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Achieving Zero Hunger

The critical role of investments in social protection and agriculture

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Achieving Zero Hunger

The critical role of investments in social protection and agriculture

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

Rome, 2015

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Advocacy note

FAO, IFAD and WFP have prepared new estimates on the additional investments required for sustainably ending hunger by 2030, in line with the highest aspirations of the post-2015 Sustainable Development agenda and the draft Addis Ababa Accord which clearly states, "Our goal is to end poverty and hunger".

FAO, IFAD and WFP welcome this global commitment to end poverty, hunger and malnutrition by 2030. We are making our proposal on how to achieve zero hunger by 2030 in the context of the proposed Sustainable Development Goal 2 to eliminate hunger and malnutrition by 2030 which goes hand-in-hand with the proposed Strategic Development Goal 1 to eliminate poverty at the same time. With almost 800 million people suffering from hunger and four-fifths of the poor living in rural areas, it is necessary to raise agricultural and rural incomes to achieve the two most important Strategic Development Goals.

The 'dollar-a-day' extreme poverty line - adopted for Millennium Development Goal 1 monitoring purposes - was originally based on the estimated costs for individuals to meet their basic needs, of which access to food was, by far, the most significant. Food expenditure generally ranged between 50 to 70 percent of the poverty line income, depending on the country and context. The so called dollar-a-day extreme poverty line was last adjusted by the World Bank to US$1.25 a day.

Hence, the extreme poverty line is a reasonably good indicator of who goes hungry, although the poverty and hunger numbers differ due to the different data and methodological approaches used.

We can end poverty and hunger!

We can end poverty and hunger by 2030. But we will need a new approach that combines public investment in social protection with public and private efforts to raise investment levels in productive sectors - especially in rural areas and particularly agriculture - to much higher levels than in a 'business as usual' scenario.

To eliminate hunger by 2030, much more investment will be needed, than what is expected in what may be described as a business as usual scenario. An average of US$267 billion per year during 2016-2030, i.e. 0.3 percent of world economic output in 2014, is required to fund social protection and additional targeted pro-poor investments, of which rural areas would receive US$181 billion annually. This would average US$160 annually for each of the extreme poor over the 15-year period.

Agricultural investment and rural development

Increasing aggregate investments is expected to increase growth, employment and thus, incomes. Properly designed and implemented investments in zero hunger will increase the productivity and incomes of small-scale producers, while offering broader opportunities for the poor and vulnerable.

Of the total average annual financing of US$267 billion needed, some US$151 billion will be for additional pro-poor investments in the productive sectors – US$105 billion for rural development and agriculture and US$46 billion for urban areas.

To sustainably eradicate extreme poverty and hunger, we need to boost both private and public investment to raise rural and agricultural productivity and incomes, as well as to promote more productive, sustainable and inclusive food systems. Farmers are the major source of investment in the sector, but formal systems of credit and insurance often discriminate against them, especially smallholder family farmers and others less well endowed.

Most developing countries are characterized by high unemployment and underemployment, with youth unemployment growing rapidly. Sadly, this has also become a feature of many developed economies in recent years following the adoption of fiscal austerity measures.

Furthermore, there remains continued uncertainty about future economic prospects, especially with the recent slowing down of the world economy. As there are few effective measures in place likely to reverse this situation, we cannot rely on business as usual investment and growth to eliminate hunger and poverty by 2030.

Social protection

To break the vicious cycle of poverty and hunger, people who are extremely poor and hungry have to be assisted -- through social protection. Adequate, well designed social protection would enable the people in this category to quickly overcome poverty, hunger and undernutrition.

From the total investment of US$267 billion, an investment of US$116 billion per annum is needed for social protection programmes, of which US$75 billion will go to rural areas, where most of the poor live, and US$41 billion to urban areas.

While many may see social protection simply as consumption, the evidence is strong and growing that even modest savings will be deployed by the poor to enhance their productive capacities and their incomes. Also, better nutrition raises productivity, and thus, incomes, both in the short and long term. Social protection is a powerful investment in human capacities and the productive potential of the poor.

Thus, the combination of social protection and pro-poor investments will enable most of the rural poor to escape poverty and hunger sustainably. As other enabling factors are also needed, social protection and pro-poor investments are necessary, though not sufficient.

As rural incomes rise due to targeted, additional, pro-poor rural investments, there should be a corresponding decline in the amount of social protection needed.

Funding issues

The UN's Third International Conference on Financing for Development in Addis Ababa seeks to ensure that all countries, especially developing countries, have the means to implement national policies and programs to achieve their development objectives, including the post-2015 Sustainable Development Goals.

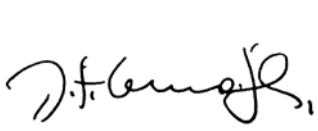
Currently, low income countries have very meagre fiscal resources because they are able to impose few taxes on relatively low national incomes. The least developed and other low-income countries must be enabled to enhance their fiscal resources efficiently and equitably.

Their funding gap should be closed and this can be achieved through more generous international resource transfers than what has been the case in the last quarter century. Such transfers should be used to increase poor countries' budget envelopes, to accelerate progress in eliminating poverty, hunger and malnutrition from our planet. International cooperation can also help share and develop appropriate know-how.

Other factors will need to be taken into account. For example, with the continued increase in greenhouse gas emissions, average temperatures and extreme weather events, efforts have to be made to address both adaptation to as well as mitigation of climate change. We intend to address these issues in the near future, especially in relation to agriculture.

This technical report should assure everyone that our proposal to end poverty, hunger and malnutrition is clearly viable and affordable, provided that a strong political will exists. This has been demonstrated in large and small countries, and also in middle income as well as poor countries.

We look forward to working with governments and the rest of the international community to ensure that hunger and poverty will be history by 2030.



José Graziano da Silva
FAO Director-General

Kanayo F. Nwanze
IFAD President

Ertharin Cousin
WFP Executive Director

Executive Summary

Despite progress in recent decades, including the near achievement of the Millennium Development Goal target of halving the proportion of hungry people in the world by the end of 2015, about 795 million people – or around one in nine – still suffer from chronic (dietary energy) undernourishment, or hunger. The eradication of hunger by 2030 is likely to be a target of the new Sustainable Development Goal 2 (SDG2) to be approved in September 2015 at the 70th Session of the United Nations General Assembly. Ending hunger is also in line with the Zero Hunger Campaign promoted by the UN Secretary-General, and closely linked to the Sustainable Development Goal 1 target to eliminate poverty by 2030. Governments in various regions have responded to that call of the UN Secretary-General and have committed to eradicating hunger as a major step towards poverty reduction. Almost four-fifths of the world's poor live in rural areas.

To achieve zero hunger (ZH) by 2030, the international community needs to build upon approaches and options that have proven to be effective, and which ensure continuous access to food for the undernourished, and improve livelihood opportunities for the poor and hungry. This paper presents new estimates on investments required to eradicate hunger by 2030.

To estimate the additional investment requirements, we begin with reference to a "baseline" "business as usual" scenario. In this scenario, around 650 million people would still suffer from hunger, or chronically inadequate dietary energy, in 2030. We then estimate the investment requirements to eliminate hunger by 2030.

This paper specifically considers how hunger can be eliminated through a combination of social protection and targeted pro-poor investments.

The investment requirements proposed in this paper are prepared for the Third International Conference on Financing for Development taking place from 13 to 16 July 2015, in Addis Ababa, Ethiopia.

Social Protection

Hunger, undernutrition and poverty can be rapidly eliminated through social protection as soon as possible. Access to food is the most significant basic need by far, with the minimal cost of basic food ranging between 50 to 70 percent of the total poverty line income. Income is provided to the poor and hungry through social protection so that they can afford sufficient food to meet their basic nourishment needs.

Bringing people to the US$1.25/day extreme poverty line income in purchasing power parity (PPP) terms would ensure that everyone has access to their basic food needs. The poor can be immediately brought to the US$1.25/day poverty line through social protection by a "Transfer to cover the Poverty Gap" (PGT). This PGT eliminates poverty and hunger as soon as possible. The PGT is thus the cost of bringing all those with less than US$1.25/day to that income level.

Accelerating pro-poor growth

In the longer term, additional investment is required to stimulate and to sustain higher pro-poor rural growth of incomes and employment than in the business as usual scenario. To be pro-poor, investments in urban and rural areas, including in agriculture, should be properly targeted so that the poor could earn enough to overcome poverty. In the longer term, as the incomes of the poor increase because of investments, the need for social protection to close the poverty gap declines.

Consequently, the cost of this approach will require adding the costs of both components while also recognizing the implications of the higher incomes generated. First, the annual average "gross PGT" – inclusive of a mark-up of

20 percent for administrative costs and leakages –between 2016 and 2030 is estimated. Second, the additional annual global investment requirements are also estimated.

An average of US$267 (bn) per year is estimated to be required to fund the PGT and additional targeted agricultural investments from 2016 to 2030, of which rural areas would receive US$181 bn annually. Initially, the poor are expected to earn incomes from wage work and their meagre productive assets (such as land), but are not expected to be able to invest much. This means that to induce private investments, the additional investment required has to be adequately remunerated. However, as the poor save more, they are able to invest more, and thus become more productive and increase their earnings.

Both public and private investments can help to accelerate the transition from social protection to production. While private agents including farmers are, by far, the largest source of investment in rural areas, investment in public goods, such as rural transport and other infrastructure as well as productivity-enhancing research, development and extension, should attract more productive investments. Additional public investment can also diversify sources of rural income and expand the provision of rural and agricultural goods and services.

To summarize, hunger and extreme poverty can be eliminated immediately with adequate investments in social protection. However, low income countries will find it unaffordable, and will require continuous external support until they are able to raise incomes and tax revenues sufficiently. A combination of social protection and targeted pro-poor investments can quickly take people out of hunger and extreme poverty while raising earned incomes for the poor in the medium term. Doing so requires an appropriate mix of public and private investments, and appropriate policies and coordinated programmes to ensure that the poor actually benefit from such additional investment and the growth and employment opportunities thus generated.

Appendices

Pro-poor growth can be organized in many different ways. Appendix 1 considers the costs and benefits of providing more generous social protection by comparing the likely implications of transfers equivalent to a poverty line of US$2/day compared to US$1.25/day. Additional social protection over the poverty line can assure access to basic food and other needs and augment investments by the poor, enabling them to become more productive and to earn more. This option is premised on the "from protection to production" assumption that additional social protection will increase investments by the poor, enabling them to become more productive and earn more, thus transitioning from a vicious cycle of poverty, hunger, and low productivity to a virtuous cycle by enabling income growth.

A higher PGT would enable more diverse and thus healthier diets. The higher PGT can also improve nutrition by addressing 'hidden hunger', or micronutrient deficiencies, due to the inadequate intake of vitamins, minerals and trace elements critical for a healthy human life. Improving nutrition in the short and long term should enable the poor to engage more productively in economic activities, improving their incomes and livelihoods.

More generous transfers would also enable the poor to save and invest parts of their income to improve their productivity, and livelihoods. After all, almost by definition, an income of US$1.25 a day would only cover basic needs, but would not enable saving and investing. Savings and investments would allow the poor to break out of vicious cycles of poverty, hunger, low productivity and incomes and to enter these virtuous cycles leading to higher incomes, more investments, greater resilience and lives of dignity.

Appendix 2 considers the additional investment requirements of an alternative overall balanced growth scenario above that of the business as usual starting scenario. This approach would require, on average, an additional US$1463 bn per year between 2016 and 2030, of which about US$111 bn is expected to go to agriculture. In this scenario, an estimated 338 million people (up to 5 percent of the population in countries requiring additional investment) would still be unable to earn enough to overcome hunger or chronic (dietary energy) undernourishment after 2030. The average annual costs of a "Food Deficit Transfer" (FDT), i.e. to meet the Minimum Dietary Energy Requirement (MDER), for the bottom five percent "left behind" are estimated at US$14 bn (including a 20 percent mark-up for administrative costs and leakages).

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Introduction

This report presents estimates of the additional investment that would be required to achieve the objective of world-wide zero hunger (ZH) by 2030, i.e. virtually eliminating the prevalence of undernourishment. To estimate the additional investment requirements, we adopt and compare two alternative methodologies. The first methodology, which estimates the additional investment required to raise GDP to achieve zero hunger, builds upon Schmidhuber and Bruinsma (2011)[1]. While this document follows the same broad steps, it complements the 2011 study with some new approaches using the FAO GAPS global partial equilibrium model for country-wise long term projections of food demand and supply[2], and estimation of a "Food Deficit Transfer" (FDT), i.e. the transfers required to enable people not able to earn enough to feed themselves, to no longer remain undernourished. This approach involves very large, economy-wide investments to achieve zero hunger by 2030, most of which are likely to involve private investments by farmers themselves, presumably according to their different means.

The second methodology involves (targeted pro-poor) Social Protection (SP) to immediately lift people out of extreme poverty. This approach assumes that thanks to the possibility of meeting their basic needs, including diversifying their diets (thus improving their nutrition), the poor will enhance their productive capacities to increase their incomes. This will enable the poor to break out of a vicious cycle of poverty, hunger and low productivity into a virtuous cycle of higher productivity, and income generation. This progression from protection to production will accelerate the reduction of poverty, hunger and malnutrition, allowing the ZH target to be realized, no poverty as well as dietary diversity.

This report is structured as follows: Section 2 frames the need for investment to achieve zero hunger in the broader context of financing for development. Section 3 outlines the business as usual (*BaU*) scenario, which serves as a reference for all the subsequent scenarios. Section 4 presents the main scenario, where ZH is achieved by social protection measures, aimed at immediately taking people out of hunger, and targeted investments in rural areas and agriculture (*ZHbotmea* scenario), to sustainably raise incomes in the longer term. Section 5 specifies the types of investments required and priority areas for agricultural development, while Section 6 provides concluding remarks. Other scenarios considered are appended: Appendix 1 considers the costs and benefits of providing more generous social protection to cover a PGT for a poverty line equivalent to US$2 a day. Appendix 2 looks into a scenario where ZH is achieved through investment for economy-wide growth (*ZHtotinv* scenario) and a transfer to fill the Food Deficit Gap (FDT) for the bottom 5 percent "left behind" by the growth process. Finally, methodological details and statistical tables follow in Appendices 3 and 4.

[1] Schmidhuber, J. and J. Bruinsma (2011). "Investing towards a world free of hunger: lowering vulnerability and enhancing resilience". Chapter 27 in Prakash, A. (2011) (ed.). *Safeguarding Food Security in Volatile Global Markets*. FAO, Rome. See: http://www.fao.org/economic/est/issues/volatility/vgm/en/

[2] FAO (2015). Global Agriculture Perspectives System (GAPS), Version 1.0 Global Perspectives Studies Team. ESA. FAO. Rome.

Investing for development

Funding the post-2015 development agenda

The estimate of investment required to achieve zero hunger fits within the broader exercise of planning suitable investments to support the post-2015 development agenda and to achieve the Sustainable Development Goals (SDGs) that will be adopted in September 2015 by the United Nations. The third international conference on Financing for Development (FfD3), to be held in Addis Ababa from 13 to 16 July 2015, is expected to identify the modalities for funding implementation of the post-2015 development agenda.

The challenges ahead

Setting achievable sustainable development objectives in a forward-looking global framework is both timely and urgent, in light of the challenges that humanity is facing. The world population, which was barely one billion at the beginning of the nineteenth century, is now, after two centuries, more than seven billion. While Gross World Product (GWP) in 1800 was around US$175 bn[3], it is now almost US$76,000 bn[4]. Agriculture dramatically evolved during this period. For instance, wheat yields in Europe increased from around 1.2 tons per hectare in 1800[5] to around 7.0 tons per hectare today. Also globally, in the last fifty years, cereal yields have more than tripled, helping to feed the fast growing human and livestock populations.

However, this dramatic increase in the production of goods and services has progressively stressed the capacity of the Earth to support human activities, hindering prospects for future development. "…*Current policy, financing and investment patterns are not delivering the future we want… Some countries have fallen further behind, and inequalities have increased... Shocks from economic crises, conflict, natural disasters, and disease outbreaks spread rapidly in our highly interconnected world. Environmental concerns, climate change and other global risks threaten to undermine past successes and future prospects" (UN 2015)*[6].

Climate change is of particular concern, *inter alia*, for food security and nutrition, as it is more severely impacting already fragile ecosystems where most food and nutrition insecure people live[7]. All in all, it is estimated that our current "ecological footprint", i.e. the quantity of land-equivalent required to absorb the impacts of our activities corresponds to one and half Earths. Under a business as usual scenario, we would need three planets by 2050[8]. Although these figures may be broad indicative estimates, they raise concerns about the sustainability of our development path on economic, environmental and social grounds.

Sustainably Achieving Zero Hunger

A major target of the SDG agenda is the eradication of hunger. This is a UN system-wide priority and the centrepiece of the Zero Hunger Campaign promoted by the UN Secretary General's High-Level Task Force on World Food Security (HLTF). To achieve zero hunger by 2030, governments and the international community need to build upon approaches that have proven to be effective, and which combine three important elements:

a. *Providing immediate access.* Promote immediate access to food and nutrition-related services to the hungry people through Social Protection programmes, including transfers

[3] DeLong, J. Bradford (1998). "Estimating World GDP, One Million B.C. – Present

[4] The World Bank (2014). Data Bank. Gross Domestic Product 2013.

[5] Grigg, D.B. (1980). *Population Growth and Agrarian Change: An Historical Perspective*. Cambridge University Press, Cambridge.

[6] UN (2015). Zero-draft outcome of the third international conference on Financing for Development, Addis Ababa, July 2015. New York, March 2015. http://www.un.org/pga/wp-content/uploads/sites/3/2015/03/160315_ffd-zero-draft-outcome.pdf

[7] IPCC (2014). *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds)]. IPCC, Geneva, http://www.ipcc.ch/pdf/assessment-report/ar5/syr/SYR_AR5_FINAL_full.pdf

[8] Global Footprint Network: www.footprintnetwork.org.

of food and/or cash to immediately relieve hunger and also to increase human productive potential;

b. *Increasing opportunities.* Create opportunities for the poor and hungry to improve their livelihoods by promoting decent labour conditions, promoting investment to improve farm productivity, rural infrastructure and market access, knowledge generation, learning and information;

c. *Ensuring sustainability*. Increase the sustainability of food systems by conserving natural resources and adopting sustainable agricultural practices, reducing food losses in production and processing, modify unsustainable dietary preferences, reduce levels of food waste in consumption, and reduce emissions of greenhouse gases from agriculture and other sectors, to slow the pace of climate change and ensure the food security of future generations (HLPE, 2012)[9].

Investing in agriculture.

Investing in agriculture is a way of increasing the productivity of agricultural labour and land. Productivity increases enable better remuneration, as productivity is a major determinant of farm incomes, thus contributing to raising the living conditions of food insecure strata of the population while helping to reduce pressure on scarce natural resources. Private agents, including farmers, are, by far, the largest source of investment in rural areas. However, public investment in public goods -- such as institution building, productivity-enhancing research, rural transport, health, education and social protection -- is needed to ensure food security, nutrition and inclusive sustainable development (FAO 2012, 2015)[10].

[9] HLPE (2012). Food security and climate change. A Report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security. Committee on World Food Security, Rome.

[10] FAO (2012). *State of Food and Agriculture, 2012*. FAO, Rome. FAO (2015). *State of Food and Agriculture, 2015* (forthcoming). FAO, Rome.

The baseline scenario to 2030: business as usual

To test the effectiveness of the various measures envisaged to achieve ZH by 2030, we begin by building a scenario to reflect a business as usual (*BaU*) situation. This scenario provides projections of undernourishment to 2030 assuming that no significant changes in policies and actions to achieve ZH will be undertaken.

Measuring undernourishment.

If the Dietary Energy Consumption (DEC) is a measure of the dietary energy nourishment of people, the Prevalence of Undernourishment (PoU) is calculated as the proportion of a population with a DEC below the minimum caloric intake to conduct a decent life, also known as the Minimum Daily Energy Requirement (MDER)[11]. An increase of the DEC of undernourished people that brings them above the MDER reduces the prevalence of undernourishment. The prevalence of undernourishment is calculated on the basis of three parameters: the Average (per capita) Dietary Energy Consumption (ADEC), the MDER, and an estimate of the coefficient of variation (CV).

The base year

To build the BaU scenario, reference is made to the period 2005-2007, the base years that anchor the projections of undernourishment in the future (FAO, 2012)[12]. In the base period, around 949 million people were undernourished[13]. The large majority of the undernourished (829 million) were concentrated in 60 countries, expected to miss the zero hunger target by 2030 if no additional investment occurred. The others (120 million) were in 50 countries expected to be on target by 2030 with no additional investments (Table 1, first panel). Most undernourished people (920 million) were concentrated in low and medium income countries in five areas, notably sub-Saharan Africa (SSA), Near East and North Africa (MNA), Latin America and Caribbean (LAC), South Asia (SAS) and East Asia (EAS). In these areas, although ADEC greatly exceeded the MDER, almost 18 percent of the population was undernourished. The prevalence of undernourishment was particularly high in SSA (29 percent) and in SAS (20.5 percent)[14].

Business as usual scenario to 2030

Food consumption projections to 2030 reveal that by 2030, 653 million people will still be undernourished.

In the BaU scenario, the global world product is expected to grow at 2.4 percent per annum to 2030. In the various regions GDP is projected to increase at rates between 2.2 percent, as in LAC, and 4.5 percent, as in EAS (Table 2). At the same time, population and investments are also expected to grow.

The shift in GDP is expected to raise the Average Dietary Energy Consumption (ADEC) from 2619 to 2857 kcal/person/day (+9 percent) in low and middle income countries

[11] FAO (2014). *State of World Food Insecurity, 2015*. (SOFI 2015). Meeting the 2015 international hunger targets: taking stock of uneven progress. Annex 2. FAO, Rome. http://www.fao.org/3/a-i4646e.pdf

[12] Alexandratos, N. and J. Bruinsma (2012). "World agriculture: towards 2030 and 2050 – the 2012 revision". ESA Working Paper No. 12-03, FAO, Rome, available at: http://www.fao.org/economic/esa/esag/en/

[13] Food consumption is distributed across the population according to calorie distribution functions calibrated on the prevalence of undernourishment reported in SOFI 2015. Due to calibration procedures to match the FAO GAPS model, which is calibrated on food consumption as in FAO AT 2030/50, and the SOFI dataset, the undernourishment indicators we obtain for the base year are only slightly different from the indicators reported in SOFI 2015.

[14] These figures are substantially aligned with the statistics reported in SOFI 2015. Some discrepancies are due to calibration procedures.

TABLE **1**

Undernourishment in the business as usual *(BaU)* scenario

	Population	Minimum Daily Energy Requirements (MDER)	Average Dietary Energy Consumption (ADEC)	Coefficient of Variation (CV)	Persons chronically undernourished	
	million	*kcal/person/day*			*percent*	*million*
			2005/07 (Base Year)			
WORLD	**6,568**	**1,846**	**2,769**	**0.297**	**14.4**	**949**
High-Income countries	1,351	1,949	3,348	0.223	2.2	29
Low & middle income countries	5,216	1,819	2,619	0.317	17.6	920
sub-Saharan Africa	730	1,747	2,238	0.327	29.0	212
Near East / North Africa	432	1,832	3,007	0.285	8.3	36
Latin America /Caribbean	556	1,838	2,898	0.278	8.4	47
South Asia	1,520	1,769	2,292	0.276	20.5	311
East Asia	1,957	1,875	2,850	0.362	15.9	311
50 countries on target in 2030	2,626	1,886	3,122	0.243	4.6	120
60 countries not on target in 2030	3,941	1,819	2,534	0.333	21.0	828
25 worst-off countries*	492	1,752	2,062	0.373	39.8	196
			2030 Business as Usual (BaU) scenario (Baseline)			
WORLD	**8,274**	**1,865**	**2,955**	**0.272**	**7.9**	**653**
High-Income countries	1,437	1,941	3,425	0.217	1.1	16
Low & middle income countries	6,838	1,849	2,857	0.283	9.3	637
sub-Saharan Africa	1,245	1,812	2,528	0.288	17.4	216
Near East / North Africa	615	1,865	3,133	0.266	4.7	29
Latin America /Caribbean	682	1,872	3,091	0.258	4.0	27
South Asia	2,016	1,825	2,587	0.245	9.3	188
East Asia	2,247	1,878	3,133	0.327	7.8	175
50 countries on target in 2030	3,113	1,895	3,243	0.233	2.0	63
60 countries not on target in 2030	5,161	1,846	2,782	0.295	11.4	590
25 worst-off countries*	833	1,812	2,363	0.320	25.2	210

* The worst-off countries are defined as countries that would have to raise their average DEC in 2030 by more than 10 percent to eliminate hunger.

Source: own calculations based on Alexandratos, N. and J. Bruinsma (2012) and SOFI 2015.

TABLE **2**

GDP and Investment in the Business as Usual Scenario

	GDP (constant 2013 Billion US$)		GDP growth (%) Average, p. a. 2016-2030	Av. Gr. Inv., bn US$ 2016-2030
	2005/7	2030		
		BaU	*BaU*	*BaU*
WORLD	**56,263**	**101,131**	**2.40**	**9,202**
High-Income countries	42,388	61,530	1.65	4,189
Low & middle income countries	13,875	39,601	3.79	5,013
sub-Saharan Africa	548	1,629	4.01	163
Near East / North Africa	1,881	4,334	3.33	512
Latin America /Caribbean	3,588	6,413	2.02	517
South Asia	1,393	4,391	3.82	396
East Asia	6,037	21,859	4.52	3,303
50 countries on target in 2030	49,820	76,654	1.83	5,697
60 countries not on target in 2030	6,443	24,476	4.63	3,506
25 worst-off countries*	273	793	4.02	70

(Table 2, second panel)[15]. The latter implies that the Coefficient of Variation (CV) of food distribution drops and the overall percentage of the undernourished in those countries falls to 9.3 percent[16]. However, this percentage remains high in SSA and SAS (at 17.4 percent and 9.3 percent respectively), and above target in four of the five areas under consideration.

The projections of undernourishment to 2030 in the BaU clearly indicate that efforts are needed to increase food consumption for more than 650 million people who would otherwise remain undernourished.

In the following sections, this paper explores a scenario (*ZHbotmea)* where ZH can be achieved through a mix of social protection and additional targeted "pro-poor" investments, specifically in rural areas, where the great majority of the poor live.

Two alternative scenarios are also explored for comparative purposes, notably the achievement of ZH through social protection *(ZHsocpro)* to close a US$2 a day poverty gap and additional investment for economy-wide growth (*ZHtotinv)* complemented by financing to cover the remaining dietary energy gap for the bottom five percent presumed to be 'left behind'. The findings for these scenarios are reported in Appendices 1 and 2 respectively[17].

[15] The Average Dietary Energy Consumption (ADEC) is not merely net caloric intake, but a gross figure which includes a proportion of waste.

[16] The drop of the Coefficient of Variation for Dietary Energy Consumption (DEC) distribution is obtained by keeping the Standard Deviation (SD) of the DEC distribution constant over time at its base year (2005/07) level for every country. Since CV = SD / ADEC, the CV declines when the ADEC increases with a constant SD.

[17] The three main approaches adopted so far estimate the cost and related funding requirements for development goals as provided in the European Report on Development – 2015 (European Commission, 2015 pp 68-69: 1) "Unit cost-based analyses"; 2) Growth-based approaches; and 3) Computable General Equilibrium (CGE)-based approaches. The approaches adopted here for the estimation of social protection needs fit in the first family while those for the estimation of additional investment requirements belong to the second family.

Achieving zero hunger by investing in social protection and pro-poor development

In this paper it is assumed that hunger is essentially caused by a lack of entitlements or purchasing power, that do not allow people to have access to sufficient and nutritious food. Therefore hunger can be defeated by providing people the opportunity to obtain enough income to afford sufficient and nutritious food and to satisfy basic needs for adequate food utilization.

How much income is needed to exit hunger?

People who are out of extreme poverty are also free of hunger. Assuming the US$1.25/day PPP poverty line as a threshold for extreme poverty, each person who disposes of at least US$1.25/day is also free of hunger.

Therefore, the additional per capita income to exit poverty can be measured as the additional amount of income required on average by the poor to overcome the US$1.25/day PPP poverty line, i.e. the so called "poverty gap". On the basis of the poverty gap and the number of the poor, the total amount of income required each year to pull everybody out of poverty is calculated[18].

In the BaU scenario, both the poverty gap and the number of the poor are projected to vary due to changes in national income, population and income distribution from 2016 to 2030. Therefore, the additional income needed to take people out of poverty varies as well. Table 3 provides the additional income required with respect to the BaU scenario to pull people out of poverty both in US$ and as percentage of the GDP for 2016, 2030 and on average from 2016 to 2030.

Figure 1 shows the required additional income to pull people out of poverty from 2016 to 2030. While, overall, per capita GDP growth reduces the proportion of the poor as well as the poverty gap, the increase of the population will tend to increase the amount of additional income required with respect to the BaU to exit poverty. Globally, the additional income required decreases slightly from US$150 bn to US$147 bn. The average income requirements from 2016 to 2030 are estimated at around US$148 bn.

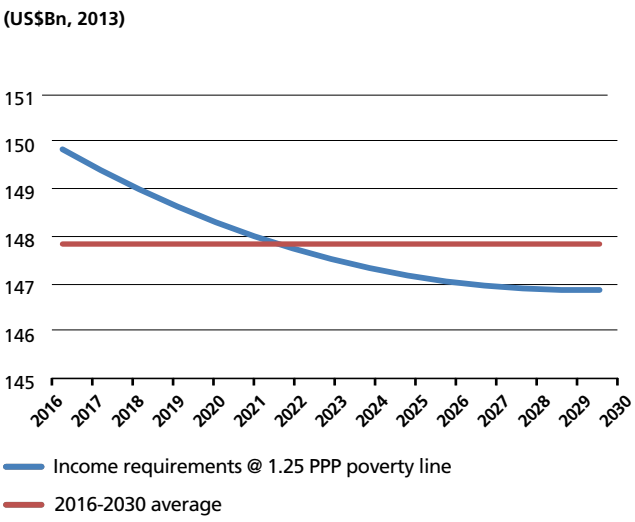
How to provide additional income to the poor

In this scenario (*ZHbotmea*), two instruments are considered to provide the poor with additional income to pull them out of poverty, namely: 1) investment in social protection; and 2) investment in agriculture and rural development. The two instruments are combined so that:

a. Universal exit out of poverty and hunger is achieved as soon as possible;
b. Productive capacities and earned incomes of the poor progressively increase, particularly in rural areas;
c. Reliance on social protection incomes progressively declines.

FIGURE **1**

Additional income required to pull people out of poverty, 2016-2030 (US$ bn, constant 2013 prices)



[18] The poverty gap and the number of the poor, calculated as total population times the percentage of the poor (prevalence of poverty) are estimated on the basis of country-wise log-normal distribution functions fitted to the poverty indicators in the World Bank *Povcalnet database. The annual income required at country level to pull people out of poverty* is calculated as the poverty gap (as percent of the poverty line) times the poverty line times the number of poor times 365.

TABLE **3**

Additional income required to pull people out of poverty at US$1.25 PPP poverty line

	Required additional income at US$1.25 PPP (US$bn, 2013)	Required additional income at US$1.25 PPP (US$bn, 2013)	Required additional income at US$1.25 PPP (US$bn, 2013)	Required additional income at US$1.25 (% GDP)	Required additional income at US$1.25 (% GDP)	Required additional income at US$1.25 (% GDP)
	2016	*2030*	*Av.2016-2030*	*2016*	*2030*	*Av.2016-2030*
WORLD	**150**	**147**	**148**	**0.21**	**0.15**	**0.17**
High-Income countries	2	2	2	0.01	0.00	0.00
Low & middle income countries	147	145	146	0.63	0.37	0.47
sub-Saharan Africa	61	72	66	6.45	4.39	5.27
Near East / North Africa	3	3	3	0.10	0.07	0.09
Latin America /Caribbean	5	5	5	0.10	0.07	0.09
South Asia	57	51	54	2.20	1.16	1.58
East Asia	21	13	16	0.18	0.06	0.10
50 countries on target in 2030	29	30	30	0.05	0.04	0.04
60 countries not on target in 2030	121	116	118	0.93	0.48	0.65
25 worst-off countries*	40	48	44	8.83	6.04	7.22

The role of Social Protection.

Achieving zero hunger as soon as possible requires immediately providing the poor with additional incomes to achieve satisfactory nutrition. In the initial periods all additional income required to pull all the poor out of poverty is provided through a Transfer to cover the Poverty Gap (PGT). In subsequent periods the PGT is expected to drop due to:

1. The growth of the whole economic system as projected in the BaU and
2. The progressive increase in earned income.

The cost of the PGT, which in addition to the income to be transferred includes a 20 percent mark-up for administrative costs and leakages (gross PGT), amounting globally to US$116 bn annually on average, mostly concentrated in the low and middle income countries (Table 4).

Although expenditure for social protection is usually viewed as current expenditure, social protection can contribute to investment and achievement of the zero hunger target. To achieve the target, selected groups of people, particularly landless workers or marginal smallholders in rural areas, need to be supported through appropriate Social Protection systems that ensure the predictability and regularity of income flows. This would increase their chances of being reinserted into productive sectors while contributing to improve their food and nutrition status.

Social Protection, for instance, may help overcome household liquidity constraints, enhance human resources and enable individuals and communities to engage in more risk-taking, but profitable employment-generating activities. In the absence of social protection systems or other risk sharing arrangements, poor rural households are often forced to cope in ways that further increase their vulnerability and undermine their future income generation capacity such as, overexploitation of the natural resources they depend on, or refraining from making risky investments.

In addition, many countries will need to provide social protection to meet the needs of ageing populations. Investing in Social Protection would also contribute to increasing overall economic growth. By providing the poor with enough income to satisfy their basic needs, and improving their nutritional status, they are likely to start accumulating productive resources through a saving-investment process.

The role of investment

While additional income has to be provided immediately through social protection, progressively higher earned incomes for the poor are expected thanks to the additional investment that increases the productivity of existing activities and stimulates new activities. Increasing earned incomes will increase their resilience and correspondingly reduce the need for and reliance on social protection.

TABLE **4**

Average annual PGT and economy-wide investment from 2016 to 2030 (panel 1) and *in rural areas* (panel 2) *(US$1.25 a day PPP)*

	Average 2016-2030 annual values					
	PGT at US$1.25 PPP (US$Bn, 2013)	**PGT at US$1.25 PPP (US$Bn, 2013)**	**Aditional investment at US$1.25 PPP (US$Bn, 2013)**	**Aditional investment at US$1.25 PPP (US$Bn, 2013)**	**PGT at US$1.25 PPP (% GDP)**	**Aditional investment at US$1.25 PPP (% GDP)**
	Total	*Rural*	*Total*	*Rural*	*Total*	*Total*
WORLD	**116**	**75**	**151**	**105**	**0.13**	**0.18**
High-Income countries	2	1	1	1	0.00	0.00
Low & middle income countries	114	74	149	105	0.37	0.48
sub-Saharan Africa	47	32	80	53	3.73	6.41
Near East / North Africa	2	2	3	2	0.07	0.07
Latin America /Caribbean	5	1	3	1	0.08	0.05
South Asia	43	34	54	42	1.25	1.57
East Asia	16	5	9	5	0.10	0.05
50 countries on target in 2030	23	14	35	25	0.03	0.05
60 countries not on target in 2030	93	61	116	81	0.51	0.64
25 worst-off countries*	31	20	48	30	5.14	7.95

Source: Calculations based on WB Povcalnet data

Note: Country-wise details are reported in table D3 in the appendix 4.

It is assumed that by 2030, all the additional income required by the poor – except for the bottom 5 percent of the population, assumed to be "left behind" – will no longer come from the PGT, but will have become earned income.

Investment requirements are calculated on the basis of the income that progressively has to be provided to people to keep them out of poverty, under the assumption that, by 2030 the PGT will be phased out, apart from the transfers to the 5 percent of the population[19]. Globally, the investment required amounts to US$151 bn (Table 4, third column).

Initially, the poor are expected to earn incomes from labour remuneration and their productive assets (such as land), as they will not be able to invest much. However, as the poor have the possibility to save and invest themselves, they are expected to increase their earnings.

As the investors are entitled to the remuneration from the capital they invest, a provision is made to adequately remunerate the additional investment required[20].

Where are the poor

To the extent possible, income transfers and income-earning opportunities have to be provided to the poor wherever they are. Currently 78 percent of the poor are in rural areas. This implies that a corresponding share of the total additional income, as well as of additional investments, will be allocated to rural areas[21]. Therefore, out of the total PGT of US$116 bn,

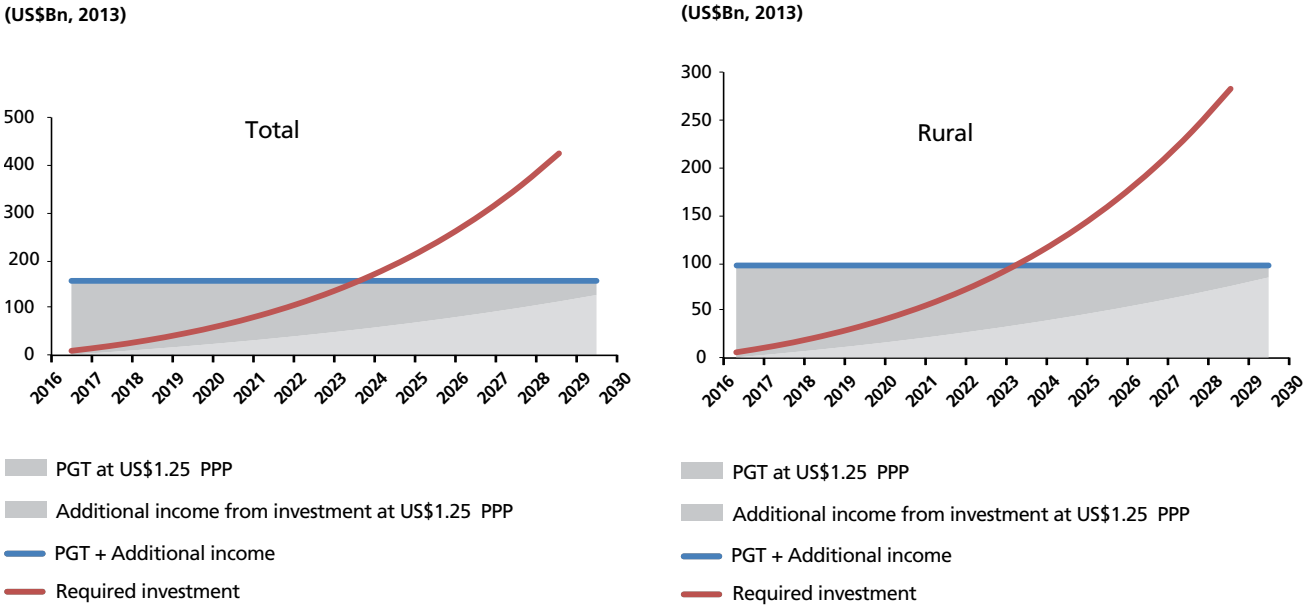
[19] The investment requirements are calculated on an annual basis with reference to an Incremental Capital Output Ratio, which is lower than the ones applied for the economy-wide investment in appendix B, to account for the higher marginal productivity of capital at lower levels of income.

[20] The provision for the remuneration of capital is based on country-specific capital-labour ratios derived from historical data.

[21] This scenario raises some questions: first, how will the investment rate be effectively and sustainably raised; second, how will the tendency for the agricultural sector investment rate to be lower than the overall investment rate be reversed; third, how will the tendency for the agricultural sector wage rate to be lower than the overall wage rate be reversed enough so as to exceed the poverty line income. Here, the role of the public sector and solid institutions to create opportunities for and protect the poor becomes very important.

FIGURE **2**

Annual PGT and investment from 2016 to 2030 in the ZHbotmea scenario economy-wide (panel 1) and for rural areas (panel 2)



US$75 bn is for poor people living in rural areas, and, of the US$151 bn in investment, US$105 bn is for rural areas. Table 4 provides annual averages for both the PGT and economy-wide investment, in rural and urban areas for the period 2016-2030. The results are also shown in Figure 2.

The PGT, as designed in this scenario, is expected to shrink, both due to the economic growth projected in the BaU and the role of additional "pro-poor" targeted investment. However, it is assumed that five percent of the population, who will not benefit due to various reasons, such as personal disability, health and socio-economic conditions will continue to meet their basic needs through social protection transfers. In the medium-long run the PGT could be absorbed by more structured Social Protection Floors (SPFs).

ILO has estimated the cost of SPF benefit package, i.e. the amount of money to be spent annually to ensure universal minimums for selected disadvantaged categories[22]. These costs, as average shares of GDP, range between 1.9 percent for East Asia to 7.6 percent for the poorest countries, with an average of 3.1 percent of GDP for all low and middle income countries[23]. The costs and benefits of the PGT are different from the ILO SPF, as the targeted people and measures are different. While the PGT targets the poor on the basis of the US$1.25 PPP, the SPF has several "universal" components and the costs of the transfers are calculated on the basis of national poverty lines. However, significant complementarities exist between the PGT and the SPFs. On the one hand, full implementation and realization of the SPFs will leave less room for hunger. On the other hand, if implementation and realization of nationally-defined social protection floors is to be achieved progressively, "temporary interventions could still be required"[24]. While investment in agriculture and rural development will reduce the need for the PGT to 2030, effective SPFs can replace it.

[22] ILO (2015). *A Global Fund for Social Protection Floors in Least Developed Countries*. Informal note prepared by the ILO Social Protection Department as a technical input for preparations for the Addis Ababa Conference on Financing for Development, 13-16 July 2015.
This global estimate is based on the cost of: (i) a universal child benefit of 12 percent of a country's national poverty line; (ii) a benefit of 100 percent of a country's national poverty line to all orphans; (iii) a maternity benefit for 4 months, of 100 percent of a country's national poverty line to all mothers with new-borns; (iv) unemployment support of 100 percent of a country's minimum wage to one person per vulnerable household for 90 days; (v) a benefit of 100 percent of a country's national poverty line to all persons with severe disabilities; and (vi) a universal pension of 100 percent of a country's national poverty line. All these include administrative costs.

[23] The aggregate percentages are own calculations. For countries without data, shares of similar countries or regional averages were assumed. ILO does not report data for the HICs.

[24] Written comments on the zero draft of this paper by ILO.

Targeted pro-poor investment in rural areas: possible domains

Pro-poor investment

In this scenario, if a progressive reduction of the Poverty Gap Transfer has to be realized, investment has to generate enough income in the hands of the people targeted by the PGT, to bring them out of poverty. Economic growth generated by pro-poor investment has to be inclusive, so as to provide opportunities for improving the livelihoods of the poor (SOFI, 2015). Indeed, if hunger is to be overcome, the additional investment in rural development and agriculture has to be geared to economically, environmentally and socially sustainable development in domains that may be overlooked in a business as usual scenario, but are strategic to bring hunger reduction and poverty alleviation.

A broad categorization of how agricultural capital stock is currently allocated among investment categories is reported in Table 5. The relative importance of each category varies across regions and countries.[25]

Possible domains for additional investment.

Part of the additional pro-poor investment required to generate income in the hands of the poor may fit within the broad categories of Table 5. However, as the basic objective of additional investments is to increase access to food, they have to offer opportunities for the poorer and more vulnerable segments of the population to increase their incomes.

TABLE **5**

Categories of capital stock in agriculture

	Land Development	Machinery & Equipment	Plantation Crops	Livestock related assets	Total
	%	%	%	%	%
WORLD	**35.10**	**16.59**	**9.56**	**38.75**	**100.00**
High-Income countries	31.10	36.82	4.47	27.61	100.00
Low & middle income countries	36.45	9.77	11.28	42.50	100.00
sub-Saharan Africa	26.88	3.56	9.47	60.10	100.00
Near East / North Africa	62.69	13.53	3.84	19.95	100.00
Latin America /Caribbean	27.73	7.99	7.80	56.48	100.00
South Asia	44.35	9.22	7.41	39.02	100.00
East Asia	33.33	10.51	13.63	42.53	100.00
50 countries on target in 2030	33.20	26.58	7.50	32.71	
60 countries not on target in 2030	36.44	9.53	11.02	43.01	100.00
25 worst-off countries*	24.06	3.42	7.06	65.46	100.00

Source: FAOSTAT 2015.

[25] Allocation of investment for different purposes could be the subject of additional work.

Table 6 allocates the annual average investment envelope for rural areas of low and middle-income countries to possible investment domains, following Schmidhuber *et al.* (2011), Schmidhuber and Bruinsma (2011) and FAO (2010)[26].

This can comprise, for instance, investment enabling and incentivizing sustainable smallholder activities, such as investment in agricultural research and development, professional education and extension services land and water management and conservation.

Also investment for the development of the rural space is strategic for creating income opportunities in rural areas. Transport infrastructure, electricity, and communication are key assets needed worldwide in rural areas. Rural financial services facilitate the access to credit and the management of households' savings.

In rural areas, the development of off-farm employment opportunities will have synergies with the development of the agricultural sector. On the one hand, additional investment in agriculture could increase the capital stock for sustainable agricultural production, increase the ratio of capital to worker (FAO, 2012), and smoothen structural changes. On the other hand, medium-to-longterm investment in other sectors in rural areas would allow developing employment opportunities likely to absorb the excess labour released by agriculture, should the structural transformation process of the sector continue, due for example to mechanization.

Investment in agriculture should enhance sustainable agricultural practices, including soil and water conservation, improved irrigation systems, higher water efficiency, preservation of biodiversity as well as genetic improvements in agriculture, fisheries and forestry. Mechanization may also be required to increase agricultural productivity.

Investments in agro-processing operations, such as milling cereals, extracting oil, ginning cotton, storage and marketing facilities should help reduce food losses and waste, and in turn increase quality and food safety. This would also require food inspection services with trained staff, upgraded laboratories and expertise to design and monitor food safety standards.

Institution building, such as authorities providing services to secure tenure rights, is also important for protecting the assets of the poor to encourage productivity increases.

Research and Development (R&D) useful to improve the productivity of the poor is also essential.

Public and private investment

While the bulk of investment in agriculture under the BaU scenario is and will be carried out by private agents, including small farmers, provision of goods and services in selected domains requires public investment. There are several reasons why public investments are needed: 1) the most needed goods and services are public goods, from which private investors would not profit enough to invest, due to non-excludability (e.g., rural roads); 2) the scale of investment is either beyond the reach of private investors; or 3) they are natural monopolies, such as irrigation systems, where only one network is required for efficiency reasons; 4) returns may only materialize in a time frame unattractive to private investors. This additional public investment is expected to complement private investment, mostly provided by farmers and other entrepreneurs in the BaU scenario. Additional public investment is also expected to accompany diversification of income sources with the expansion of goods and services provided by agriculture.

As shown in Table 6, around 60 percent of the additional investment required to enhance the incomes of the poor in rural areas are public investments. These include public facilities, such as transport infrastructure, services with economies of scale, such as research and development, or services normally provided by public authorities, such as land titling and tenure security[27].

Domestic and foreign investment

The self-reliance of countries in funding additional investment depends on their capacity to save part of their income and allocate it to cover additional investment needs[28].

Investment for zero hunger in a policy and governance context

Investment is necessary to achieve zero hunger, and, more generally, the SDGs. If carried out in a context where policies are coherent, the authorities should effectively provide public goods and regulatory frameworks and institutions strong enough to coordinate the efforts of various agents, prevent and solve conflicts, exploit market opportunities and address market asymmetries and failures. For instance, the adoption

[26] Schmidhuber, J., Bruinsma, J., and Boedeker, G. (2011). 'Capital requirements for agriculture in developing countries to 2050'. In Conforti, P. (ed.). *Looking Ahead in World Food and Agriculture: Perspectives to 2050*. Agricultural Development Economics Division, Economic and Social Development Department, FAO, Rome, pp. 317-343.
Schmidhuber, J. and Bruinsma, J. (2011). 'Investing towards a World Free of Hunger: Lowering Vulnerability and Enhancing Resilience'. In Prakash, A. (ed.). *Safeguarding Food Security in Volatile Global Markets*. FAO, Rome, pp. 543-569
FAO (2010). 'Investing in Food Security'. Processed, FAO. Retrieved from: https://www.responsibleagroinvestment.org

[27] The shares of public investment reported in Table 10, given the limited information available, are based on expert judgement.

[28] Preliminary estimates of the capacity of countries to fund additional investments by looking at their National Gross Savings (NGS) rate as a percentage of the GDP are available.

TABLE **6**

Additional rural investment per investment domain and region (US$ million; constant 2013 prices)

	Sub-Saharan Africa	Near East/ North Africa	Latin America / Caribbean	South Asia	East Asia	Total	%	of which public	% of public over total
Improving primary agriculture and natural resources:						**21,698**	**21**	**5,842**	**27**
Soil conservation	1,778	29	27	921	470	3,225	3	967	30
Water conservation/improved irrigation	1,444	361	25	4,097	189	6,115	6	1,835	30
Preservation/improvement of crop genetic resources	317	76	28	341	209	970	1	291	30
Preservation/improvement of animal genetic resources	147	60	29	258	147	641	1	192	30
Preservation/improvement of fish genetic resources	651	85	49	636	1,147	2,567	2	770	30
Preservation/improvement of forest genetic resources	4,021	92	104	276	348	4,841	5	1,452	30
Mechanization	941	55	32	2,221	90	3,339	3	334	10
Improving agro-processing operations:						**16,502**	**16**	**4,056**	**25**
Cold and dry storage	1,237	60	28	1,535	156	3,016	3	603	20
Rural and wholesale market facilities	2,517	113	25	2,461	143	5,259	5	2,630	50
First stage processing	3,275	177	47	4,380	348	8,228	8	823	10
Improving infrastructure:						**34,089**	**33**	**29,542**	**87**
Rural roads	13,186	336	169	8,324	697	22,712	22	20,441	90
Rural electrification	6,598	173	95	4,162	349	11,376	11	9,101	80
Improving institutional framework:						**14,493**	**14**	**8,891**	**61**
Land titling, tenure security	1,586	38	32	709	74	2,440	2	2,196	90
Rural finance	5,652	173	67	4,146	342	10,381	10	5,191	50
Food safety related regulations (incl. veterinary and pest controls, crop inspections)	705	42	24	835	65	1,672	2	1,505	90
Improving research, development and extension:						**17,628**	**17**	**15,865**	**90**
Research and development	2,385	113	48	2,770	288	5,605	5	5,044	90
Extension	7,140	216	77	4,159	432	12,023	12	10,821	90
Total	**53,580**	**2,198**	**906**	**42,232**	**5,492**	**104,409**	**100**	**64,195**	**61**

in national legislations of principles highlighted in the Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests (FAO-CFS 2012)[29] may contribute to shaping a sustainable pro-poor or pro-undernourished investment climate.

Also, adoption of Responsible Agricultural Investment (RAI)[30] principles and, more generally, the adoption of measures that maximize the domestic multiplier effects of investment and its benefits for the weaker members of society are most likely to speed up achievement of the zero hunger objective. This has to be associated with stricter regulations and monitoring of child labour in agriculture[31], as well as gender-balanced investment aimed at closing the gender gap in agriculture[32].

[29] FAO-CFS (2012). *Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests in the Context of National Food Security*. FAO, Rome. http://www.fao.org/docrep/016/i2801e/i2801e.pdf

[30] FAO-CFS (2014). *Principles for Responsible Investment in Agriculture and Food Systems*. FAO, Rome. http://www.fao.org/3/a-au866e.pdf

[31] FAO (2015). *Handbook for monitoring and evaluation of child labour in agriculture*. FAO, Rome.

[32] FAO (2011). *State of Food and Agriculture, 2011*. FAO, Rome. Quisumbing, A.R, Ruth Meinzen-Dick, Terri L. Raney, Andre Croppenstedt, Julia A. Behrman, Amber Peterman (eds) (2015). *Gender in Agriculture: Closing the Knowledge Gap.* Springer for FAO and IFPRI.

Further considerations and concluding remarks

"Hunger in a world of plenty is not just a moral outrage; it is also short-sighted from the economic point of view" [33].

The paper presents new estimates for financing hunger eradication by 2030, consistent with the aspirations of the post-2015 Sustainable Development agenda. In the UN system, the Secretary General's High-level Task Force on World Food Security and Nutrition has also been focusing on the Zero Hunger Challenge which, *inter alia*, seeks to eliminate poverty, hunger and malnutrition.

The proposed SDG2 to eliminate hunger by 2030 is paralleled by SDG1 to eliminate poverty at the same time. The hunger estimates for MDG monitoring purposes has involved chronic undernourishment defined in terms of dietary energy, i.e. carbohydrates, calories or joules. For MDG monitoring purposes, the dollar-a-day poverty line was adopted, which has recently been adjusted to $1.25 per day by the World Bank.

Hence, to end hunger and rural poverty involves closing the 'poverty gap' using the MDG dollar (now US$1.25) a day poverty line. In other words, a minimal income of a dollar a day, or its current US$1.25 PPP equivalent, closing the gap between current incomes below the poverty line and the poverty line income itself will eliminate both poverty and hunger. Social assistance[34], including transfers, should therefore ensure that basic consumption needs are met, as also implied by UN General Assembly adoption of the term Social Protection Floor.

Since the UN General Assembly's commitment to establish a 'social protection floor' for all, there have been important efforts to cost the creation of such a floor throughout the world, most notably by the ILO. The ILO estimates use national poverty lines, which are often lower for many low income countries, but higher for some low-income countries, as well as for all high-income countries.

This paper addresses the challenge of achieving zero hunger by presenting an alternative scenario [35]. While appreciative of the pioneering ILO work in this regard, it

[33] FAO (2002). Anti-Hunger programme. A twin-track approach to hunger reduction. Priorities for national and international action. ftp://ftp.fao.org/docrep/fao/006/j0563e/j0563e00.pdf

[34] Social protection, social assistance and other such terms have different meanings in different historical and cultural contexts. Usage in this paper is consistent with ILO terminological usage.

[35] The scope of the present study can be further extended. This will include, for instance, the development of other scenarios, to take into account inequality in income distribution and other factors likely to affect agricultural productivity, such as climate change.
Climate change scenarios could be built, for instance, assuming shifts in yields due to climate change. In the FAO GAPS model, yields are explicitly modeled as crop/livestock "own-price" functions, shifted by country and time-dependent coefficients. Downward shifts in yields through alternative vectors of yield shifters can be used to obtain alternative zero hunger climate change scenarios. Reduced yields are likely to be reflected in higher food prices, and consequently, in reduced purchasing power. This, in turn, is expected to lead to further investment requirements achieve the zero hunger objective.
Scenarios reflecting greater (or lower) inequality in food distribution could also be simulated through alternative hypotheses regarding the Coefficient of Variation (CV) for Dietary Energy Consumption (DEC). Last, but not least, the methodology described above only implicitly takes into consideration the multiplier effects that selected investment may have on domestic activities. This also applies to employment generation and related impacts on income distribution that specific investments may generate, and the impacts of growth on natural resource and environmental sustainability. Enlarging the scope of analysis to take into consideration these aspects requires: 1) applying a dynamic global economy-wide model that captures the relationships among investment, GDP, employment, income distribution and natural resources; 2) exploring investment priorities required to achieve specific economic, social and environmental sustainability objectives. All such extensions of the study would provide additional insights on investments required to eliminate poverty, hunger and undernutrition to 2030 and beyond. However, the work required is time and resource-consuming, and can only be completed in a work programme over a much longer period.

departs from the ILO methodology by using the MDG's US$1.25/day PPP adjusted poverty line for all countries, which may well exceed national poverty lines in low-income, some lower-middle income and other countries.

If effectively and efficiently delivered, the US$1.25 PPP/day social protection coverage will eliminate poverty and hunger immediately. Complementary investments, for example in agriculture, can reduce longer-term reliance on such income transfers with the acquisition of greater earned incomes, whether from wages or other productive assets. However, this requires a balanced mix of public and private investments and appropriate policies to ensure that the poor actually benefit from additional investment.

While investments can indeed increase growth, employment and incomes, including in agriculture, such gains may not be linear and are unlikely to be equally shared. Most agricultural investments are made by farmers, but rarely by the poor. Hence, unless clearly pro-poor and inclusive, they may even increase inequality in farm productivity and factor incomes.

Appendix 1. **Achieving zero hunger by investing in social protection**

To compare the approach to achieve zero hunger by 2030 illustrated in the scenario *ZHbotmea*, with alternative options, the scenario *ZHsocpro* for the period from 2016 to 2030 is considered. In this scenario, poor people below the US$1.25 (PPP)/day poverty line are provided with a Transfer to fill the Poverty Gap (PGT), such that their incomes are raised to this poverty line. As this poverty line is believed to cover the minimum required food expenditure, people who receive the PGT at US$1.25 are considered to be free from hunger.

The annual average PGT from 2016 to 2030 is reported in the first column of Table A1 net of administrative costs, while the estimate in column 2 includes a 20 percent mark-up for administrative costs and leakages. The PGT plus markup (gross PGT) globally amounts to US$177 bn annually on average, mostly concentrated in the low- and middle-income countries. India alone accounts for around US$50 bn, while SSA requires a total of US$79 bn. On average, the gross PGT is equivalent to 0.2 percent of projected annual Gross World Product (GWP) for the period 2016-2030 (Table A1, fourth column). However, the share of the PGT in GDP is greater for low- and middle-income countries (0.6 percent), particularly for SSA (6.3 percent).

Globally, the PGT share of total public expenditure is 0.8 percent (Table A1, sixth column). However this share is more

TABLE **A1**

Poverty Gap Transfer at $1.25 /day PPP (US$ bn: constant 2013 prices)

	US$Bn, 2013		% GDP		% Public expenditures	
	PGT at US$1.25 PPP (US$Bn, 2013)	**PGT+Admin. Cost (@ 20%)**	**PGT at US$1.25 PPP (% GDP)**	**PGT+Admin. Cost (@ 20%)**	**PGT at US$1.25 PPP (% Gov. Expenditures)**	**PGT+Admin. Cost (@ 20%)**
	Av.2016-2030	*Av.2016-2030*	*Av.2016-2030*	*Av.2016-2030*		
WORLD	**148**	**177**	**0.17**	**0.21**	**0.67**	**0.80**
High-Income countries	2	3	0.00	0.00	0.01	0.02
Low & middle income countries	146	175	0.47	0.57	2.30	2.76
sub-Saharan Africa	66	79	5.27	6.32	34.40	41.28
Near East / North Africa	3	4	0.09	0.10	0.31	0.37
Latin America /Caribbean	5	6	0.09	0.10	0.37	0.44
South Asia	54	65	1.58	1.90	10.33	12.39
East Asia	16	20	0.10	0.12	0.57	0.68
50 countries on target in 2030	30	36	0.04	0.05	0.16	0.20
60 countries not on target in 2030	118	142	0.65	0.78	3.64	4.37
25 worst-off countries*	44	53	7.22	8.66	44.70	53.64

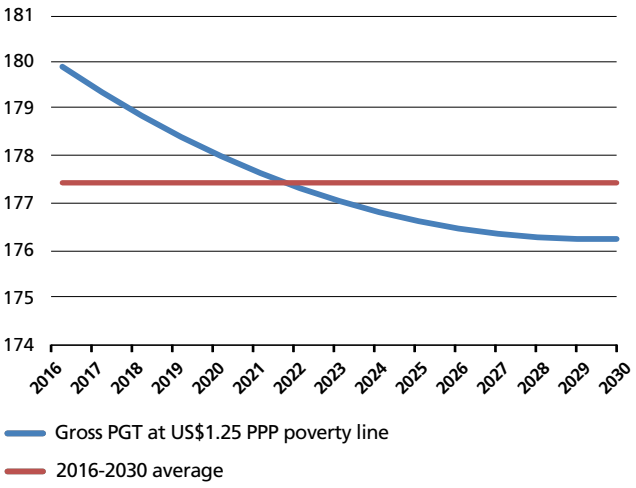
Source: Calculations based on World Bank Povcalnet database. Data on public expenditure: World Development Indicators database. World Bank.

Note: Country-wise details are reported in table D1 in appendix 4.

FIGURE **A1**

Gross Poverty Gap Transfer at US$1.25 PPP poverty line

(US$Bn, 2013)

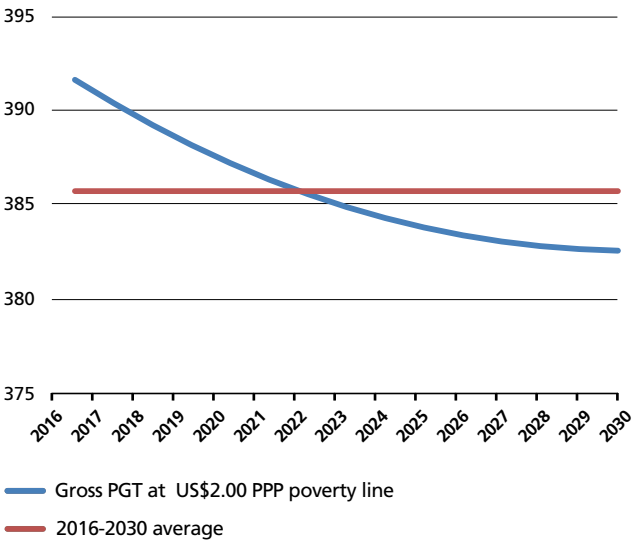


Sources: Calculations based on World Bank Povcalnet database.

FIGURE **A2**

Gross Poverty Gap Transfer at US$2.00 PPP poverty line

(US$Bn, 2013)



Sources: Calculations based on World Bank Povcalnet database.

pronounced for SAS, and particularly high for SSA (12.9 percent and 41.3 percent respectively). Funding the PGT may not be problematic for countries where the overall annual amount is a relatively small proportion of the GDP and public expenditure, such as for selected countries in Near East/ North Africa, Latin America or East Asia. However, the burden of the PGT may be not be affordable by other countries, specifically in South Asia and sub-Saharan Africa where, on average, it could come to more than 40 percent of recent annual public expenditure[35]. If countries spend up to 15 percent of their national budgets on social protection, it will cover 59 percent of the US$177 bn needed to provide universal social protection to close the poverty gap. The remaining US$72 bn needed will have to be externally funded by international transfers. Most of these external funds, almost US$60 bn will be required by SSA, as public budgets in SSA will cover only 20 percent of their PGT[36] if no more than 15 percent is spent on the PGT.

However, a careful assessment of countries' "fiscal space" could be carried out, to explore the possibilities for domestic funding of the PGT and other Social Protection schemes (ILO, 2015)[37].

The evolution of the PGT over time is reported in Figure A1. Due to the growth of GDP in the baseline, both the prevalence of poverty and the poverty gap decline over time. This leads to a decline of the PGT. However, the increase of the population, particularly high in some regions, such as SSA, partially offsets this tendency.

Table A2 and Figure A3 report for comparative purposes, the same calculations carried out with a US$2.00 PPP poverty line (Table A2 and Figure A3). As expected, the new PGT is greater than the PGT at US$1.25/day. Globally, the new PGT amounts to US$386 bn, more than double the previous PGT and costings 0.45 percent of the GWP. The US$2.00 PPP poverty line leaves more margin for improving nutritional status[38] as well as the savings, investment, productivity and incomes of the poor.

With the post-2015 SDGs, it is necessary to address 'hidden hunger', or micronutrient deficiencies, involving inadequate vitamins, minerals and trace elements, from the time of conception through the entire life cycle. Progress in

[35] A statistical annex reports data on the share of PGT in GDP and Public Expenditure, by country, classified by income level.

[36] Detailed tables by country are in annex.

[37] ILO, 2014. *World Social Protection Report 2014/15. Building economic recovery, inclusive development and social justice*. International Labour Office, Geneva: pp 149-153.

[38] Following the Second International Conference on Nutrition, organized by FAO and the WHO last November, the world is now aware that for people to realize their full human potential, it is necessary not only to address hunger, or chronic undernourishment in terms of inadequate dietary energy, but also hidden hunger, or micronutrient deficiencies, best overcome through access to diverse diets.

TABLE **A2**

Poverty Gap Transfer at $2.00 /day PPP (US$ bn: constant 2013 prices)

	US$Bn, 2013		% GDP		% Public expenditures	
	PGT at US$1.25 PPP (US$Bn, 2013)	**PGT+Admin. Cost (@ 20%)**	**PGT at US$1.25 PPP (% GDP)**	**PGT+Admin. Cost (@ 20%)**	**PGT at US$1.25 PPP (% Gov. Expenditures)**	**PGT+Admin. Cost (@ 20%)**
	Av.2016-2030	*Av.2016-2030*	*Av.2016-2030*	*Av.2016-2030*		
WORLD	**321**	**386**	**0.37**	**0.45**	**1.46**	**1.75**
High-Income countries	7	9	0.01	0.02	0.05	0.06
Low & middle income countries	314	377	1.02	1.22	4.96	5.95
sub-Saharan Africa	130	156	10.40	12.48	67.89	81.47
Near East / North Africa	8	10	0.23	0.28	0.82	0.98
Latin America /Caribbean	13	16	0.24	0.29	1.01	1.22
South Asia	117	141	3.43	4.11	22.39	26.87
East Asia	43	51	0.26	0.31	1.47	1.76
50 countries on target in 2030	66	79	0.10	0.12	0.36	0.44
60 countries not on target in 2030	256	307	1.41	1.69	7.88	9.45
25 worst-off countries*	86	103	14.07	16.88	87.14	104.57

Source: Calculations based on World Bank Povcalnet database. Data on public expenditure: World Development Indicators database. World Bank.

Note: Country-wise details are reported in table D1 in appendix 4.

improving nutrition will need reforms in our health and food systems and to ensure other complementary progress, e.g., in sanitation, pre- and post-natal maternal and childcare and nutrition education, to adequately address this challenge. Hence, all people, including the poor, will need to be enabled to have access to healthier, diverse diets.

Appendix 2. **Achieving zero hunger by investing in growth**

Under the scenario ZHtotinv, ZH is expected to be achieved through a general increase of the GDP generated by investment. The methodology followed to build this scenario is outlined below.

Investment to reduce undernourishment

The methodology to calculate the investment required to achieve zero hunger by 2030 hinges on the relationships between investment, output or gross domestic product (GDP) and level of Dietary Energy Consumption (DEC), on the assumption that hunger is mainly caused by poverty (lack of purchasing power). Additional investment, in agriculture and all other sectors of the economy, is expected to raise GDP. The GDP's upward shift increases per capita income, which should lead to an upward shift in per capita food consumption and consequently, in Average Dietary Energy Consumption (ADEC), measured in kilocalories/day/person[39]. It is also assumed that DEC is distributed across the population so that an increase in ADEC benefits all strata of the population. We assume that variability in the distribution of DEC across the national population is captured by an estimate of the Coefficient of Variation (CV) of the distribution[40].

Figure B1 sketches the causal relationships implied by the proposed methodology to estimate the investments required in agriculture to achieve the zero hunger target by 2030.

An appropriate upward shift of investment in the whole economic system is expected to lead, through the above-mentioned cause-effect relationships, to eliminate the prevalence of undernourishment. The objective of this methodology is to determine the appropriate additional investment in agriculture (and the rest of the economic system) required to achieve the "zero" prevalence of hunger in each country, where undernourishment is projected to prevail until 2030. However, we also assume a minimum threshold of undernourishment below which it is not possible to go simply by means of GDP expansion. In this work, we adopt a prudential threshold of 5 percent of the population, compared to the 3 percent used in Schmidhuber and Bruinsma (2011).

The zero hunger with total investment (ZHtotinv) and the business as usual (BaU) scenarios

To determine the additional investment required above expected investment in a business as usual scenario, we compare the investment required to achieve the zero hunger target in 2030, i.e. under the so called zero hunger (*ZHtotinv*) scenario, with the baseline business as usual (BaU) scenario.

The *BaU* scenario offers projections up to 2030, reported in the last FAO long-term projections of world agriculture to 2030 and 2050. The *ZHtotinv* scenario is instead built by using, in reverse order, the cause-effect relationships described in Figure 1 below (the backward arrow ← means: requires):

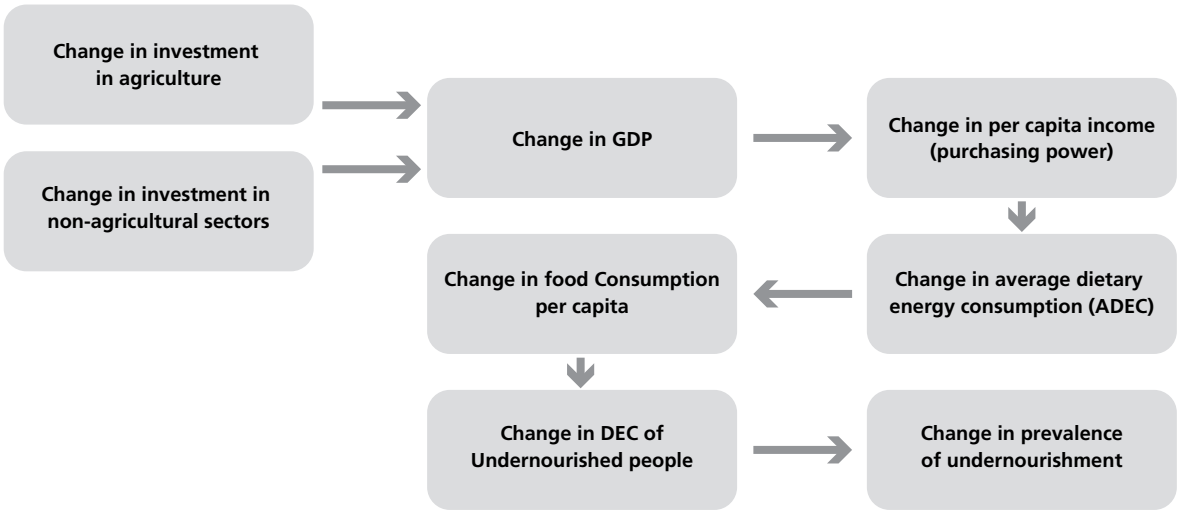
Change in prevalence of undernourishment (targeted to be virtually zero) ← change in food intake of undernourished people ← change in Average (per capita) Dietary Energy Consumption (ADEC) ← change in per capita food expenditure ← change in expendable per capita income ← change in per capita GDP ← change in GDP ← change in investment.

[39] Higher demand for agricultural and food products will imply, *inter alia*, increasing levels of agricultural value added, rising with agricultural investment. This entails multiplier effects, which are implicitly accounted for using the incremental capital-output ratios (ICORs) in this methodology.

[40] This approach essentially relies on the "trickle-down" of growth, i.e. it is assumed that the growth of per capita GDP will also benefit the poor and undernourished. See Kakwani, N., *et al*. (2004). Pro-poor growth: Concepts and measurement with country case studies. International Poverty Centre Working paper no. 1, August 2004, UNDP, Brasilia. http://www.ipc-undp.org/pub/IPCWorkingPaper1.pdf

FIGURE **B1**

Causal relationships linking investment with the prevalence of undernourishment



Following the above reverse cause-effect chain, the methodology develops as follows:

1. The starting point is to estimate by how much the Average Dietary Energy Consumption (ADEC) would need to be raised by 2030, given the way Dietary Energy Consumption (DEC) is distributed across the population, to bring all people above the Minimum Daily Energy Requirement (MDER).
2. As food consumption generally depends on income, in the next step, how much per capita income (approximated by GDP per capita) economy-wide should increase in order to increase ADEC to its desired level is calculated. Additional GDP is then calculated by multiplying additional per capita GDP by the population size.
3. The *additional* investment required to achieve the additional GDP is then calculated assuming a plausible gross Incremental Capital Output Ratio (ICOR).
4. The additional investment required in agriculture is then calculated as a share of total investment, assuming that the agricultural investment share is equivalent to the share of agricultural value-added in GDP.

The findings of this step-wise methodology are reported below[41].

ZHtotinv scenario to 2030 and comparison with the BaU

While in the BaU scenario, per capita GDP is projected to increase due to technical progress and other factors, in this scenario, GDP has to increase further in order to reduce the prevalence of undernourishment in all countries to 5 percent or less. The *ZHtotinv* scenario is built step-wise, and then compared with the BaU scenario, to work out the additional investment required to achieve the zero hunger target.

ZHtotinv Average Dietary Energy Consumption

First, we estimate by how much the Average Dietary Energy Consumption (ADEC) would need to be raised by 2030, so that undernourishment (i.e. caloric intake below the Minimum Daily Energy Requirement MDER) would affect less than 5 percent of the population, assuming that the MDER and the distribution of Dietary Energy Consumption (DEC) across the population is as in the BaU scenario. In low- and middle-income countries, the ADEC has to further increase by more than 5 percent, from 2,857 to 3,019 kcal/person / day (Table B1, panels 1 and 2). For SSA and the 25 "worst-off" countries, this change is more marked (13.7 percent and 17.9 percent respectively).

[41] A more detailed step-wise procedure is reported in the Annex.

TABLE **B1**

Undernourishment in the *BaU* and *ZHtotinv* scenarios

	Population	Minimum Daily Energy Requirements (MDER)	Average Dietary Energy Consumption (ADEC)	Coefficient of Variation (CV)	Persons chronically undernourished	
	million	*kcal/person/day*			*percent*	*million*
2030 Business as Usual (BaU) scenario (Baseline)						
WORLD	**8,274**	**1,865**	**2,955**	**0.272**	**7.9**	**653**
High-Income countries	1,437	1,941	3,425	0.217	1.1	16
Low & middle income countries	6,838	1,849	2,857	0.283	9.3	637
sub-Saharan Africa	1,245	1,812	2,528	0.288	17.4	216
Near East / North Africa	615	1,865	3,133	0.266	4.7	29
Latin America /Caribbean	682	1,872	3,091	0.258	4.0	27
South Asia	2,016	1,825	2,587	0.245	9.3	188
East Asia	2,247	1,878	3,133	0.327	7.8	175
50 countries on target in 2030	3,113	1,895	3,243	0.233	2.0	63
60 countries not on target in 2030	5,161	1,846	2,782	0.295	11.4	590
25 worst-off countries*	833	1,812	2,363	0.320	25.2	210
2030 ZHtotinv scenario						
WORLD	**8,274**	**1,865**	**3,088**	**0.266**	**4.1**	**338**
High-Income countries	1,437	1,941	3,415	0.248	1.8	26
Low & middle income countries	6,838	1,849	3,019	0.270	4.6	312
sub-Saharan Africa	1,245	1,812	2,868	0.252	4.6	57
Near East / North Africa	615	1,865	3,171	0.275	3.7	23
Latin America /Caribbean	682	1,872	3,099	0.266	3.8	26
South Asia	2,016	1,825	2,734	0.232	4.9	99
East Asia	2,247	1,878	3,294	0.313	4.7	106
50 countries on target in 2030	3,113	1,895	3,245	0.254	2.6	80
60 countries not on target in 2030	5,161	1,846	2,993	0.273	5.0	258
25 worst-off countries*	833	1,812	2,881	0.259	5.0	42

* The worst-off countries are defined as countries that would have to raise their average DEC in 2030 by more than 10 percent to eliminate hunger.

Source: Calculations based on FAO GAPS and SOFI 2015 datasets.

ZHtotinv GDP (and new prices of agricultural goods)

Subsequently, we calculate the per capita income (approximated by per capita GDP) required for achieving the desired ADEC. This calculation is carried out using the FAO "Global Agriculture Perspectives System (GAPS)" partial equilibrium model.

For countries that need to increase their ADECs, we fix the ADEC at the desired level and compute the per capita GDP sufficiently high to increase demand for food to meet the ADEC target[42]. Food consumption in GAPS is a function of per capita income and prices. Hence, to target a higher level of food intake, per capita income needs to increase[43]. Increased demand also stimulates domestic supply and trade, leading to new equilibrium prices.

In GAPS, the new ADEC target requires additional physical consumption of food. However, on the assumption that additional output is only available at higher marginal cost, the additional demand also leads to price increases[44]. Thus, the required per capita GDP is simultaneously determined with new prices that equilibrate demand and supply. GDP is then calculated by multiplying per capita GDP with the population. Table B2 reports the GDP required for the *ZHtotinv* scenario in the first panel. The second panel of Table B1 reports the annual GDP growth rates for zero hunger. They range from 2.1 percent in LAC to 5.8 percent in SAS. In the 25 "worst-off" countries, the average annual growth rate required is even larger (7.8 percent). These zero hunger GDP growth rates need to be compared with growth rates in the BaU scenario. All in all, the 60 countries not on target in 2030 would require almost 1.4 percent additional annual GDP growth to achieve the zero hunger target. Sub-Saharan Africa and SAS would require 1.8 percent and 1.5 percent more respectively.

Investment for ZHtotinv (and BaU) GDP

We then calculate the investment required to achieve the incremental GDP with respect to the base year, under both the *ZHtotinv* and *BaU* scenarios. To this end, we make use of the concept of a gross Incremental Capital Output Ratio (ICOR)[45], which gives the amount of investment required to generate one additional unit of net output (GDP). Table B2 reports the economy-wide annual average gross investment necessary to achieve GDP growth under both the BaU and *ZHtotinv* scenarios and highlights the additional investment required by the zero hunger scenarios in the third panel, as compared with the BaU.

Additional gross economy-wide investment under the *ZHtotinv* scenario amounts to US$1.5 trillion, all concentrated in low and middle income countries, as all HICs are already on target. It consists of a 15.9 percent increase with respect to BaU. This percentage change is different across regions, ranging from 3.3 percent in LAC to 68.6 percent in SAS. The 25 worst-off countries require much more than doubling their investment (+176 percent).

ZHtotinv (and BaU) share of agriculture value added in GDP

To work out the required additional investment in agriculture to achieve the zero hunger target, the share of total investment in agriculture is assumed to be broadly proportional to the share of agricultural value added (VA) in GDP. Using cross-sectional GDP shares in the base year, we estimate a relationship between agriculture VA and GDP. The share of agricultural VA in GDP decreases as GDP increases. We assume that the same relationship will also hold in the future. This allows us to calculate the share of agriculture VA in GDP for both the *ZHtotinv* and BaU scenarios. As GDP is larger under the *ZHtotinv* scenario (Table B2, first panel), the share of agriculture VA is lower, compared to the BaU scenario.

[42] Only countries which have not reduced their prevalence of undernourishment to 5 percent or less by 2030 will have to increase their ADEC. Countries already on target will not require additional investment.

[43] In GAPS, physical demand is linked to income via "income elasticities of demand". For the purpose of this exercise, we keep income elasticities constant across periods.

[44] In the GAPS model, this is reflected by upward sloping supply curves. A scenario where the expansion of demand occurs in a "fixed price" context was also explored. In this scenario, additional agricultural output is available at no additional production cost, due, for instance, to increased productivity of agricultural production factors.

[45] ICOR values were set in the base year at three for countries with a per capita income up to $2000, at four for countries with per capita GDP up to $4000, and at five for countries with GDP per capita over $4000. For each year from 2005/07 to 2030, annual investments were calculated as INVTt = ICORt * ΔGDPt. Annual investment was then cumulated. The ICOR was assumed to be country-specific and increasing with GDP. A similar ICOR-based approach was followed, for instance, by Devarajan, *et al*. (2002), to estimate the investment required to achieve selected MDGs (Devarajan, S., Miller, M. J. and Swanson, E. V. (2002) 'Goals for Development: History, Prospects, and Costs'. Working Paper No. 2819, World Bank, Washington, DC. Recent estimates of ICORs, in the range of those we adopted, are found in: Taguchi, H. and Lowhachai, S. (2014), based on previous work by Sato (1971) and the seminal work of Kuznets (1960). Taguchi, H. and Lowhachai, S. (2014). A revisit to the incremental capital-output ratio: the case of Asian economies and Thailand. *International Journal of Economic Policy in Emerging Economies*, Vol. 7, No. 1, pp. 35-54. Kuznets, S. (1960). Quantitative aspects of the economic growth of nations: V. Capital formation proportions: international comparisons for recent years. *Economic Development and Cultural Change*, Part 2, Vol. 8, No. 4, pp. 1-96. Sato, K. (1971). International Variations in the Incremental Capital-Output Ratio. *Economic Development and Cultural Change*, Vol. 19, no. 4, pp. 621-640.

TABLE **B2**

Additional economy-wide investment required for zero hunger

	GDP (constant 2013 Billion US$)			GDP growth (%) Average, per annum		Average Gross Annual Investment, billion US$ (2016 / 2030)		Additional Gross Invest. Billion US$	Additional Gr. Invest. % change
	2005/7	2030	2030	2016-2030					
		BaU	*ZH*	*BaU*	*ZH*	*BaU*	*ZH*	*Diff. ZH-BaU*	*ZH/BaU*
WORLD	**56,263**	**101,131**	**106,160**	**2.40**	**2.74**	**9,202**	**10,665**	**1,463**	**15.90**
High-Income countries	42,388	61,530	61,530	1.65	1.65	4,189	4,189	0	0.00
Low & middle income countries	13,875	39,601	44,631	3.79	4.62	5,013	6,476	1,463	29.18
sub-Saharan Africa	548	1,629	2,099	4.01	5.78	163	265	101	62.08
Near East / North Africa	1,881	4,334	4,417	3.33	3.46	512	532	19	3.79
Latin America /Caribbean	3,588	6,413	6,477	2.02	2.09	517	534	17	3.26
South Asia	1,393	4,391	5,465	3.82	5.34	396	668	272	68.57
East Asia	6,037	21,859	25,137	4.52	5.50	3,303	4,336	1,034	31.31
50 countries on target in 2030	49,820	76,654	76,654	1.83	1.83	5,697	5,697	0	0.00
60 countries not on target in 2030	6,443	24,476	29,506	4.63	5.94	3,506	4,969	1,463	41.74
25 worst-off countries*	273	793	1,363	4.02	7.84	70	193	123	175.97

Source: Calculations based on FAO GAPS and SOFI 2015 datasets.

ZH (and BaU) annual investment in agriculture

We then calculate the investment in agriculture as a proportion of the total investment required to achieve the incremental GDP in both scenarios. To this end, we use the share of agriculture value added in GDP, as per the assumptions above. The cumulative investment, calculated on an annual basis from 2016 to 2030 in both scenarios is then averaged per annum. The results are provided in the third panel of Table B3.

Additional zero hunger BaU investment

In the last step, we compare the annual investment in the ZH scenario with annual investment under BaU. The figures for additional investment are provided in the fourth panel of Table B3. The additional average annual gross investment for the period 2016-2030 to achieve the zero hunger target is US$111 bn (in constant 2013 prices). Looking at the regional allocation of this amount, more than half (US$60 bn) is for EAS[46]. In some areas, such as SSA and SAS, where the ZHtotinv scenario requires additional investments of 67 percent and 56 percent more than in the BaU respectively (Table B3, last column), implementing such an additional investment programme may be challenging, not only for funding reasons, but also for institutional, managerial and logistical ones. These difficulties could even be exacerbated in the worst-off countries, where the ZHtotinv scenario requires a shift in annual investment of around 132 percent.

Gross and net investment

The figures provided here refer to additional "gross" investment, i.e. investment required both to increase the capital asset-base of the countries and to replace fixed capital consumption (depreciation). To provide a rough order of magnitude, 20 percent to 40 percent of this additional

[46] As the *ZHtotinv* scenario to 2030 is built with the partial equilibrium model "GAPS", where food prices respond to interactions between supply and demand, the increased demand for agriculture and food items generated by the per capita GDP increase is satisfied by an expansion of supply associated with increased prices. However, this price increase, slightly below 10 percent on average, only partially offsets the increase in per capita income.

TABLE **B3**

Additional investment in agriculture in the *ZHtotinv* scenario

	Share of agriculture VA in GDP (%)			Annual investment in agriculture (constant 2013 Billion US$)		Additional Agric. Invest. (constant 2013 Billion US$)	Additional investment % change ZH/BaU
	2016	2030	2030				
		BaU	*ZH*	*BaU*	*ZH*	*Diff. ZH-BaU*	
WORLD	**4.55**	**4.11**	**4.11**	**469**	**580**	**111**	**23.61**
High-Income countries	2.77	2.50	2.50	117	117	0	0.00
Low & middle income countries	8.32	6.63	6.32	352	462	111	31.50
sub-Saharan Africa	17.75	15.21	13.67	24	40	16	67.02
Near East / North Africa	7.19	5.97	5.98	29	32	3	8.53
Latin America /Caribbean	6.27	5.66	5.65	31	32	2	4.85
South Asia	15.51	12.42	11.03	53	83	30	55.97
East Asia	7.35	5.40	5.06	210	270	60	28.64
50 countries on target in 2030	3.33	3.03	3.03	196	196	0	0.00
60 countries not on target in 2030	10.26	7.52	6.91	273	384	111	40.55
25 worst-off countries*	21.33	18.52	14.06	14	33	19	131.53

Source: Calculations based on GAPS and SOFI 2015 datasets.

investment would compensate for fixed capital consumption, depending on the countries and the specific period[47]. Only the remaining share would actually be available to expand the capital base of the countries.

Complementing additional investment with a transfer to cover the food deficit

In the *ZHtotinv* scenario, we assume that a proportion of the undernourished, assumed here to be 5 percent of the population, is not going to benefit from the additional investment due to personal disability, health and socio-economic conditions. Therefore, their food deficit has to be filled by a Food Deficit Transfer, i.e. the annual transfer needed to lift them out of hunger or undernourishment[48]. The calculations are based on the estimated average food deficit expressed in kilocalories and an estimated unit cost of a kilocalorie country-wise[49]. For the total annual cost of the food deficit, a mark-up of 20 percent,

[47] Preliminary estimates. The share of fixed capital consumption in gross investment depends on the composition of the capital stock. Countries with a large share of physical structures and machinery have lower depreciation rates than countries with higher shares of transport and information technologies. Higher income countries tend to have larger depreciation rates, e.g. in 2011, the depreciation rate for the USA was 4.1 percent, while for China, it was 3.1 percent; see Inklaar, R. and Timmer, P.M. (2013). Capital Labor and TFP in PWT 8.0. University of Groningen. http://www.rug.nl/research/ggdc/data/pwt/v80/capital_labor_and_tfp_in_pwt80.pdf.

[48] The annual expenditure to pull undernourished people out of undernourishment in region r for period t, , net of implementation costs, can be calculated as the average share (across all the population) of the Minimum Daily Energy Requirement the undernourished lack to get out of undernourishment times the total population , times the Minimum Daily Energy Requirement , times the average (economy-wide) consumer price of one kilocalorie times the days in a year.

[49] Source: ERS, USDA. Calculations based on annual household expenditure data from Euromonitor International, available at: http://www.euromonitor.com/

TABLE **B4**

Summary findings of the *ZHtotinv* scenario

	FDT ≤ 5% Und. Annual aver. (B. US$)	Additional TOT Ann.Invest. (B. US$)	Annual FDT + Add.TOT.Inv. (B. US$)	Annual FDT + Add.TOT.Inv. (% GDP)	Additional Ann. AGR.Invest. (B. US$)	Annual FDT + Add. AGR.Inv. (B. US$)	Annual FDT + Add. AGR.Inv. (%GDP)
	ZHtotinv	*Zhtotinv*	*Zhtotinv*	*Zhtotinv*	*Zhtotinv*	*Zhtotinv*	*Zhtotinv*
WORLD	**14.1**	**1,463.1**	**1,477.2**	**1.7**	**110.8**	**124.9**	**0.15**
High-Income countries	2.9	-	2.9	0.0	-	2.9	0.01
Low & middle income countries	11.2	1,463.1	1,474.2	4.8	110.8	121.9	0.40
sub-Saharan Africa	1.9	101.5	103.3	8.3	16.2	18.1	1.44
Near East / North Africa	1.2	19.4	20.6	0.6	2.5	3.7	0.11
Latin America /Caribbean	2.2	16.9	19.1	0.3	1.5	3.7	0.07
South Asia	1.9	271.8	273.7	8.0	29.9	31.8	0.93
East Asia	3.8	1,033.9	1,037.8	6.4	60.1	63.9	0.39
50 countries on target in 2030	6.3	-	6.3	0.0	-	6.3	0.01
60 countries not on target in 2030	7.8	1,463.1	1,470.9	8.1	110.8	118.6	0.65
25 worst-off countries*	1.3	123.2	124.5	20.4	18.7	20.0	3.28

assuming 10 percent for administrative costs and 10 percent for leakages, is added[50].

The cost of this transfer, reported in the first column of Table B4, for low- and middle-income countries is US$11.2 bn, while it amounts to US$14.1 bn if high-income countries (HICs) are included. FDT as share of GDP, as expected, varies across regions. In the zero hunger scenario, it ranges from a minimum of 0.1 percent for the HICs to a maximum of 0.3 percent for the worst-off countries.

Table B4 reports the summary findings for the *ZHtotinv* scenario. The average additional annual economy-wide investment required from 2016 to 2030 for zero hunger by 2030 is US$1,476.1 bn (in constant 2013 prices). This comprises a Food Deficit Transfer (FDT) of US$14.1 bn.

Globally, this amounts to 1.7 percent of average annual GDP from 2016 to 2030. However, this percentage rises to 7.5 percent for SSA, and to 15.1 percent for the worst-off countries.

Of the total additional investment, US$110.7 bn is for agriculture. The annual additional investment in agriculture and the FDT amounts to US$124.8 bn. Globally, this amount is 0.1 percent of average global GDP from 2016 to 2030. At the country and regional level, however, it is 1.3 percent of the GDP in SSA, or 2.4 percent for the worst-off countries.

[50] Varying estimates of mark-ups for administrative costs of cash transfer programmes exist, from 5 percent for universal cash transfer programmes adopted by ILO in the abovementioned exercise to 100 percent of the CT-OVC programme in Kenya. For a review of administrative costs of social protection programmes, see, for example: Caldés, N., Coady, D. and Maluccio, J. (2004). 'The Cost of Poverty Alleviation Transfer Programs: a Comparative Analysis of Three Programs in Latin America'. Discussion Paper Brief 174, IFPRI, Washington, DC. Samson, M., van Niekerk, I. and MacQuene, K. (2006). 'Designing and Implementing Social Transfer Programmes'. EPRI, Johannesburg.

Appendix 3. **Step-wise approach for investing in growth**

The determination of the investment in agriculture required to achieve zero hunger to 2030 develops as follows.

Definition of the zero hunger (ZH) scenario

The definition of the zero hunger scenario implies the following steps:

1. *Choice of a minimum threshold for prevalence of undernourishment*. A minimum threshold for prevalence of undernourishment achievable through GDP growth (In previous works 3 percent prevalence of undernourishment was assumed as the minimum achievable through expansion of GDP)
2. *Determination of the mean Minimum Dietary Energy Requirement* (*MDER*) by country. This may vary depending on population cohorts, prevailing activities etc.
3. *Determination of the ADEC (ZH) by country*, i.e. the Average Dietary Energy Consumption required for bringing the DEC of all the undernourished people exceeding the 3 percent of the population above the *MDER*. This step is carried out assuming a given functional form of the distribution function of the DEC[51].
4. *Determination of GDP level required to achieve the desired DEC*. The *GDP(ZH)* by country is the GDP level required to achieve the desired *DEC* by country. The calculation of the GDP level is carried out using the FAO GAPS model. In the FAO GAPS model The A*DEC* (*DES* in GAPS terminology) in the BaU scenario is calculated as an accounting identity, depending on the levels of the endogenous physical consumption variables determined by the solution of the model, while GDP is exogenous.

Thus, using GAPS for working out the GDP level that determines the required DEC implies:

- Making the *DEC* variable exogenous, to be set at the desired level.
- Making the *GDP* level endogenous, to allow the model to set it at a level required to with the desired *DEC*[52].

Note that this results in a new equilibrium where a new vector of equilibrium prices and consumed/produced quantities are determined. The required GDP level therefore is co-determined with the price levels reflecting the (new) relative scarcity of goods.

BaU scenario

The BaU scenario to 2030 is defined according to the information provided in AT2030-2050, adopted in the GAPS model. Here, the BaU prevalence of undernourishment by country in 2030 has already been calculated on the basis of assumptions related to:

- GDP projections (World Bank)
- Population Projections (UN)
- Technological shifts (AT 2030-2050)
- Resulting country-wise consumption patterns;
- Resulting *ADEC* (Average DES, in AT2050/GAPS terminology)
- Assumed food distribution function and related variance

Scenario comparison

5. Calculation of ΔGDP level by country. The difference ΔGDP = GDP(ZH) – GDP(BaU) provides the required expansion of GDP to generate the ADEC (ZH).
6. Calculation of required agricultural investment by country. The calculation of required investment by country is based on the Incremental Capital-Output Ratio (ICOR) by country and assumptions regarding the ratio of agricultural value

[51] SOFI 2012, 2013 and 2014 assume that the Dietary Energy Consumption is distributed as a Skewed Log-Normal distribution function characterized by three parameters: mean, variance and skewedness. However, previous studies similar to this one assume that the DEC is distributed according to a log-normal distribution function, defined by the mean and standard deviation. For practical purposes we keep this assumption.

[52] This implies, among other: a) adding two equations to the model: ADEC = f(Consumption by commodity, unit caloric content by commodity) ; ADEC = $\overline{ADEC}$; b) adding two variables: ADEC and GDP.

added over GDP deemed necessary to meet the required food demand. Updated country-wide ICORs need to be retrieved. The calculation of the investment required INV (incremental capital) is calculated as: .

Allocation of additional investment by sector

7. Allocation of investment by sector. To calculate the investment required by sector, the total INV needs to be allocated to sectors on the basis of some assumptions. In previous works the share of agricultural value added (VA) on GDP in the base year was used as allocation criterion to calculate investment required in the agricultural sector.

$$\Delta INV_{agric} = \Delta INV_{tot} \frac{VA_{agric}}{GDP}$$

The share of the agricultural value added in the GDP is retrieved from exogenous sources, and adjusted to the specific zero hunger scenario. As an alternative, if available, specific sectoral ICORs could be adopted.

Note that the assumption that investment in agriculture determined according this methodology would allow reaching the zero hunger objective, implies that, among other things, all the other sectors invest at the same rate as the agricultural sector to move the GDP in such a way as to move the DEC as desired.

Appendix 4. **Statistical tables**

TABLE **D1**

Transfers to cover the Poverty Gap (PGT) at $1.25 PPP poverty line (US$ million; constant 2013 prices) *(Scenario ZHsocpro)*

			US$mn, 2013		% GDP		% Public expenditures	
			PGT at US$1.25 PPP (US$mn, 2013)	PGT+Admin. Cost (@ 20%)	PGT at US$1.25 PPP (% GDP)	PGT+Admin. Cost (@ 20%)	PGT at US$1.25 PPP (% Gov. Expenditures)	PGT+Admin. Cost (@ 20%)
			Av.2016-2030	*Av.2016-2030*	*Av.2016-2030*	*Av.2016-2030*		
High-Income countries		Australia	13	16	0.00	0.00	0.00	0.00
		Canada	4	5	0.00	0.00	0.00	0.00
		Central Asian Republics	114	137	0.02	0.02	0.06	0.07
		European Union 27	443	531	0.00	0.00	0.01	0.01
		Israel	1	2	0.00	0.00	0.00	0.00
		Japan	12	14	0.00	0.00	0.00	0.00
		New Zealand	3	4	0.00	0.00	0.00	0.01
		Rest of Eastern Europe	6	7	0.00	0.00	0.01	0.01
		Rest of Western Europe	3	4	0.00	0.00	0.00	0.00
		Russian Federation	8	10	0.00	0.00	0.00	0.00
		United States of America	332	399	0.00	0.00	0.01	0.01
		South Africa	1284	1541	0.32	0.39	1.06	1.28
		Total	**2224**	**2668**	**0.00**	**0.00**	**0.01**	**0.02**
Low & middle income countries	**sub-Saharan Africa**	Angola	1468	1762	0.78	0.94	3.05	3.67
		Burundi	951	1142	56.70	68.04	404.74	485.69
		Benin	887	1064	8.55	10.26	65.02	78.02
		Burkina Faso	1009	1210	6.07	7.29	50.50	60.60
		Botswana	63	75	0.28	0.33	0.87	1.04
		Central African Republic	536	643	19.11	22.94	127.34	152.81
		Côte d'Ivoire	1194	1433	3.59	4.30	24.13	28.96
		Cameroon	689	826	1.71	2.05	12.18	14.62
		Democratic Republic of the Congo	15725	18870	71.43	85.71	683.53	820.24

TABLE **D1**

(Continued)

			US$mn, 2013		% GDP		% Public expenditures	
			PGT at US$1.25 PPP (US$mn, 2013)	PGT+Admin. Cost (@ 20%)	PGT at US$1.25 PPP (% GDP)	PGT+Admin. Cost (@ 20%)	PGT at US$1.25 PPP (% Gov. Expenditures)	PGT+Admin. Cost (@ 20%)
			Av.2016-2030	*Av.2016-2030*	*Av.2016-2030*	*Av.2016-2030*		
Low & middle income countries	sub-Saharan Africa	Congo	280	337	1.32	1.58	5.70	6.84
		Eritrea	210	252	10.38	12.46	79.36	95.23
		Ethiopia	412	494	0.66	0.79	5.01	6.02
		Gabon	20	24	0.12	0.14	0.85	1.03
		Ghana	545	654	1.25	1.50	6.26	7.51
		Guinea	530	636	6.05	7.26	43.16	51.79
		Gambia	27	32	1.88	2.25	14.07	16.89
		Kenya	2298	2757	4.91	5.89	26.89	32.27
		Liberia	860	1032	54.20	65.04	332.71	399.26
		Lesotho	198	238	8.00	9.59	17.98	21.57
		Madagascar	2564	3077	20.44	24.53	191.97	230.36
		Mali	1087	1304	6.41	7.69	44.09	52.91
		Mozambique	2335	2803	8.00	9.60	35.12	42.15
		Mauritania	91	110	1.69	2.03	12.08	14.50
		Mauritius	0	0	0.00	0.00	0.00	0.00
		Malawi	2039	2447	21.01	25.21	149.93	179.92
		Namibia	150	180	1.07	1.28	3.83	4.60
		Niger	722	866	7.36	8.83	73.55	88.26
		Nigeria	12852	15422	4.09	4.91	47.73	57.28
		Rwanda	1001	1201	8.83	10.60	59.60	71.52
		Sudan	606	728	0.64	0.77	4.59	5.51
		Senegal	772	926	3.35	4.02	20.27	24.32
		Sierra Leone	465	558	15.15	18.18	83.14	99.77
		Somalia	463	556	9.11	10.93	99.42	119.30
		Swaziland	97	116	1.93	2.31	13.74	16.49
		Chad	938	1126	5.56	6.67	39.66	47.59
		Togo	547	657	13.03	15.63	83.04	99.64
		United Republic of Tanzania	5644	6773	12.11	14.53	53.28	63.94
		Uganda	1692	2031	4.93	5.92	27.62	33.15
		Zambia	1633	1960	5.70	6.84	35.96	43.15
		Zimbabwe	2293	2752	23.61	28.33	225.89	271.06
		Total	**65893**	**79071**	**5.27**	**6.32**	**34.40**	**41.28**

TABLE **D1**

(Continued)

			US$mn, 2013		% GDP		% Public expenditures	
			PGT at US$1.25 PPP (US$mn, 2013)	PGT+Admin. Cost (@ 20%)	PGT at US$1.25 PPP (% GDP)	PGT+Admin. Cost (@ 20%)	PGT at US$1.25 PPP (% Gov. Expenditures)	PGT+Admin. Cost (@ 20%)
			Av.2016-2030	*Av.2016-2030*	*Av.2016-2030*	*Av.2016-2030*		
Low & middle income countries	Near East / North Africa	Afghanistan	1850	2221	10.57	12.68	25.52	30.63
		Algeria	134	161	0.06	0.07	0.26	0.31
		Egypt	133	159	0.05	0.06	0.19	0.22
		Iran (Islamic Republic of)	81	98	0.02	0.02	0.10	0.11
		Iraq	147	176	0.16	0.20	0.61	0.73
		Jordan	2	2	0.00	0.01	0.02	0.02
		Lebanon	18	22	0.04	0.05	0.13	0.16
		Libya	38	46	0.03	0.04	0.19	0.23
		Morocco	168	202	0.15	0.17	0.49	0.59
		Saudi Arabia	8	10	0.00	0.00	0.01	0.01
		Syrian Arab Republic	90	108	0.14	0.17	0.79	0.95
		Tunisia	5	7	0.01	0.01	0.03	0.03
		Turkey	51	61	0.00	0.00	0.01	0.01
		Yemen	260	313	0.63	0.75	2.34	2.80
		Total	**2986**	**3583**	**0.09**	**0.10**	**0.31**	**0.37**
	Latin America /Caribbean	Argentina	99	119	0.02	0.03	0.12	0.14
		Bolivia (Plurinational State of)	60	72	0.28	0.34	1.09	1.30
		Brazil	1105	1326	0.06	0.07	0.22	0.26
		Chile	9	10	0.00	0.00	0.02	0.02
		Colombia	435	522	0.15	0.17	0.58	0.69
		Costa Rica	7	9	0.02	0.02	0.07	0.09
		Cuba	66	79	0.07	0.08	0.20	0.23
		Dominican Republic	24	28	0.03	0.03	0.19	0.23
		Ecuador	59	70	0.07	0.09	0.31	0.37
		Guatemala	310	372	0.53	0.64	4.17	5.01
		Guyana	46	55	1.75	2.10	7.59	9.11
		Honduras	150	180	0.70	0.84	3.26	3.91
		Haiti	1018	1222	12.91	15.49	56.04	67.25
		Jamaica	27	32	0.17	0.20	0.49	0.58
		Mexico	359	431	0.02	0.03	0.11	0.13
		Nicaragua	27	32	0.27	0.33	1.94	2.32

TABLE **D1**

(Continued)

			US$mn, 2013		% GDP		% Public expenditures	
			PGT at US$1.25 PPP (US$mn, 2013)	PGT+Admin. Cost (@ 20%)	PGT at US$1.25 PPP (% GDP)	PGT+Admin. Cost (@ 20%)	PGT at US$1.25 PPP (% Gov. Expenditures)	PGT+Admin. Cost (@ 20%)
			Av.2016-2030	*Av.2016-2030*	*Av.2016-2030*	*Av.2016-2030*		
Low & middle income countries	Latin America /Caribbean	Panama	22	27	0.07	0.08	0.28	0.34
		Peru	92	111	0.04	0.05	0.22	0.27
		Paraguay	21	25	0.12	0.14	0.72	0.87
		El Salvador	42	50	0.15	0.18	0.82	0.98
		Suriname	45	54	1.18	1.41	4.78	5.74
		Trinidad and Tobago	179	215	0.49	0.59	1.87	2.24
		Uruguay	0	0	0.00	0.00	0.00	0.00
		Venezuela (Bolivarian Republic of)	639	766	0.24	0.28	0.96	1.16
		Total	**4840**	**5808**	**0.09**	**0.10**	**0.37**	**0.44**
	South Asia	Bangladesh	7568	9082	5.68	6.82	62.02	74.42
		India	41513	49815	1.42	1.70	9.18	11.01
		Sri Lanka	90	107	0.14	0.16	0.66	0.79
		Nepal	588	705	2.20	2.64	14.40	17.28
		Pakistan	4308	5169	1.62	1.95	10.05	12.06
		Total	**54066**	**64879**	**1.58**	**1.90**	**10.33**	**12.39**
	East Asia	China	5817	6981	0.05	0.06	0.32	0.38
		Hong Kong, China Special Administrative Region	3	3	0.00	0.00	0.00	0.00
		Indonesia	3896	4675	0.43	0.51	2.58	3.10
		Cambodia	164	196	0.94	1.13	10.18	12.22
		Korea, Republic of	9	11	0.00	0.00	0.00	0.00
		Lao People's Democratic Republic	192	230	2.10	2.52	19.46	23.35
		Myanmar	2389	2867	3.82	4.59	114.09	136.90
		Mongolia	135	162	1.65	1.98	6.71	8.05
		Malaysia	10	11	0.00	0.00	0.01	0.02
		Philippines	1740	2088	0.60	0.72	3.53	4.24
		Korea, Democratic People's Republic of	1159	1391	2.33	2.79	25.40	30.47
		Thailand	25	30	0.00	0.01	0.03	0.03
		Taiwan	5	6	0.00	0.00	0.00	0.00
		Viet Nam	916	1100	0.58	0.69	3.44	4.13
		Total	**16459**	**19751**	**0.10**	**0.12**	**0.57**	**0.68**
	Other		1380	1656	0.18	0.21	0.68	0.82
		WORLD (GRAND TOTAL)	**147847**	**177417**	**0.17**	**0.21**	**0.67**	**0.80**

TABLE **D2**

Transfers to cover the Poverty Gap (PGT) at $2.00 PPP poverty line (US$ million; constant 2013 prices) *(Scenario ZHsocpro)*

			US$mn, 2013		% GDP		% Public expenditures	
			PGT at US$2.00 PPP (US$mn, 2013)	PGT+Admin. Cost (@ 20%)	PGT at US$2.00 PPP (% GDP)	PGT+Admin. Cost (@ 20%)	PGT at US$2.00 PPP |(% Gov. Expenditures)	PGT+Admin. Cost (@ 20%)
			Av.2016-2030	*Av.2016-2030*	*Av.2016-2030*	*Av.2016-2030*		
High-Income countries		Australia	52	63	0.00	0.00	0.02	0.02
		Canada	23	28	0.00	0.00	0.01	0.01
		Central Asian Republics	463	555	0.07	0.09	0.25	0.30
		European Union 27	1966	2360	0.01	0.01	0.03	0.03
		Israel	7	8	0.00	0.00	0.01	0.01
		Japan	69	83	0.00	0.00	0.01	0.01
		New Zealand	12	15	0.01	0.01	0.02	0.02
		Rest of Eastern Europe	33	40	0.01	0.01	0.03	0.04
		Rest of Western Europe	15	18	0.00	0.00	0.01	0.01
		Russian Federation	46	55	0.00	0.00	0.01	0.01
		United States of America	1331	1597	0.01	0.01	0.03	0.04
		South Africa	3271	3925	0.83	0.99	2.71	3.25
		Total	**7289**	**8746**	**0.01**	**0.02**	**0.05**	**0.06**
Low & middle income countries	sub-Saharan Africa	Angola	2993	3592	1.60	1.92	6.23	7.47
		Burundi	1701	2042	101.41	121.69	723.82	868.58
		Benin	1871	2245	18.04	21.65	137.19	164.63
		Burkina Faso	2423	2908	14.59	17.51	121.30	145.56
		Botswana	150	180	0.67	0.80	2.09	2.50
		Central African Republic	1228	1474	43.82	52.58	291.92	350.31
		Côte d'Ivoire	2820	3384	8.47	10.16	57.00	68.40
		Cameroon	1797	2156	4.45	5.34	31.79	38.14
		Democratic Republic of the Congo	27632	33158	125.51	150.62	1201.10	1441.32
		Congo	572	686	2.69	3.23	11.61	13.94
		Eritrea	477	572	23.52	28.22	179.79	215.75
		Ethiopia	2023	2428	3.22	3.87	24.64	29.56
		Gabon	54	65	0.32	0.39	2.32	2.78
		Ghana	1306	1567	3.00	3.60	14.99	17.98
		Guinea	1227	1472	14.01	16.81	99.98	119.98
		Gambia	98	118	6.87	8.24	51.49	61.79
		Kenya	4875	5850	10.42	12.51	57.04	68.45
		Liberia	1525	1830	96.10	115.32	589.94	707.93

TABLE **D2**

(Continued)

			US$mn, 2013		% GDP		% Public expenditures	
			PGT at US$2.00 PPP (US$mn, 2013)	PGT+Admin. Cost (@ 20%)	PGT at US$2.00 PPP (% GDP)	PGT+Admin. Cost (@ 20%)	PGT at US$2.00 PPP |(% Gov. Expenditures)	PGT+Admin. Cost (@ 20%)
			Av.2016-2030	*Av.2016-2030*	*Av.2016-2030*	*Av.2016-2030*		
Low & middle income countries	sub-Saharan Africa	Lesotho	404	484	16.27	19.52	36.58	43.90
		Madagascar	4389	5267	34.99	41.99	328.56	394.27
		Mali	2248	2698	13.25	15.90	91.21	109.45
		Mozambique	4993	5992	17.10	20.52	75.09	90.11
		Mauritania	221	265	4.10	4.92	29.24	35.09
		Mauritius	1	1	0.00	0.01	0.02	0.03
		Malawi	4140	4968	42.65	51.18	304.43	365.32
		Namibia	332	399	2.37	2.84	8.50	10.19
		Niger	2360	2832	24.08	28.90	240.59	288.71
		Nigeria	23363	28035	7.44	8.92	86.77	104.13
		Rwanda	1968	2362	17.37	20.85	117.23	140.67
		Sudan	1673	2007	1.77	2.13	12.67	15.20
		Senegal	1799	2158	7.80	9.36	47.24	56.69
		Sierra Leone	996	1195	32.45	38.94	178.12	213.74
		Somalia	1075	1289	21.12	25.35	230.60	276.72
		Swaziland	196	235	3.89	4.67	27.79	33.35
		Chad	2088	2506	12.37	14.84	88.28	105.94
		Togo	1211	1453	28.83	34.59	183.73	220.48
		United Republic of Tanzania	10704	12844	22.97	27.56	101.04	121.25
		Uganda	4293	5151	12.51	15.01	70.07	84.08
		Zambia	2984	3581	10.42	12.50	65.69	78.83
		Zimbabwe	3831	4597	39.44	47.33	377.40	452.87
		Total	**130037**	**156044**	**10.40**	**12.48**	**67.89**	**81.47**

TABLE **D2**

(Continued)

			US$mn, 2013		% GDP		% Public expenditures	
			PGT at US$2.00 PPP (US$mn, 2013)	PGT+Admin. Cost (@ 20%)	PGT at US$2.00 PPP (% GDP)	PGT+Admin. Cost (@ 20%)	PGT at US$2.00 PPP |(% Gov. Expenditures)	PGT+Admin. Cost (@ 20%)
			Av.2016-2030	*Av.2016-2030*	*Av.2016-2030*	*Av.2016-2030*		
Low & middle income countries	Near East / North Africa	Afghanistan	3997	4797	22.82	27.39	55.13	66.16
		Algeria	429	515	0.20	0.24	0.82	0.99
		Egypt	472	567	0.19	0.23	0.66	0.79
		Iran (Islamic Republic of)	314	377	0.08	0.09	0.37	0.44
		Iraq	462	555	0.51	0.62	1.92	2.30
		Jordan	10	12	0.03	0.03	0.09	0.11
		Lebanon	61	73	0.13	0.16	0.45	0.54
		Libya	109	131	0.10	0.12	0.55	0.66
		Morocco	622	746	0.54	0.64	1.80	2.16
		Saudi Arabia	33	40	0.01	0.01	0.02	0.02
		Syrian Arab Republic	433	520	0.69	0.82	3.81	4.58
		Tunisia	29	35	0.04	0.05	0.15	0.18
		Turkey	233	280	0.02	0.02	0.05	0.06
		Yemen	761	913	1.83	2.20	6.82	8.19
		Total	**7967**	**9560**	**0.23**	**0.28**	**0.82**	**0.98**
	Latin America /Caribbean	Argentina	364	437	0.08	0.10	0.43	0.52
		Bolivia (Plurinational State of)	177	213	0.83	1.00	3.20	3.84
		Brazil	3476	4171	0.17	0.21	0.68	0.82
		Chile	40	48	0.02	0.02	0.08	0.10
		Colombia	1299	1558	0.43	0.52	1.72	2.07
		Costa Rica	27	32	0.07	0.08	0.26	0.31
		Cuba	182	219	0.19	0.23	0.54	0.65
		Dominican Republic	94	113	0.11	0.13	0.75	0.90
		Ecuador	204	245	0.25	0.30	1.08	1.30
		Guatemala	825	990	1.42	1.70	11.11	13.33
		Guyana	84	100	3.20	3.84	13.90	16.68
		Honduras	427	512	1.99	2.39	9.25	11.10
		Haiti	1953	2344	24.77	29.72	107.49	128.99
		Jamaica	70	84	0.45	0.54	1.28	1.54
		Mexico	1334	1600	0.09	0.11	0.40	0.48
		Nicaragua	113	136	1.17	1.41	8.28	9.93

TABLE **D2**

(Continued)

			US$mn, 2013		% GDP		% Public expenditures	
			PGT at US$2.00 PPP (US$mn, 2013)	PGT+Admin. Cost (@ 20%)	PGT at US$2.00 PPP (% GDP)	PGT+Admin. Cost (@ 20%)	PGT at US$2.00 PPP |(% Gov. Expenditures)	PGT+Admin. Cost (@ 20%)
			Av.2016-2030	*Av.2016-2030*	*Av.2016-2030*	*Av.2016-2030*		
Low & middle income countries	Latin America /Caribbean	Panama	72	86	0.21	0.25	0.90	1.09
		Peru	332	399	0.14	0.17	0.80	0.96
		Paraguay	78	94	0.43	0.52	2.73	3.27
		El Salvador	145	174	0.53	0.64	2.82	3.38
		Suriname	84	100	2.18	2.62	8.86	10.63
		Trinidad and Tobago	328	393	0.90	1.08	3.43	4.11
		Uruguay	2	3	0.00	0.01	0.02	0.02
		Venezuela (Bolivarian Republic of)	1574	1889	0.58	0.70	2.38	2.85
		Total	**13285**	**15942**	**0.24**	**0.29**	**1.01**	**1.22**
	South Asia	Bangladesh	16077	19293	12.07	14.48	131.75	158.10
		India	89321	107185	3.05	3.66	19.74	23.69
		Sri Lanka	277	333	0.42	0.50	2.04	2.45
		Nepal	1504	1805	5.64	6.77	36.88	44.25
		Pakistan	10047	12056	3.79	4.55	23.44	28.13
		Total	**117226**	**140671**	**3.43**	**4.11**	**22.39**	**26.87**
	East Asia	China	18166	21799	0.17	0.20	0.99	1.19
		Hong Kong, China Special Administrative Region	11	13	0.00	0.00	0.02	0.02
		Indonesia	9014	10817	0.99	1.19	5.97	7.17
		Cambodia	528	634	3.04	3.64	32.86	39.44
		Korea, Republic of	44	52	0.00	0.00	0.01	0.01
		Lao People's Democratic Republic	409	491	4.48	5.38	41.50	49.80
		Myanmar	4886	5864	7.82	9.38	233.33	279.99
		Mongolia	261	313	3.18	3.82	12.91	15.50
		Malaysia	45	54	0.01	0.01	0.06	0.07
		Philippines	4378	5254	1.52	1.82	8.90	10.68
		Korea, Democratic People's Republic of	2276	2731	4.57	5.48	49.88	59.85
		Thailand	117	140	0.02	0.03	0.13	0.16
		Taiwan	25	30	0.00	0.00	0.01	0.01
		Viet Nam	2522	3027	1.59	1.91	9.47	11.36
		Total	**42683**	**51219**	**0.26**	**0.31**	**1.47**	**1.76**
	Other		2886	3463	0.37	0.44	1.43	1.71
		WORLD (GRAND TOTAL)	**321372**	**385647**	**0.37**	**0.45**	**1.46**	**1.75**

TABLE **D3**

Transfers to cover the Poverty Gap (PGT) at $1.25 PPP poverty line and required investment to generate income to overcome poverty (US$ million; constant 2013 prices) *(Scenario ZHbotmea)*

			Average 2016-2030 annual values					
			Gross PGT (@ 20% admin costs) (US$mn, 2013)	Gross PGT (@ 20% admin costs) (US$mn, 2013)	Aditional investment (US$mn, 2013)	Aditional investment (US$mn, 2013)	Gross PGT(@ 20% admin costs) (% GDP)	Aditional investment (% GDP)
			Total	*Rural*	*Total*	*Rural*	*Total*	*Total*
High-Income countries		Australia	16	0	0.00	0.00	0.00	0.00
		Canada	5	0	0.00	0.00	0.00	0.00
		Central Asian Republics	137	87	0.00	0.00	0.02	0.00
		European Union 27	531	0	0.00	0.00	0.00	0.00
		Israel	2	0	0.00	0.00	0.00	0.00
		Japan	14	0	0.00	0.00	0.00	0.00
		New Zealand	4	0	0.00	0.00	0.00	0.00
		Rest of Eastern Europe	7	3	0.00	0.00	0.00	0.00
		Rest of Western Europe	4	0	0.00	0.00	0.00	0.00
		Russian Federation	10	0	0.00	0.00	0.00	0.00
		United States of America	399	0	0.00	0.00	0.00	0.00
		South Africa	1060	597	1246.19	702.39	0.27	0.31
		Total	**2187**	**688**	**1246**	**702**	**0.00**	**0.00**
Low & middle income countries	sub-Saharan Africa	Angola	1177	1153	1256.15	1230.38	0.63	0.67
		Burundi	639	595	1101.48	1025.31	38.11	65.65
		Benin	593	376	1099.73	696.32	5.72	10.60
		Burkina Faso	779	732	1050.68	987.69	4.69	6.33
		Botswana	53	33	56.77	34.59	0.24	0.25
		Central African Republic	383	264	715.41	492.73	13.65	25.52
		Côte d'Ivoire	842	537	1702.02	1085.22	2.53	5.11
		Cameroon	572	398	664.91	462.40	1.42	1.65
		Democratic Republic of the Congo	10843	7198	17230.66	11437.76	49.25	78.27
		Congo	213	115	268.34	145.32	1.00	1.26
		Eritrea	148	126	226.24	192.14	7.31	11.16
		Ethiopia	494	420	0.00	0.00	0.79	0.00
		Gabon	18	4	14.28	3.23	0.11	0.09
		Ghana	395	281	561.74	400.25	0.91	1.29
		Guinea	421	341	465.46	377.61	4.80	5.31
		Gambia	25	16	16.05	10.71	1.73	1.13
		Kenya	1563	1309	2856.80	2393.59	3.34	6.11
		Liberia	587	332	957.48	541.11	37.00	60.34

TABLE **D3**

(Continued)

			Average 2016-2030 annual values					
			Gross PGT (@ 20% admin costs) (US$mn, 2013)	**Gross PGT (@ 20% admin costs) (US$mn, 2013)**	**Aditional investment (US$mn, 2013)**	**Aditional investment (US$mn, 2013)**	**Gross PGT(@ 20% admin costs) (% GDP)**	**Aditional investment (% GDP)**
			Total	*Rural*	*Total*	*Rural*	*Total*	*Total*
Low & middle income countries	**sub-Saharan Africa**	Lesotho	140	115	220.96	182.23	5.63	8.91
		Madagascar	1683	1293	2993.32	2298.62	13.42	23.86
		Mali	815	645	1051.77	832.80	4.80	6.20
		Mozambique	1945	1400	2597.76	1869.92	6.66	8.90
		Mauritania	67	41	102.08	62.98	1.24	1.89
		Mauritius	0	0	0.00	0.00	0.00	0.00
		Malawi	1456	1347	2126.57	1967.12	15.01	21.91
		Namibia	106	85	179.54	144.09	0.75	1.28
		Niger	513	457	767.80	684.25	5.24	7.83
		Nigeria	8431	5781	21553.36	14778.21	2.68	6.86
		Rwanda	768	647	1097.26	924.91	6.78	9.69
		Sudan	541	449	402.78	334.33	0.57	0.43
		Senegal	598	423	789.28	558.21	2.59	3.42
		Sierra Leone	311	237	568.11	432.37	10.14	18.52
		Somalia	324	256	501.81	395.77	6.38	9.86
		Swaziland	70	63	99.41	89.70	1.38	1.98
		Chad	754	644	1089.08	931.38	4.46	6.45
		Togo	374	291	800.66	623.88	8.90	19.07
		United Republic of Tanzania	3981	0	7114.33	0.00	8.54	15.27
		Uganda	1315	1260	1537.47	1473.27	3.83	4.48
		Zambia	1140	900	1760.81	1389.25	3.98	6.15
		Zimbabwe	1556	1215	2568.02	2005.70	16.01	26.44
		Total	**46632**	**31779**	**80166**	**53.50**	**3.73**	**6.41**

TABLE **D3**

(Continued)

			Average 2016-2030 annual values					
			Gross PGT (@ 20% admin costs) (US$mn, 2013)	**Gross PGT (@ 20% admin costs) (US$mn, 2013)**	**Aditional investment (US$mn, 2013)**	**Aditional investment (US$mn, 2013)**	**Gross PGT(@ 20% admin costs) (% GDP)**	**Aditional investment (% GDP)**
			Total	*Rural*	*Total*	*Rural*	*Total*	*Total*
Low & middle income countries	Near East / North Africa	Afghanistan	1243	995	2243.91	1797.29	7.10	12.81
		Algeria	161	78	0.00	0.00	0.07	0.00
		Egypt	159	120	0.00	0.00	0.06	0.00
		Iran (Islamic Republic of)	98	0	0.00	0.00	0.02	0.00
		Iraq	147	80	94.30	51.11	0.16	0.10
		Jordan	2	0	0.00	0.00	0.01	0.00
		Lebanon	22	10	0.00	0.00	0.05	0.00
		Libya	46	22	0.77	0.37	0.04	0.00
		Morocco	198	146	9.05	6.65	0.17	0.01
		Saudi Arabia	10	0	0.00	0.00	0.00	0.00
		Syrian Arab Republic	108	52	0.00	0.00	0.17	0.00
		Tunisia	7	0	0.00	0.00	0.01	0.00
		Turkey	61	37	0.00	0.00	0.00	0.00
		Yemen	221	181	212.15	173.73	0.53	0.51
		Total	**2481**	**1723**	**2560**	**2.03**	**0.07**	**0.07**
	Latin America /Caribbean	Argentina	119	0	0.00	0.00	0.03	0.00
		Bolivia (Plurinational State of)	57	26	36.66	16.57	0.27	0.17
		Brazil	1326	0	0.00	0.00	0.07	0.00
		Chile	10	1	0.00	0.00	0.00	0.00
		Colombia	441	147	186.05	62.02	0.15	0.06
		Costa Rica	9	3	0.00	0.00	0.02	0.00
		Cuba	74	48	10.74	6.94	0.08	0.01
		Dominican Republic	28	11	0.00	0.00	0.03	0.00
		Ecuador	70	42	0.00	0.00	0.09	0.00
		Guatemala	257	179	330.58	230.14	0.44	0.57
		Guyana	35	0	44.51	0.00	1.33	1.71
		Honduras	133	74	107.34	59.96	0.62	0.50
		Haiti	677	0	1197.12	0.00	8.58	15.18
		Jamaica	24	16	18.41	11.90	0.15	0.12
		Mexico	431	127	0.00	0.00	0.03	0.00
		Nicaragua	32	20	0.00	0.00	0.33	0.00

TABLE **D3**

(Continued)

			Average 2016-2030 annual values					
			Gross PGT (@ 20% admin costs) (US$mn, 2013)	Gross PGT (@ 20% admin costs) (US$mn, 2013)	Aditional investment (US$mn, 2013)	Aditional investment (US$mn, 2013)	Gross PGT(@ 20% admin costs) (% GDP)	Aditional investment (% GDP)
			Total	*Rural*	*Total*	*Rural*	*Total*	*Total*
Low & middle income countries	Latin America /Caribbean	Panama	27	17	0.00	0.00	0.08	0.00
		Peru	111	45	0.00	0.00	0.05	0.00
		Paraguay	25	13	0.00	0.00	0.14	0.00
		El Salvador	47	21	7.43	3.32	0.17	0.03
		Suriname	32	25	48.04	37.89	0.83	1.25
		Trinidad and Tobago	135	107	176.26	139.01	0.37	0.49
		Uruguay	0	0	0.00	0.00	0.00	0.00
		Venezuela (Bolivarian Republic of)	511	0	628.12	0.00	0.19	0.23
		Total	**4611**	**922**	**2791**	**568**	**0.08**	**0.05**
	South Asia	Bangladesh	5429	4282	8265.78	6519.10	4.08	6.20
		India	33442	26395	40675.92	32104.82	1.14	1.39
		Sri Lanka	104	90	8.13	7.03	0.16	0.01
		Nepal	533	482	390.00	352.71	2.00	1.46
		Pakistan	3305	2543	4220.92	3247.44	1.25	1.59
		Total	**42812**	**33791**	**53561**	**42231**	**1.25**	**1.57**
	East Asia	China	6981	0	0.00	0.00	0.06	0.00
		Hong Kong, China Special Administrative Region	3	0	0.00	0.00	0.00	0.00
		Indonesia	3405	2191	3042.13	1957.66	0.37	0.33
		Cambodia	154	141	95.89	87.41	0.89	0.55
		Korea, Republic of	11	0	0.00	0.00	0.00	0.00
		Lao People's Democratic Republic	143	119	197.55	163.98	1.57	2.16
		Myanmar	1840	1451	2311.97	1823.42	2.94	3.70
		Mongolia	101	41	131.18	53.51	1.24	1.60
		Malaysia	11	8	0.00	0.00	0.00	0.00
		Philippines	1506	0	1422.62	0.00	0.52	0.49
		Korea, Democratic People's Republic of	906	715	1089.90	859.59	1.82	2.19
		Thailand	30	23	0.00	0.00	0.01	0.00
		Taiwan	6	0	0.00	0.00	0.00	0.00
		Viet Nam	865	783	526.89	476.61	0.55	0.33
		Total	**15963**	**5472**	**8818**	**5422**	**0.10**	**0.05**
	Other		1066	706	1364	903	0.14	0.17
		WORLD (GRAND TOTAL)	**115752**	**75079**	**150507**	**49882**	**0.13**	**0.18**

Achieving Zero Hunger

The critical role of investments in social protection and agriculture

This paper provides estimates of investment costs, both public and private, required to eliminate chronic dietary energy deficits, or to achieve zero hunger by 2030. This target is consistent with achieving both the Sustainable Development Goal 2, to eliminate hunger by 2030, and the Sustainable Development Goal 1, to eradicate poverty.

The study adopts a reference "baseline" scenario, reflecting a "business as usual" situation, to estimate the additional investment requirements. In this scenario, around 650 million people will still suffer from hunger in 2030. We then estimate the investment requirements to eliminate hunger by 2030.

Hunger is eliminated through a combination of social protection and targeted "pro-poor" rural investments. The first component aims to bring the poor immediately to the US$1.25/day poverty line income in purchasing power parity (PPP) terms through social protection for a "Transfer to cover the Poverty Gap" (PGT).

The second component requires additional investment to accelerate pro-poor rural growth of incomes and employment particularly in rural areas, where most of the poor live, than in the business as usual scenario. Targeted pro-poor rural, including rural and agricultural, investments are required to raise the earned incomes of the poor. This would, in turn, reduce the need for social protection to cover the PGT.

The analysis is complemented by looking at alternative ways to achieve such pro-poor rural growth.

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