the two regions are expected to take.

As discussed above, a critical element in the divergent developments in labour productivity across regions is largely a reflection of the different developments in the agricultural labour force of the various regions. Latin America, for instance, will almost halve its labour force while sub-Saharan Africa will nearly double it. How important this effect is can be appreciated when agricultural output is related to land rather than labour (Table 9).

Table 9: Harvested land per agricultural labourer (ha per person)

	2005	2030	2050	2050/2005
Developing countries	0.69	0.75	0.90	1.30
sub-Saharan Africa	0.86	0.68	0.63	0.73
Latin America and Caribbean	3.47	5.53	8.62	2.49
Near East / North Africa	1.41	1.50	1.87	1.33
South Asia	0.60	0.56	0.65	1.08
East Asia	0.45	0.57	0.81	1.80

Output per hectare in Latin America is “only“ 2.5 times higher than in sub-Saharan Africa and indeed somewhat lower than in East Asia. But crucially, a worker in Latin America will crop twice as much land by 2050 while ***arable land available per labourer*** will further shrink in sub-Saharan Africa. This poses – once again - the question of how sustainable the outlook for sub-Saharan Africa’s is if it continues to be based on a farming system in which a limited resource base has to be shared with a rising number of resource users. Even if the basis of the argument is largely arithmetical, small scale agriculture is unlikely to provide much of a basis for widespread revenue generation and poverty reduction. It also poses the question as whether it needs to be combined with exit strategies that ensuring that those left in the sector have enough resources to generate sufficient income.

What bang for the buck? ICORs and investment rates in primary agriculture

In an increasingly globalized world, private investors, development planners and policy makers alike are interested in identifying investment opportunities in agriculture at home and abroad. A broad and easy-to-calculate indicator that helps address this question is the Incremental Capital Output Ratio (ICOR)[10]. High ICORs suggest that increases in agricultural output require high investments and vice versa.

[10] It must be noted that the ICORs and investment rates used and presented here are only approximations and need to be qualified from a number of different perspectives. One factor is that numerator and denominator of ICORs and investment rates are based on different monetary definitions. The denominator of the investment rates for instance (the value of production) is based on 2004/06 ‘international commodity prices”, while the numerator (incremental capital stocks) is based on values in prices of constant 2009 US$; the same qualification is to be made in the calculation of the investment rates; another factor is that investments include non-monetary elements (such as an indigenous increase in the herd sizes or self-constructed farm buildings), which overstate investment rates and understates ICORs. However, as these shortcomings apply across all regions, they leave cross-regional comparisons unaffected and relative values consistent.

Table 10: ICORs and investment rates in primary agriculture

	investment as share of AGVP	**inputs as share of AGVP[11]**	**investment as share of AGDP**	**incremental capital output ratio (ICOR)**
	average over 2005/07 to 2050			
	percent			
Developing countries	6.7	27	9.2	6.3
excl. China and India	7.5	27	10.3	5.8
sub-Saharan Africa	6.2	11	6.9	3.1
Latin America /Caribbean	5.7	29	8.0	4.8
Near East / North Africa	11.4	40	19.0	11.1
South Asia	9.0	28	12.5	7.2
East Asia	5.2	28	7.2	7.4

The comparison of the ICORs across regions (Table 10) suggests that changes in agricultural capital stocks are expected to render fairly different levels of agricultural output across the main developing regions. By far the highest ICORs (over 11) are projected for the Near East and North Africa (NENA) region, while by far the lowest ICORs (just over 3) are expected for sub-Saharan Africa. In both regions, the expected ICORs are consistent with current factor endowments and expected factor returns. High ICORs for the Near East and North Africa region reflect the fact that the region has already attained a high level of capital intensity and is left with few options to step-up production through an easy expansion of cropland or irrigation water use. In fact, the region has virtually exhausted its agricultural land base and is also approaching the limits of its renewable water resources. This makes further increases in production a capital-intensive endeavour and ultimately renders low returns on future additions to the existing capital stock. Extreme examples include agricultural production systems that operate on ground water mining or water supplies from energy-intensive desalinization plants; ICORs are particularly high where such investments were geared towards low value outputs such as cereals and other food staples. Such farming systems operate at unit production costs that often exceed international commodity prices by multiples and can only be sustained with exorbitantly high subsidies.

From a planning and policy perspective, this suggests that a further expansion of production in the NENA region has to be weighed against alternatives such as increased imports of agricultural goods or investments in foreign capital stocks and crop land. While the region has for long focused on imports, it recently also pursues the option to secure domestic supplies through foreign direct investment in other regions.

An inspection of the ICORs in other regions (Table 10) helps explain why much of these new investments are currently directed to sub-Saharan Africa. The low ICORs of just over 3 suggest that incremental capital invested in Africa's agriculture renders nearly four times the returns of investments in NENA. This is consistent with the fact that Africa's agriculture has abundant land and labour but suffers from a shortage of capital (working capital as well as fixed capital) that is needed to make the existing land and labour base more productive.

How will farm revenues fare relative to non-agricultural incomes?

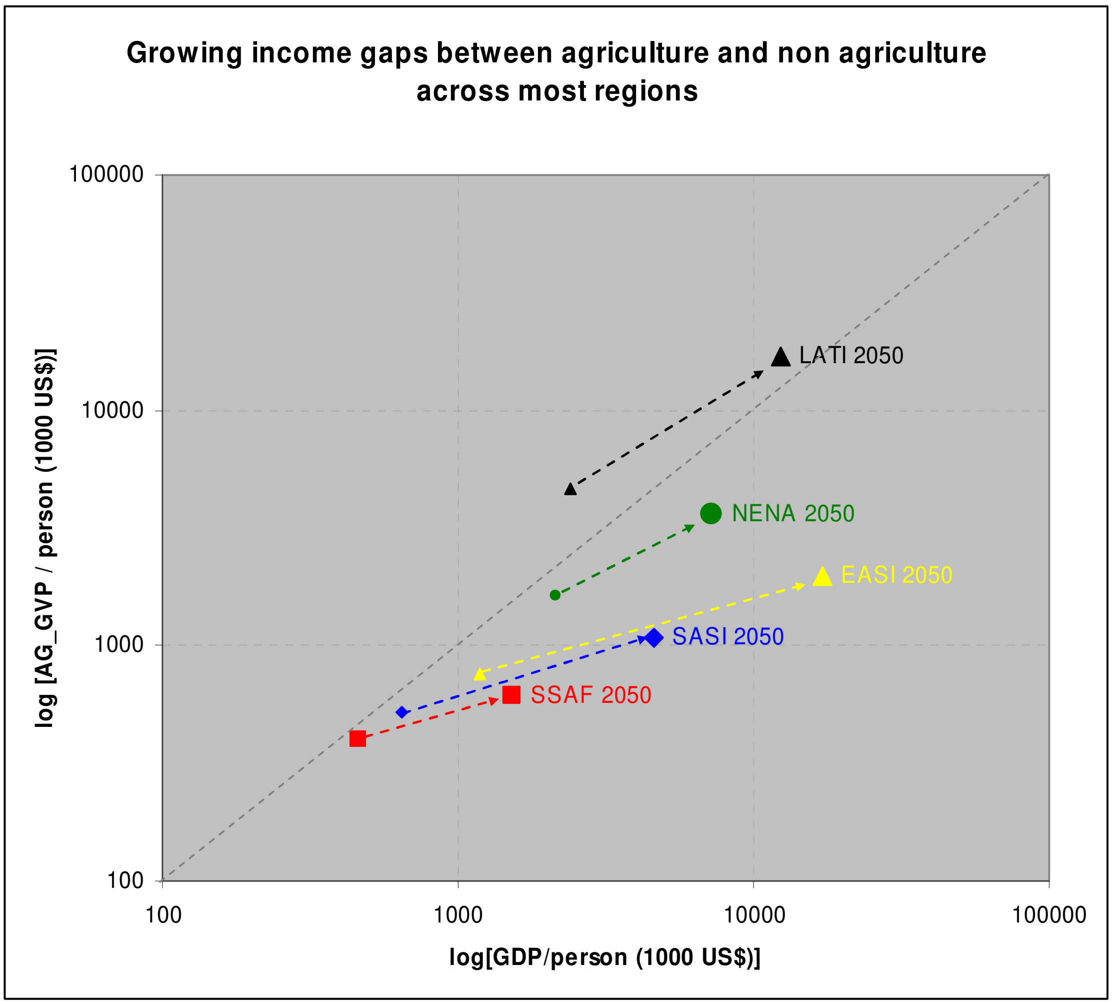
As outlined above, the trends in future farm revenues exhibit vast differences across regions and people dependent on agriculture in the various regions will see vastly different growth potentials for their agricultural income growth potentials. A crucial question that remains open is whether the projected revenue paths in agriculture are more or less favourable than those outside of agriculture or, more precisely, more or less favourable than those of the average income earner (agriculture and non-agriculture combined). The results of the comparison between agriculture and non-agriculture income trajectories are summarized in .

Figure 3 depicts three important features of the projected income trajectories for the various regions. First, the horizontal extension of the paths captures the projected income growth for each region. It suggests that income growth per person is expected to be much higher in East Asia than in any other region; compared to sub-Saharan Africa for instance, income growth is expected to be three times as high and overall the picture

[11] The value of inputs as a share of output are taken from Alexandratos (1988).

suggest a continuation of the growth patterns seen over the last three decades. Income growth is also projected to be high in South Asia, followed by Latin America and the Near East and North Africa region. The second feature is captured by the slope of the trajectories. The steeper the slope, the higher the agricultural growth prospects relative to overall growth. A slope steeper than the 45 degree diagonal denotes that agriculture outperforms the average of a region. Clearly, that is not expected for any of the regions; instead, trajectories are rather flat for all regions and move further away from an equal (45 degree) diagonal on the way to 2050. This unequal growth is particularly pronounced for all regional aggregates of sub-Saharan Africa and Asia. The third feature stems from the location of a trajectory above or below the diagonal. Locations above (below) denote whether agricultural incomes are above (below) average incomes, both for the starting and the end year. As can be seen immediately from , the only region where agricultural incomes are above average incomes is Latin America, while the reverse is the case for all other regions. And even for Latin America, it should be noted that vertical axis depicts agricultural GVP rather than agricultural GDP, i.e. agricultural incomes are overstated by the amount of working capital employed. Given the relative advanced stage of agriculture in Latin America, the effect of overestimation of incomes could be quite considerable; taking this into account, it is probable that in no region agricultural incomes are above average ones, neither in the base year nor in 2050.

Figure 3: Regional income trajectories: agriculture vs. non-agriculture



In summary, this means that the projected income trajectories suggest a largely negative outlook for agriculture. In no region will agricultural labourers be able to accomplish the same income growth as their peers outside of agriculture. The only exception is Latin America, where farm revenues are slightly above average incomes and where growth rates in farm revenues - on average – just match those of the region's economy. The outlook also suggests a growing divergence between agricultural and non-agricultural incomes and thus probably an even stronger concentration of poverty in rural areas. The results are likely to even understate the true agriculture vs. non-agriculture income gap for two reasons. First, agricultural income growth is compared to average income growth. Where agriculture accounts for a large share of the total economy, this would further increase the difference to non-agricultural incomes. Second, the population projections for agriculture are those for agricultural labour force, which is just a subset of the overall agricultural population. If agricultural incomes were to divided over the larger agricultural population, this would further widen the gap to non-agricultural incomes.

It must be emphasized here that these results are still highly preliminary; they need to be vetted further and confirmed by projections for AG-GDP, rather than those for AG-GVP only. The growing divergence may also bring to the fore a possible shortcoming of the underlying partial equilibrium approach. No doubt, past developments show that considerable and even growing rural – urban income differences can persist over extended periods of time, but a growing income divergence over more than four decades may become untenable and suggest that hitherto exogenous assumptions such as the projections for agricultural labour force or even population general projections may need to be endogenized. Rising income gaps would ultimately raise the pressure to leave rural areas (push) and attract cheap labour to more remunerative urban areas and non-farm environments (pull).

The prospect of a widening income gap between farm and non-farm incomes has also given rise to new initiatives to provide support to developing countries farmers. FAO is currently examining various possibilities of such support measures; the decisive criterion for these measures is that they help farmers to catch-up to average incomes attained in an economy or region without introducing new or augmenting existing measures that distort international competition, resource allocation and trade. Scope, options and limits of such measures will be discussed at the Summit on World Food Security in November 2009.

REFERENCES

Alexandratos, N. (ed.) (1988), *World agriculture: towards 2000, an FAO Study,* Belhaven Press, London and New York University Press, New York.

Alexandratos, N. (ed.) (1995), *World agriculture: towards 2010, an FAO Study,* J. Wiley and Sons, Chichester, UK and FAO, Rome.

FAO (1980), "Agriculture toward 2000: Estimation of investment requirements", (mimeo), Global Perspective Studies Unit, Rome.

FAO (1981), "Agriculture: towards 2000", Rome.

FAO (1996), "Investment in agriculture: evolution and prospects", Technical Background Document No. 10 for The World Food Summit, Rome.

FAO (1999), "Investment in agriculture for food security: Situation and resource requirements to reach the World Food Summit objectives", CFS:99/Inf 7, Rome.

FAO (2001), "Mobilizing resources to fight hunger", CFS:2001/Inf. 7, Rome.

FAO (2003), "Anti-Hunger Programme", Rome. (available at ftp://ftp.fao.org/docrep/fao/006/j0563e/j0563e00.pdf)

FAO (2006a), "World agriculture: towards 2030/2050 – Interim report", Rome. (available at http://www.fao.org/ES/esd/AT2050web.pdf)

FAO (2006b), "Livestock's long shadow: Environmental issues and options", Rome. (available at http://www.fao.org/docrep/010/a0701e/a0701e00.HTM)

ANNEX 1: LIST OF COUNTRIES INCLUDED IN THE ANALYSIS

Africa, sub-Saharan

Angola
Benin
Botswana
Burkina Faso
Burundi
Cameroon
Central Afr. Rep.
Chad
Congo
Côte d'Ivoire
Dem. Rep. of Congo
Eritrea
Ethiopia
Gabon
Gambia
Ghana
Guinea
Kenya
Lesotho
Liberia
Madagascar
Malawi
Mali
Mauritania
Mauritius
Mozambique
Niger
Nigeria
Rwanda
Senegal
Sierra Leone
Somalia
Sudan
Swaziland
Togo
Uganda
United Rep. of Tanzania
Zambia
Zimbabwe

Latin America and Caribbean

Argentina
Bolivia
Brazil
Chile
Colombia
Costa Rica
Cuba
Dominican Rep.
Ecuador
El Salvador
Guatemala
Guyana
Haiti
Honduras
Jamaica
Mexico
Nicaragua
Panama
Paraguay
Peru
Suriname
Trinidad and Tobago
Uruguay
Venezuela

Near East/North Africa

Afghanistan
Algeria
Egypt
Iran, Islamic Rep.
Iraq
Jordan
Lebanon
Libyan Arab Yam.
Morocco
Saudi Arabia
Syrian Arab Rep.
Tunisia
Turkey
Yemen

South Asia

Bangladesh
India
Nepal
Pakistan
Sri Lanka

East Asia

Cambodia
China
Dem. Rep. of Korea
Indonesia
Lao
Malaysia
Myanmar
Philippines
Rep. of Korea
Thailand
Viet Nam

ANNEX 2: CUMULATIVE INVESTMENT REQUIREMENTS OVER 2005/07 TO 2050 IN BILLION 2009 US$ BY REGION

	Sub-Saharan Africa			Latin America and Caribbean			Near East/North Africa			South Asia			East Asia		
	Net	Depre-ciation	Gross	Net	Depre-ciation	Gross	Net	Depre-ciation	Gross	Net	Depre-ciation	Gross	Net	Depre-ciation	Gross
Total	479	462	940	842	962	1804	451	742	1193	843	1444	2286	1022	1928	2950
total investment in primary production	272	225	496	479	365	844	300	470	771	585	808	1392	743	941	1684
of which in crop production	101	218	319	183	345	528	151	468	619	223	801	1024	206	809	1015
Land development, soil conservation and flood control	45	3	48	44	4	48	5	1	7	21	5	25	25	9	33
Expansion and improvement of irrigation	14	31	45	28	69	96	52	215	267	28	236	265	36	251	288
Permanent crops establishment	4	41	45	4	47	51	2	15	17	16	52	68	58	256	314
Mechanization	22	37	59	85	207	292	77	224	300	115	304	420	57	184	241
Other power sources and equipment	10	105	115	0	19	19	1	13	14	17	204	220	6	108	114
Working capital	6	0	6	22	0	22	15	0	15	26	0	26	25	0	25
of which in livestock production	171	7	178	296	20	316	149	3	152	362	6	368	536	133	669
Herd increases	67	0	67	85	0	85	37	0	37	96	0	96	128	0	128
Meat and milk production	104	7	110	211	20	231	112	3	115	265	6	272	408	133	541
total investment in downstream support services	207	237	444	363	597	960	150	272	422	258	636	894	279	987	1266
Cold and dry storage	41	37	78	96	88	184	20	46	66	55	109	164	65	240	305
Rural and wholesale market facilities	87	72	159	60	61	121	68	68	136	100	163	263	96	184	280
First stage processing	79	129	207	207	447	654	62	158	220	103	364	468	119	563	682