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Norwegian aid to food security, nutrition and agriculture

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Acronyms

CIMMYT	International Maize and Wheat Improvement Center
CMI	Chr. Michelsen Institute
DAC	Development Assistance Committee
DRC	Democratic Republic of Congo
FAO	Food and Agriculture Organization of the United Nations
FERDI	Foundation for international development study and research
GDP	Gross Domestic Product
IFPRI	International Food Policy Research Institute
NGO	Non-Governmental Organization
NMBU	Norwegian University of Life Sciences
NOK	Norwegian kroner
NORAD	Norwegian Agency for Development Cooperation
NUPI	Norwegian Institute of International Affairs
ODA	Official development assistance
OECD	Organization for Economic Co-operation and Development
PRIO	Peace Research Institute Oslo
R&D	Research and Development
UP	Uttar Pradesh
USD	United States dollar
WDI	World Development Indicators
WDR	World Development Report
WIDER	World Institute for Development Economics Research

Preface

This report is commissioned by the Ministry of Foreign Affairs under a framework agreement. The objectives are to provide an overview of activities Norway is supporting within food security, nutrition and agriculture (chapter 2), to summarize research on current development policies specific to these areas (chapters 3-5), and to provide input on how Norwegian aid may contribute (chapters 6 and 7). The report should cover issues like: land-titling, index-insurance, learning and adoption of new technologies within small-scale agriculture, subsidy programs, the links between agriculture and other sectors (structural transformation, access to markets), and the links between local agricultural production, food security and nutrition. The report is based on available international research on the role of agriculture in poor areas of the world (Sub-Saharan Africa and South-Asia). I thank the Ministry of Foreign Affairs, NORAD, and Sosina Bezu (CMI) for useful inputs to the report. I am, however, solely responsible for the content, including conclusions, recommendations, and any remaining errors.

Magnus Hatlebakk

CMI, Bergen, December 2017

Summary

There is an increased interest in Norway in agricultural development in poor countries. This reflects a general increase in aid to agriculture among the OECD-DAC donors, which, in turn, reflects the realization that the majority of the poor still live in rural areas, with agriculture being the main economic activity among the poor. The report reviews available research on the links between agriculture and the rest of the economy, with a focus on structural adjustment and the role of agriculture in economic growth and poverty reduction. Furthermore, the report discusses the links between agricultural production, nutrition and food security.

The report goes on to discuss constraints on agricultural growth, both external constraints, such as roads and other infrastructure, institutional constraints that may reflect market failures, and more immediate constraints such as lack of modern seeds, fertilizers and irrigation. At all levels underlying market failures are identified, and relevant policy interventions are discussed. The report concludes that agricultural policies should be integrated with general policies for development in remote areas. Smallholders have complex livelihood strategies where they combine agriculture with non-farm activities. Family members work outside the village for short or longer stretches of time, and within the village they combine farming with other activities depending on the season. This is to increase their incomes, and to avoid negative income shocks, with the coping mechanisms potentially leading to lower incomes over time.

Government and donor supported safety nets may help in reducing the risks facing poor farmers, and thus allow them to invest in potentially more productive techniques. Such safety nets may target other sectors, with the health sector being potentially the most important one, since own labor is the main source of income for poor people. Emergency aid, or other social protection systems, will also provide villagers with the necessary safety nets.

Beyond insurance and basic income support, there is a need to invest in roads, infrastructure, basic education, and training in improved agricultural techniques, including localized soil management systems. Training should be linked to localized research and extension services, including model farmers at the village level. Donors

should fill the financial gaps with respect to large scale investments in roads, other infrastructure, health and education, but also help facilitating development of localized R&D, including support to international research collaboration within agriculture and rural livelihoods.

1. Introduction

The international donors have increased the aid to agriculture during the last decade¹. All aid increased from 2006 onwards, but with a more rapid increase in aid allocated to agriculture (Figure 1)². The increase reflects a renewed focus on agriculture in development policy and research. The 2008 World Development Report (WDR) from the World Bank focused on agriculture, and reviewed available research³. In parallel with the increase in aid to agriculture, there was an increase in food prices (Figure 2), although world staple food *production* in poor countries was relatively stable, at about 0.5 kg cereals per person per day (Figure 3). While a sustained new interest in agriculture may reflect the food-price crisis, it also reflects the fact that despite a solid economic growth in South-Asia and Sub-Saharan Africa there is still a high level of poverty in rural Africa and South-Asia⁴. Economic growth is trickling down to the rural poor, but at a slow rate. The WDR (2008) concluded that agriculture will have a main role in the growth process of poor agriculture-dependent countries, and it will also play an essential role for poverty reduction in countries less dependent on agriculture.

The increased focus on agriculture is also reflected in Norwegian aid policy, with an increase in aid to agriculture from 2013 onwards (Figure 4)⁵, and the parliament has asked the government to further increase aid to the sector. The present report will give an overview of Norwegian aid to agriculture, and related areas of food security and nutrition. Based on available research the report will go on to discuss development policies in support of agricultural development and how Norwegian aid may contribute.

¹ The aid statistics in this report is downloaded from the OECD-DAC statistics website. This is supplemented using NORAD's database for the year 2016. NORAD's database (avansert datauttrekk) is more detailed, and the 2016 data are not yet available in the DAC database.

² Figures are found in the appendix.

³ The work on the WDR started with a donor meeting in Paris in June 2006.

⁴ The latest numbers (Povcalnet via ourworldindata.org) show that 746 million live in extreme poverty, with 48% of them living in three countries, India (218 million), Nigeria (86 million) and DRC (55 million).

⁵ The 2016 numbers are, however, back to the pre 2013 level according to NORAD's database. This may indicate that the higher level during 2013-2015 was a temporary shift.

2. Norwegian agricultural assistance

Norwegian aid to agriculture is organized through programs for sustainable agriculture, climate change (including climate-smart agriculture), food security and rural livelihoods. In 2016 Norway allocated NOK 460 million to agriculture, narrowly defined (sector 311 in the ODA-DAC system), with 168 million going to Malawi and 123 million to Ethiopia. NOK 350 million went to 22 projects of six million or more. In Ethiopia the main program (60 million) supported the Ministry of Agriculture (via the World Bank) in their efforts to support smallholders and government institutions with the objective of reducing land degradation. The second largest project (18 million) supported research and training through the collaboration between Noragric and Hawassa and Mekelle universities, with the purpose of improving livelihoods in rural communities.

In Malawi there were eight large programs (ranging from 10 to 50 million). The largest program was a sector-wide support to the Ministry of Agriculture with the aim of doubling the area under sustainable land management. The second largest (24 million) supported the Malawi Lake Basin program with the aim of improved livelihoods of rural communities. And the third largest (18 million) supported infrastructure at Lilongwe University of Agriculture and Natural Resources. Another program (14 million) supported human capacity building at Bunda College of Agriculture, and the National Smallholder Farmers Association of Malawi was supported with NOK 17 million for their Strategic Development Program. Utviklingsfondet received 14 million for their Lead Farmer program in Malawi with the aim of supporting livelihoods of rural communities. And also in other countries there were support for smallholder development, with many of the smaller programs focusing on climate resilience.

The third largest recipient of Norwegian aid to agriculture was Mozambique, with 38 million. Here the focus is on climate-smart agriculture. Norwegian People's Aid is building organizational capacity within gender, land rights and climate smart agriculture (16 million). The Cooperative League of the USA, an NGO, is starting an initiative to fund climate-smart agriculture (15 million).

Aid in support of food security may be allocated via other budget posts. Sector 520 in the DAC-system covers food aid and food security, but only an intern in the World Food Program was assigned this code in 2016. Aid to forestry (sector 312) may, in principle, include food products, but in reality there were not many relevant aid projects in 2016. Among the three projects of five million or more, the most relevant was a seven million community forest project in Myanmar. Similarly for fisheries (sector 313), there were six projects of five million or more, four of them with a global unspecified reach, and with the largest (after the 71 million to the Norwegian Institute of Marine Research) being a 10 million support to the Ministry of Fisheries in Mozambique to strengthen their abilities to promote small scale fisheries. When it comes to emergency aid (code 720) the largest programs in 2016 were 74 million to the World Food Program's response in Yemen, and 40 million to the Norwegian Red Cross combined food and non-food relief in Syria.

In sum, Norwegian aid to agriculture focuses on Ethiopia and Malawi in terms of funding, while also the smaller amounts go primarily to Africa. Some smaller NGO projects, as well as climate projects, go to Asia and Latin-America. The main purpose of the larger programs is support to smallholder livelihoods, including climate adjustments and research collaborations. One may question some of the amounts, but it is beyond the scope of this report to conduct any assessment of particular projects. The focus on smallholders, in general, seems well placed, as we shall see below. The focus on research is also pertinent, but we are not able to judge whether the funded projects in fact focus on development of agricultural methods that are adjusted to the needs of smallholder farmers. We will discuss the potential role of Norwegian aid to agriculture in some more detail in chapter seven.

3. Agriculture, food security and nutrition

Since Amartya Sen's seminal analysis of famines, it is well known that lack of food is normally explained by lack of income, and/or delivery problems in situations where

rulers are not accountable to the people⁶. The recent food-crisis in Eastern Africa seems to be primarily of the latter kind, with drought as the immediate cause, while conflict and lack of accountability explain why it is not well handled⁷.

It appears that even in poor parts of the world production will adjust to the demand for food among the poor, as illustrated by the production of cereals shown in Figure 3. As income increases, the poor will not necessarily buy more of these staples, there is even evidence that they will buy less as they switch away from hard manual labor⁸. But nutrition will tend to improve in a more general sense as increased incomes allow for a more diverse diet (micronutrients, protein), as well as improved sanitation and access to health services, which both leads to better uptake of nutrients⁹. As an economy develops we shall thus expect to see staple food production keeping up with population growth, and at the same time an increase in high-value agricultural products, such as vegetables, dairy, meat and farmed fish. As high value products also requires access to land, including for animal-fodder, the relative productivity in staple food production will have to increase with more than the population growth.

At the household level, food security and nutritional status will mainly depend on income. In some areas of the world, in particular in remote African villages, the main income of many households will not be in terms of money, but will rather to a large extent consist of food produced for own consumption. For these poor farmers, one may argue that food security and nutritional outcomes are determined primarily by agricultural productivity. But even in remote African villages there are very few households that only depend on own agricultural production¹⁰. First, they depend on

⁶ Sen, A. (1981). *Poverty and Famines*. Oxford University Press, and Sen, A. (1999). *Development as Freedom*. Oxford University Press. For a good discussion of related research see Ravallion, M. (1997). "Famines and Economics". *Journal of Economic Literature*. 35(3): 1205-1242.

⁷ The crisis has hit the strongest in conflict ridden countries (Somalia, South-Sudan, Yemen, Northern Nigeria). For a presentation of the World Bank efforts to prepare for and meet the crisis, see: www.worldbank.org/en/news/immersive-story/2017/06/07/breaking-the-cycle-of-crisis.

⁸ A classical study is Behrman, J.R. and Deolalikar, A.B. (1987). "Will Developing Country Nutrition improve with Income? A Case study for Rural South-India". *Journal of Political Economy*. 95(3): 492-507.

⁹ For a good discussion of these processes, and how they have developed historically, see Deaton, A. (2013). *The Great Escape*. Princeton University Press.

¹⁰ A large share of poor farmers are net-buyers of food, partly because they do not own much land, and partly due to low yields. As a result they do not benefit from higher food prices, and they will benefit from broad policies to improve small-holder productivity to be discussed in more detail below. For a broad discussion, see: de Janvry, A. and Sadoulet, E. (2011). *Subsistence farming as a safety net for food-price shocks*. *Development in Practice*. 21(4-5): 472-480. For a longer, and broader, version, see: de Janvry, A. and Sadoulet, E. (2010).

other food sources, in particular fish, but also other harvested food resources. Second, most households trade to some extent, either in products or via labor market participation. In fact, diversification into non-farm rural economic activities is today a major pathway out of poverty and vulnerability. Poor households both reduce the variability and increase their incomes by adding other economic activities to agricultural production, and they also diversify within agriculture as a result of increased local demand for non-staple food¹¹.

Despite an increase in market participation, and the improved livelihoods that follow, we know that markets are far from perfect. The main underlying market failures are coordination failures that leads to under-provision of public goods (irrigation, transportation) and information failures (asymmetric information) that may lead to under-utilization of hired labor and misallocation of capital: the large fixed costs of roads and other infrastructure, the lack of collateral needed for credit when lenders do not know potential borrowers, the costs of supervision of non-family labor, the lack of tenure security for land in historically land-abundant countries, may all contribute to under-utilization of resources and lack of investment in new technologies.

Small farmers may thus lack the capital to invest in new technology and education for their children, the local community lacks the capacity to invest in roads and irrigation, and the resulting high transportation costs will hinder trade in inputs and outputs, which in turn may lead to lack of competition in those markets. As a result incomes stay low, both in terms of production for own consumption and marketable surplus. People may thus experience food deficits at the household level as each farmer does not produce enough food for own consumption, and at the community level as bad harvests, and lack of buffers, may hit the whole community at the same time. Again this is a form of market failure, as insurance markets are not fully developed in poor economies, in particular when many households are hit at the same time. We shall

Agriculture for development in Africa: business-as-usual or new departures? *Journal of African Economies*. 19(S2): ii7–ii39.

¹¹ For a good recent review, that we rely heavily on in this report, see Barrett, C.B., Christiansen, L., Sheahan, M. and Shimeles, A. (2017). "On the Structural Transformation of Rural Africa". *Journal of African Economies*. 26(AERC Supplement 1): i11-i35. Also see a previous review: Barrett, C.B., Carter, M.R. and Timmer, C.P. (2010). "A Century-long Perspective on Agricultural Development". *American Journal of Agricultural Economics*. 92(2): 447-468.

discuss later how, for example, index-insurance schemes may solve some of these problems.

While lack of food-security, due to market failures, is mainly a problem in remote rural economies with lack of alternative income possibilities, there will also be poor people with insecure incomes in urban areas, or in rural areas with extensive non-farm incomes. In such areas, social insurance plays an important role, as neighbors may have spells of low income at different points in time, and thus can help each other out within mutual insurance mechanisms. This kind of insurance is found to work even in relatively remote African villages¹². Still, these markets are not perfect, and with very low, and variable, incomes people will regularly meet food deficiencies even in urban areas with stable access to food. Lack of income will in such places be the main constraint, in contrast to more remote villages that face a wide range of market imperfections. Development policies should thus also differ. In urban and semi-urban areas development policies may focus on income transfers, and/or insurance mechanisms, while in remote villages packages of policies are needed, in an attempt to simultaneously handle a number of constraints that poor people meet¹³.

In South-Asia it appears that the non-farm sector is relatively developed also in rural areas, which allows people to diversify incomes and enter into mutual insurance mechanisms. But even after a long period of solid economic growth, and a resulting decline in poverty, the level of malnutrition has stayed surprisingly high. There appears, however, to have been a good improvement during the last decade, and India, as well as other countries in South-Asia, is now down to the Sub-Saharan level of stunting, below 40%¹⁴. The slow progress in South-Asia may be related to diet, sanitation, and the general health condition, but the research on this is still weak¹⁵.

To summarize, there is no automatic link between agricultural production, food security and nutrition. At the aggregate world level there is an obvious direct link, but

¹² A by now classic study is Udry, C. (1994). "Risk and Insurance in a Rural Credit Market: An Empirical Investigation in Northern Nigeria". *Review of Economic Studies*. 61(3): 495–526.

¹³ For a discussion, and evaluation, of a successful broad-based program, the BRAC Graduation Program, see Banerjee, A. et al. (2015). "A multifaceted program causes lasting progress for the very poor: evidence from six countries". *Science*. 348(6236): 1260799.

¹⁴ IFPRI (2016). *Global Nutrition Report*.

¹⁵ See Deaton (2013) for a discussion. For a recent research-based commentary see: Avula, R, Raykar, N, Menon, P. and Laxminarayan, R. (2016). "Reducing Stunting in India: what Investments are needed?" *Maternal and Child Nutrition*. 12(Suppl. 1): 249-252.

it appears that production keeps track with demand, without dramatic increases in food prices in the long run. We may expect spikes, as in 2008 and 2011, but in the long run we shall expect production to keep up with demand¹⁶. In theory we may expect an increase in prices as incomes, and thus the consumption of in particular meat products, will increase in the fast growing economies of Asia. But historical trends indicate that the agricultural sector is able to keep up with growing demand from a steadily larger and richer population. Real threats would be structural changes in demand or supply, such as a massive shift in the demand for bio-fuel, or dramatic changes in production conditions due to climate change.

If markets work well, then income is the only constraint on food consumption at the household level. Landless and poor households, whether in rural or urban areas, as well as smallholders, will depend on farm and other incomes to buy food. With diversified economic activities within the household, and access to mutual insurance, the level of income, including the value of own production, is what matters for food-security and nutritional intake. Nutritional *uptake*, on the other hand, will also depend on personal health conditions. Development policies under these circumstances will need to focus on the incomes of the poor (investments in human and other capital, or direct transfers of income), as well as public investments in sanitation, access to clean water, and the health sector more in general.

In remote areas of the world, with pockets of widespread rural poverty, we shall expect market failures to explain not only household level poverty, but even economy wide poverty traps for either the full population, or for the lower rungs of society¹⁷. In such economies, consumption and production are no longer constrained only by income. How much land you own, the family size, your social network, the land distribution of the village, the village level production conditions, and a number of other factors may affect a household's access to food. In these economies a broad-based development policy is needed. We will discuss policies in more detail below, starting in

¹⁶ For a discussion of demand and supply trends for the next decade, see OECD/FAO (2016). *Agricultural Outlook 2016-2025*.

¹⁷ For a discussion of how such low-level development traps may develop, see Banerjee, A.V. and Newman, A.F. (1993). "Occupational Choice and the Process of Development". *Journal of Political Economy*. 101(2): 274-298. For an empirical test, see Hatlebakk, M. (2014). "Poverty dynamics in rural Orissa: Transitions in assets and occupations over generations." *Journal of Development Studies*. 50(6): 877-893.

chapter 5. But first we will turn to another broad issue, the links between agriculture and the rest of the economy.

4. The role of agriculture in the economy at large

4.1 Structural transformation

Economic development is normally followed by a reallocation of labor and other resources from a low-productivity agricultural sector to a high-productivity urban sector. It is important to note that if this transfer functioned well from the initial stages of development, as it will with perfect labor and capital markets, then there would not be any specific benefits from the structural change in itself¹⁸: development would happen as a result of investments and technological progress in any of the two sectors, as labor and other resources would move wherever they are most productive. If so, then an increase in labor productivity (as a result of investments or technological progress) in the urban sector would lead to migration towards cities, while an increase in agricultural productivity would counteract the migration process. As a result, one would observe the same marginal productivity everywhere, and structural transformation would be a description of the transfer of resources between sectors with no implication for government policies.

In the real world there is labor surplus in terms of under-employment in many rural areas, and by that lower average labor productivity¹⁹. This does not necessarily mean that the marginal productivity of labor or capital is lower, it just implies that labor is not fully utilized, and thus that the *average* production value-added per person will be low. The underemployed may not get a job in the urban sector, while those who in fact move will tend to have a lower productivity than the average in the urban

¹⁸ This section is to a large extent based on Barrett, C.B., Carter, M.R. and Timmer, C.P. (2010). "A Century-long Perspective on Agricultural Development". *American Journal of Agricultural Economics*. 92(2): 447-468. For a longer version of the same arguments see Timmer (2009). *A World without Agriculture*. The Henry Wendt Distinguished Lecture. The American Enterprise Institute.

¹⁹ Gollin, D., Lagakos, D., and Waugh, M. E. (2014). The agricultural productivity gap. *Quarterly Journal of Economics*. 129: 939–993.

sector²⁰. Improved productivity would require direct investments in the workers, in terms of general education and specific skill-training, as well as investments in technology and capital accumulation in general. Since workers move back and forth between sectors and regions, one may invest in urban areas, and expect people to move there. But a more direct approach will be to invest directly in the rural areas. Such investments can target agriculture, or they can take place in the growing rural non-farm sector, and should include investments in the public goods of education, health and infrastructure, which are all necessary for an effective economy with a productive labor force. Such a strategy, of combined investments in agriculture and non-agricultural sectors in rural and semi-rural areas, to reap the fruits of surplus labor, characterizes the structural transformation and strong economic growth we have seen in East-Asia.

4.2 Economic growth and poverty reduction

As discussed, the direct policy response to low productivity in agriculture is to invest more in the sector. The modern urban economy is growing fast by itself. In the long run we shall expect more people to migrate to the urban sector as the demand for labor increases. The low productivity in agriculture indicates that there are extensive market failures and thus a role to play for government intervention. The degree of market failures vary between countries. The 2008 World Development Report concluded that agriculture can be the main source of growth, and thus poverty reduction, in the poorest agriculture-based countries, while it can contribute to poverty reduction in countries less dependent on agriculture.

As agricultural productivity improves, and people gradually transfer to non-farm sectors, rural incomes will also improve and people will spend a larger share of their income on high-value agricultural products, as well as non-agricultural goods and services. In sum, the share of income spent on agricultural products will tend to decline, and with increasing incomes also among farmers, the number of farmers will

²⁰ Careful studies that compare the income of the same people before and after they move do not, in fact, find large differences in productivity between sectors, but there is still a lack of individual level studies in very poor countries. For a good study from Kenya and in particular Indonesia see: Hicks, J.H., Kleemans, M., Li, N.Y. and Miguel, E. (2017). *Reevaluating Agricultural Productivity Gaps with Longitudinal Microdata*. NBER Working Paper No. 23253.

decline. Simultaneously there will be an increased need for processing of agricultural products, as well as new marketing channels. Many of these non-farm activities will take place in the rural areas themselves. Thus higher agricultural production will contribute to rural growth, and some of the investments necessary for agricultural growth will also directly benefit the rest of the rural economy. The new non-farm activities will in many places be taken up by farming households, either as side-activities by the farmers themselves, or as the main activity of other household members. Investments in agriculture will thus lead to increased incomes for farmers, as well as households that depend more on non-farm activities, and will thus pull a broad range of people out of poverty.

In countries less dependent on agriculture, there may be pockets of rural poverty that still need to go through the process of structural adjustment. This is the case even for middle-income countries, such as India²¹. Policies for utilizing surplus labor will here be the same as in agriculture-dependent countries, just at a smaller scale. The costs of investing less in agriculture will, however, be relatively smaller as these countries will have a shorter remaining trajectory of structural transformation even if they do not invest in agriculture. What policies that can promote agricultural growth, in both groups of countries, will be discussed in more detail in chapters 5 and 6.

4.3 Small versus large-scale agriculture

Related to structural transformation and investments in the agricultural sector is the issue of whether governments should facilitate large-scale agriculture, or support smallholders. We know that with perfect labor markets and only restrictions in the land market (which may explain the unequal operational holdings in the first place²²), people will adjust labor and other inputs so that all farms are equally efficient²³. If we find that smallholders are more efficient, maybe because family labor is better utilized

²¹ We found support for village level poverty traps in remote villages of upland Orissa: Hatlebakk, M. (2014). "Poverty dynamics in rural Orissa: Transitions in assets and occupations over generations." *Journal of Development Studies*. 50(6): 877-893.

²² If small farms are the most efficient we shall expect large landowners to rent out their land, and if large farms are the most efficient we shall expect them to rent in, or buy up the small farms. Limited land transaction indicate that there are market failures.

²³ This section is based on Barrett, C.B., Carter, M.R. and Timmer, C.P. (2010). "A Century-long Perspective on Agricultural Development". *American Journal of Agricultural Economics*. 92(2): 447-468, and the literature mentioned therein.

than hired farm hands, then we also know that there are market failures beyond the land market. The market failure does not have to be in the labor market, it can equally well be in the credit market. The latter is likely to be the case if we find that large farms are the most efficient.

There is a long tradition of empirical investigations of these competing farm-size-productivity hypotheses, with recent papers supporting both findings. The recent literature has, however, focused on measurement problems arguing that the efficient smallholder hypothesis is explained by variation in land quality or other inputs, and not land size itself. But since land quality and other inputs may improve with the use of family labor it is not clear that these explanations are pure measurement problems. Some of the literature is carefully using detailed plot-level data, and a recent paper convincingly argues that small plots, rather than small farms, has its benefits²⁴. In addition to possible agronomic explanations, a major reason appears to be that people take better care of land that they can reach from the edges of the plots, and small plots will have more land near the edges.

We thus know that if small, or large, farms are the most productive, then there are likely to be context specific explanations for these findings, which may reflect underlying market imperfections in the land market as well as the labor and/or credit market, or some other market. Context specific analysis are needed to uncover such market failures, and simple conclusions based on an apparent higher productivity in one sector may lead to policy failures. The extensive support of agricultural credit in the early phases of post-independence development in many countries is an example of this. It is essential to understand the underlying market failures, and investigate whether government action can in fact lead to improvements.

If large farms are inefficient because they are not able to utilize family labor, then one should expect those landowners to split up the land and rent it out to tenants. But on the other hand, we know that tenants may not have the incentive to fully invest in the land, since they do not own the land. Similarly, smallholders may be constrained in the credit market, and thus underinvest, or they may be risk-averse due to low incomes, and underinvest in risky, but productive, technologies. The lack of

²⁴ Bevis, L. E. and Barrett, C. B. (2017). Close to the Edge: High Productivity at Plot Peripheries and the Inverse Size-Productivity Relationship. Mimeo. Cornell. See the same paper for a review of the literature.

investments in agriculture in poor countries reflect the real difficulties of finding effective policies when there are multiple market failures and complex underlying market structures. In chapters 5 and 6 we will discuss these issues in more detail.

5. Factors that may affect agricultural productivity and growth

Above we have discussed how multiple market failures jointly explain why remote rural areas lack behind in development. Rural areas have surplus labor, which explains the low average productivity, even while the marginal productivity of labor may be high²⁵. Remote areas may be in a local poverty trap, where unskilled labor is in abundance, keeping wages and thus incomes low. As a result there is also lack of local demand for goods, and transportation costs limit external sales. Limited demand and low costs of labor together explain why few investments are made, and why the few wealthy people may be satisfied with status quo²⁶. The best strategy of the poor is to send family members to urban areas for work, leaving the less productive family members in the village to survive on remittances and low-productivity activities.

To break the vicious circle of a poverty trap, one will normally need large scale interventions²⁷, and in this case a set of interventions that simultaneously solve a number of constraints on poor people's lives in rural areas²⁸:

1. Limited ownership of assets: this constrains incomes, and access to credit (since assets are needed as collateral for, in particular, external lenders).

²⁵ The average product may be high in firms, and even at some farms, but at the aggregate level, when we include under-employed people, the average product will be low. For further elaboration see for example: Barrett, C.B., Christiansen, L., Sheahan, M. and Shimeles, A. (2017). "On the Structural Transformation of Rural Africa". *Journal of African Economies*.

²⁶ Again, see Hatlebakk (2014), and the literature therein.

²⁷ A poverty trap is identified not only by people being poor, but also by mechanisms that pull them back into poverty. Massive one time interventions may lead to a permanently better outcome. For a good discussion see: Barrett, C.B. and Carter, M.R. (2013). *The Economics of Poverty Traps and Persistent Poverty: Empirical and Policy Implications*. *Journal of Development Studies*.

²⁸ See in particular: Banerjee, A. et al. (2015). "A multifaceted program causes lasting progress for the very poor: evidence from six countries". *Science*. 348(6236): 1260799.

2. Limited insurance markets (since external agents have limited information about local people): this implies that people self-insure by selecting safe, but less productive, agricultural technologies.
3. Limited access to affordable health services: medical emergencies can constraint income possibilities and constitute a massive direct cost, against which there is no insurance.
4. Limited education: basic skills in reading and mathematics are necessary to learn new agricultural techniques, and to interact with external markets.
5. Limited infrastructure: local coordination on provision of public goods, such as roads and electricity, can be limited, in particular when local funding is not affordable, and infrastructure has to be financed from national or international sources.

In this chapter we will discuss three sets of factors that particularly limits agricultural productivity and growth, that is, infrastructure, institutional factors, such as land-tenure systems and insurance mechanisms, and diffusion of new technology. This does not mean that we believe the credit market and access to education and health services are not important for farmers, but these are broader conditions for development that are important for all sectors, not only agriculture. Those factors will be included, though, in the policy discussion in chapter 6.

5.1 Infrastructure

Later we will discuss adoption of technology at the household level, but many essential investments are more or less public goods, where one person's use will not fully exclude other people from using the same. This allows for free-riding, where you hope that others will finance the investment, while you can yourself benefit, possibly even at the expense of others. Roads, public transportation, irrigation systems, marketing channels, electricity transmission and new technologies are examples of different

types, and degrees, of public goods. They will tend to be under-funded, and over-used, in unregulated market systems.

In stable village economies we know that coordination on provision and use of public goods is common, despite the predictions of simple economic models that coordination will not take place²⁹. At the regional and higher levels, centralized institutions will coordinate the efforts to provide public goods, and regulate the use. For agriculture many of the mentioned public goods are essential, as is well illustrated by the agricultural value chain: farmers need transportation services to get access to inputs such as petrol, fertilizers and pesticides, irrigation systems to provide water, electricity to run irrigation pumps and mills, knowledge to increase production or reduce costs, transportation services to move the marketable surplus, and marketing boards and auction houses to facilitate large-scale sales.

In many cases the industry itself may organize these services, potentially at the cost of concentration of market power, depending on the institutions that are set up in each case. Local, regional, national, and even international government actors may play an essential role in supporting the farmers and set up effective institutions that provide public goods that are accessible to all producers at a reasonable cost.

5.2 Institutions

Coordination on maintaining public goods may, over time, develop into customs, norms, or social institutions. These are essential for a well functioning society, and in particular for a well functioning economy. Property rights, land rental markets and land contracts of different kinds, labor markets and labor contracts of different types, mutual coordination and insurance mechanisms, all affect the level of production, output sharing, input-cost sharing, choice of technology, payment systems, and thus ultimately the incomes of different members of society. Economists from Adam Smith onwards have described the importance of institutions, and how they may, or may not, develop over time, and how institutions, or lack thereof, may in specific context

²⁹ The field of economics has caught up, and models of repeated games will explain coordination, and there is a relatively extensive literature on coordination in poor economies, see in particular Nobel Price winner Elinor Ostrom (2015). *Governing the commons*. Cambridge University Press. Reissue, first published in 1991.

constrain development³⁰. Here we will focus on institutions that may be particularly restrictive in the present agricultural context, or institutions that may potentially be replaced or improved upon by coordinated public policy.

5.2.1 Land contract systems

Property rights tend to develop over time as resources become scarce relative to the population competing for those resources, with communal user rights as an intermediate form between open commons and private property rights³¹. In particular for land, we find important differences between densely populated areas in South-Asia, where land is normally privately owned, and remote African villages, where user rights to land may be allocated by the local chief³². Over time such user rights may develop into formalized property rights. A related issue is the patchwork of ownership over plots of land that we find in many parts of the world. Such land fragmentation may also be the result of a gradual development of ownership over time, with land being split among sons, and later potentially being sold to others, leading to a patchwork of plots³³.

With small plots of land, or lack of full ownership, the farmers will have less of an incentive to invest in the land. Mechanization may be inefficient if the plots are small, and investments in the land may not benefit the investor if the user right is later transferred to others. The plot-size problem may be solved by land rental of different kinds, where one farmer rent adjacent plots of land, or if the mechanized production processes are coordinated among farmers. Rental of tractor services is, for example,

³⁰ There are numerous contributions to this literature focusing specifically on poor countries, see in particular: Bardhan, P. (1989) (ed) *The Economic Theory of Agrarian Institutions*. Clarendon Press; Basu, K. (2011). *Beyond the Invisible Hand: Groundwork for a New Economics*. Princeton University Press. Fafchamps, M. (2004). *Market Institutions in Sub-Saharan Africa*. MIT-Press; Platteau, J.-P. (2000). *Institutions, Social Norms and Economic Development*. Routledge.

³¹ For a critical discussion that warns against the most simplistic variations on this argument, see: Baland, J.M. and Platteau, J.P. (1989). *Division of the Commons: A Partial Assessment of the New Institutional Economics of Land Rights*. *American Journal of Agricultural Economics*. 80(3): 644-650.

³² See, for example: Otsuka, K. (2007). Efficiency and equity effects of land markets. Chapter 51. *Handbook of Agricultural Economics*. Vol 3. Elsevier, and for a shorter discussion: Otsuka, K. and Place, F. (2014). Changes in land tenure and agricultural intensification in sub-Saharan Africa. WIDER-WP-2014/051.

³³ For one recent study on India, see: Deininger, K., Monchuk, D., Nagarajan, H.K. and Singh, S.K. (2016). Does Land Fragmentation Increase the Cost of Cultivation? Evidence from India. *Journal of Development Studies*. 53(1): 82-98.

quite common³⁴, and in this case it will be more the layout of the plots, rather than plot ownership, that may be the constraint.

Landless households, or small farmers, may thus rent both land and other means of production, and there is an extensive literature on in particular different forms of land and labor contracts, including contracts that interlink transactions in both markets, with potential further linkages with credit or output markets³⁵. This literature shows how a wide range of contractual forms have developed over time as a response to underlying incentive problems. Classical examples are share-tenancy contracts that allow for both risk-sharing and monitoring of family labor, or tied-labor contracts that provide the owner with labor in the peak season and the laborer with secure income in the lean season.

Despite that the unregulated markets have led to what in many cases appears to be quite efficient contractual arrangements, there may be cases where those who have the resources may find that they will not benefit from spending resources on new agricultural technologies. They may find better investments in other sectors, or they may find that investments will benefit others, and not themselves³⁶. In a fast growing economy we may also imagine that traditional rural institutions become inefficient, even if they for a long time have been quite effective arrangements. Governments and donors have thus come up with a number of institutional inventions that may contribute to increased productivity, and/or decreased vulnerability. We will discuss three of these interventions, land-titling, contract farming and index-insurance.

³⁴ While economists have extensively studied land tenure systems, and labor contracts, there are not many studies of the rental markets for other means of income in agriculture, such as livestock, irrigation pumps, or tractors. For one study of tractor-rental, see: Takeshima, H. (2015). Drivers of Growth in Agricultural Returns to Scale. The Hiring in of Tractor Services in the Terai of Nepal. IFPRI Discussion Paper 01476.

³⁵ Good reviews are now found in text-books, such as Basu, K. (1997). Analytical Development Economics. MIT Press, and: Ray, D. (1998). Development Economics. Princeton University Press.

³⁶ Marxian-type models of backward agriculture will belong to this category, but also models of positive technological externalities.

5.2.2 Land titling

de Soto has made land titling famous³⁷, but this is far from a new idea³⁸. As discussed, customary user rights seem to have evolved in regions of increased land pressure, as a means to regulate conflicting interests and excessive use of land. Similarly the transition from customary user rights to private ownership may take place in regions with even more land pressure. With private ownership, one can avoid conflict over land, and people can make the long-term investments necessary to increase agricultural productivity, rather than increasing the areas under cultivation. Observing these historical trends, and variation between regions with different degree of land pressure, it is tempting for governments to speed up the process.

Land-reform programs take many different forms, ranging from confiscation of private land either for collective cultivation, or redistribution to the landless, to formalization of tenancy rights. The latter has been tried in different forms in South-Asia³⁹, and may have un-intended incentive effects: if you know the tenant will get permanent rights to continued tenancy, or even ownership, then you will not rent out the land in the first place.

In Africa, where customary user rights are more common, there are additional problems related to land-titling programs⁴⁰. In parts of Africa with high land pressure, the transition to individualized land-rights is far developed, and the government should play a role in securing those rights, in particular the rights of smallholders that have had the traditional user rights. In regions with abundance of land, locally enforced user rights may already be well defined, and any formal land-titling program may in fact lead to less secure rights for smallholders, as the process may be captured by large, and potentially absentee, owners. But even in these areas the lack of individual property rights are likely to hinder investments in the land, which is the main argument

³⁷ For a critical review of his most influential book, see: Woodruff, C. (2001). Review of de Soto's *The Mystery of Capital*. *Journal of Economic Literature*. 39(4): 1215-1223.

³⁸ For a relatively early review of the evidence at that time, see: Feder, G. and Nishio, A. (1999). The benefits of land registration and titling: economic and social perspectives. *Land Use Policy*. 15(1): 25-43.

³⁹ For a review, see for example: Ghatak, M. and Roy, S. (2007). Land reform and agricultural productivity in India: a review of the evidence. *Oxford Review of Economic Policy*. 23(2): 251-269.

⁴⁰ This discussion is based on Otsuka, K. and Place, F. (2014). Changes in land tenure and agricultural intensification in sub-Saharan Africa. *WIDER-WP-2014/051*; and Holden, S.T. and Otsuka, K. (2014). The roles of land tenure reforms and land markets in the context of population growth and land use intensification in Africa. *Food Policy*. 48: 88-97.

for allowing investors to enter areas with abundant land. This type of "land-grab" may utilize the vast areas of under-utilized land in many regions of Africa, but is obviously a different form of land-titling than the smallholder programs discussed above.

Land abundance is not straight forward to measure, since a low utilization may be the result of lack of investments, which is our concern, or simply that the land cannot be used for agriculture. FAO reports different measures of land abundance, the most conservative is *land under permanent crops*, while *agricultural area* also includes grazing land and land under temporary use. If we see the latter as an upper bound, the former as a percentage of the latter may indicate the level of development of land for intensive use. In reality there is overlap between the indicators, and we find that many of the countries with high population density also utilize the land intensively, as we shall expect. This is the case for Burundi, Rwanda, Uganda and Nigeria, which all use 70%-80% of the land for agriculture (Figure 5) and 7%-14% for crops. At the low end of agricultural land utilization we find DRC and the Central African Republic, where only 10% of the land is agricultural. Some other countries with significant land resources, and thus potential targets for land-grab are, for example, Sudan, Zambia and Ethiopia. Some of the main receivers of such direct investments in land, are in fact Sudan and Ethiopia⁴¹.

One careful study of the determinants of land-grab showed that agricultural potential matters as much as available land, but with substantial overlap between the two measures⁴². The study also found that lack of tenure security attracts foreign investors. Investors may expect to earn larger profits in countries with weak regulations of land-tenure. Foreign investments may bring in more efficient agricultural technologies, and in many ways solve the coordination problems of financing and marketing that face smallholders. But an alternative policy would be to utilize the productivity gap directly by providing the public goods needed to develop the smallholder sector, as discussed earlier.

⁴¹ For one review see: Odusola, A.F. (2014). Land grab in Africa: A review of emerging issues and implications for policy options, Working Paper, International Policy Centre for Inclusive Growth, No. 124.

⁴² Deininger, K. et al. (2011). Rising global interest in farmland. World Bank. A shorter, and more analytic, version is published as: Arezki, R., Deininger, K. and Selod, H. (2015). What drives the global "land rush"? World Bank Economic Review. 29(2): 207-233.

5.2.3 Contract farming

A variation on direct investments in land, will be direct contracts for delivery of agricultural products to the market. This has become increasingly popular among donors⁴³. Such contracts imply that farmers deliver to a particular buyer, normally at an agreed price, and with the buyer potentially paying for some of the inputs. This is a contract form that has existed historically, in particularly in areas with a few powerful leaders who may control land, politics, transportation and trade. It is a bit surprising that the international donor community attempts to re-introduce this model. The danger is the same we have observed historically, the trader may get extensive market power, in particular if the trader can also set the terms of the contract, such as prices, quantities to be delivered, and the input use⁴⁴.

The obvious counter-strategy is farmer organization⁴⁵. But if farmers are able to organize themselves, they may also be able to organize input purchases and marketing of surplus, which will make contract-farming redundant. Now, such farmer cooperatives may also enter into contracts with individual farmers, and thus operate as contract-farming monopolies. We know from Europe and USA that farmer-owned marketing cooperatives can be powerful and represent the interests of farmers. And there are examples of well functioning cooperatives also in the developing world, with the dairy cooperative Amul in India being one example of success⁴⁶.

The farmers' relative bargaining power, which will improve if they organize, will depend on the degree of monopsony power of the buyers, and potentially the ownership of the buyer. If the farmers themselves own the cooperative, then they may, in theory, maximize welfare for the farmers, although large bureaucracies are known to not always operate in the owners' interest. In the standard case of contract-farming,

⁴³ Making markets work for the poor (M4P) is now implemented by many donors, maybe with DFID as the leading force. As with many forms of development aid, the implementation tend to be outsourced to consultancy firms, the main funders and implementing firms are listed here: <http://m4phub.org/partner-finder/>, although this website lists only some of the ongoing initiatives by these organizations.

⁴⁴ This section is to some extent based on: Barrett, C.B. et al. (2012). Smallholder Participation in Contract Farming: Comparative Evidence from Five Countries. *World Development*. 40(4): 715-730. But supplemented with general economic theory on contracting and industrial organization. For an early discussion that link descriptive data on contract farming and theory, see: Grosh, B. (1994). Contract Farming in Africa: an Application of the New Institutional Economics. *Journal of African Economies*. 3(2): 231-261.

⁴⁵ Sivramkrishna, S. and Jyotishi, A. (2008). Monopsonistic exploitation in contract farming: articulating a strategy for grower cooperation. *Journal of International Development*. 20: 280-296.

⁴⁶ <https://www.ft.com/content/6f5d46cc-d189-11e1-bb82-00144feabdc0?mhq5j=e5>.

the buyer may not have full market power, and the degree of competition will affect the outcome for the farmers. In some cases an apparent monopsony may not be a de-facto monopsony, as the incumbent can only keep out potential competitors by offering competitive prices, or other benefits to the farmers, such as low cost, or high quality, inputs. Any analysis of contract-farming will thus have to be context specific, and attempt to identify any lock-in mechanisms that the buyer may enforce.

In sum, contract farming may solve some of the market failures that we have discussed earlier, since large buyers may provide credit and new technologies, including by way of new inputs and seed varieties, as well as coordination on transportation and market access. The potential cost is the market power of large buyers, which in turn may be counteracted by farmer organization. Large buyers may not only affect prices, they may force new technologies upon the farmers, adding risk that they would otherwise not take on. To the extent that the buyer can insure the farmers against the risk this may again be turned into a positive. The benefits of contract farming will thus depend on the implementation, and with many potential pitfalls on the way. This far there are not many studies that credibly identify the impacts of contract farming⁴⁷.

5.2.4 Index insurance

While land titling and contract farming attempt to copy institutions that appear to work in more developed economies, index insurance can be considered a novel approach to a market failure. Agricultural insurance exists in rich countries, but is less developed in poor countries, where many people cannot afford the premiums needed for private insurance in an economy where claims may be hard to verify. The underlying problem is, as with all insurance, asymmetric information. It is difficult for an external insurance company to verify whether a claimed bad harvest in fact happened, or whether the farmer just made some bad decisions, or did not put in the necessary efforts. Local mutual insurance mechanisms exist, and will to some extent

⁴⁷ This is a main conclusion in Barrett, C.B. et al. (2012), and there are not many later studies that would change this conclusion. The main problem with identification is that the most efficient farmers will tend to self-select into contract-farming, since this may provide new opportunities, and we thus do not have a good control group of equally efficient farmers that do not participate.

cover the needs of the farmers, in particular when only a few people get hit by idiosyncratic shocks every year. The neighbors that observe that this is not the farmer's fault will help out knowing that another year the favor will be returned.

The main problem appears if many farmers in a village are hit simultaneously, this will require insurance mechanisms that cover larger areas. Then we are back in the asymmetric information case where one will need to verify claims from full villages, rather than individual claims. The index insurance scheme is set up to solve this problem. Basically villages that are hit hard by negative weather shocks, which can be measured from afar, will get a payment that covers some of the loss.

Since farmers may be hit differently by such aggregate shocks, even this insurance scheme will meet many of the same problems as we find in standard insurance markets. Farmers who know they are likely to be hit harder than what they expect to get from the scheme will not be willing to pay for the insurance⁴⁸. As a result the scheme will be under-funded, which in turn explains why the product has not developed by itself. The scheme may still be an effective form of social protection, compared to alternative welfare schemes in rural areas, and thus lend itself to donor funding⁴⁹. Due to the low uptake, there is still not much research on the impacts, and the literature focuses instead on ways to improve the schemes, and how research should systematically investigate different design elements⁵⁰.

5.3 Learning and adoption of new technologies

Above we have discussed how technological progress, whether it happens in the urban or directly in the rural sector, will lead to economic growth and thus structural transformation where people leave agriculture to produce other goods and services

⁴⁸ This was pointed out already in (one of) the first discussions of area-based insurance: Halcrow, H.G. (1949). Actuarial structures for crop insurance. *Journal of Farm Economics*. 31(3): 418-443.

⁴⁹ For a discussion of variations on delivery of weather-based insurance or emergency aid that also summarizes the index-insurance literature going back to Halcrow (1949), see: Smith, V.H. (2016). *Producer Insurance and Risk Management Options for Smallholder Farmers*. *World Bank Research Observer*. 31(2): 271–289.

⁵⁰ See: Jensen, N. and Barrett, C. (2017). *Agricultural Index Insurance for Development*. *Applied Economic Perspectives and Policy*. 39(2): 199–219; Carter, M.R., de Janvry, A., Sadoulet, E. and Sarris, A. (2014). Index-based weather insurance for developing countries: a review of evidence and a set of propositions for up-scaling. FERDI Working Paper 112; or for a more technical discussion: Carter, M.R., Cheng, L., and Sarris, A. (2016). Where and how index insurance can boost the adoption of improved agricultural technologies. *Journal of Development Economics*. 118: 59-71.

that people will demand as their incomes increase. As people use a smaller fraction of their income on food, while farmers want to keep up with the rest, the number of farmers will decline, and as a result agricultural production becomes more capital-intensive through mechanization.

5.3.1 Production per unit of land and labor

While land yields for traditional products such as rice, wheat and maize are higher in the developed world, the value added per worker is many times higher. While farmers in Africa and South-Asia have very small plots of land with extensive use of labor, farmers in the USA will own very large and mechanized farms. As a result the value added per worker in the USA is USD 75 000 per year, while it is USD 400 per year in Malawi⁵¹.

At the same time, the land yield for maize, the staple food of East-Africa, was about 2 tons per hectare (Figure 6), while it was about 10 tons per hectare in the USA, which is also a major producer⁵². For other staples the difference in yields are smaller: the rice yield in the USA is about 8.5 tons , while it is 5.5 tons in Viet Nam, 4.5 in Bangladesh, 3.5 in India, 3 in Ethiopia, and 2 tons in Malawi. For wheat the yields do not vary much, with 3 tons in the USA, India, and Bangladesh. In East-Africa, Kenya sometimes also reaches 3 tons, while Ethiopia is in the 2-2.5 range, and Malawi produces about 1.5 tons. Thus while output per worker is much higher in developed countries, the land yield is also higher, but for some countries and products they are comparable, although the technology used is very different.

The catching up in yields in some developing countries show up also in the aggregate, with two-thirds of the world's agricultural output now being produced in developing countries, up from 42% in 1961⁵³. In Africa the increase in yields varies between countries, with the largest increase in Rwanda and Ethiopia, as illustrated by the maize yields in Figure 6. Yields in the developing world are now the same as in the

⁵¹ World Development Indicators.

⁵² FAO-statistics. The production of course varies from year to year. The FAO data is consistent with micro data, as shown in: Gollin, D., Lagakos, D. and Waugh, M.E. (2014). Agricultural productivity differences across countries. *American Economic Review*. 104(5): 165-170.

⁵³ The findings reported in this paragraph is taken from Fuglie, K. and Wang S.L. (2012). Productivity growth in global agriculture shifting to developing countries. *Choices*. A publication of the Agricultural & Applied Economics Association. 27(4): 1-7.

developed countries in the 1960s, and with increased incomes everywhere, there is also a change in the composition away from staple food towards high value crops. The growth in yields is the result of mechanization (input intensification), and more, or less, embodied technological progress, with national level agricultural research capacity being a main factor in the countries leading the progress.

Knowing that the transition to mechanized agriculture will follow the process of economic growth and structural transformation, as we also observe at the regional level within countries, is there any room for development policy to speed up the process? We have already concluded that any technological progress will lead to growth in both the urban and rural sector, and investments in the rural sector will directly benefit the surplus labor that still primarily lives in rural areas. It also appears that countries, and regions within countries, take up new technologies in a sequential manner, which potentially allows for learning:

We have seen that there are significant differences in yields between neighboring countries in East-Africa. And we have mentioned the variation in mechanization in Nepal, where in some districts in the plains most farmers use tractors, while in others this is less common. In India there are large differences in the yields of the main staple crops between states, despite that the agricultural potential appears similar⁵⁴. Today both the rice and wheat yields in Punjab are the double of Bihar⁵⁵. The pattern is an old one, despite that we know people have migrated from Bihar to Punjab for seasonal work in agriculture for decades⁵⁶. There must be some underlying constraints that explain why farmers in Bihar do not pick up the techniques they observe in Punjab, and similarly in Africa, why yields are so much higher in Kenya than in Malawi.

⁵⁴ Bihar, which is today the less productive state, is located in the Gangetic plains, with Gandak and Koshi as the main river basins. The potential yield of rice is estimated to 9.7 tons in Bihar, as compared to 10.6 tons in Punjab, and the wheat potential is estimated to 6.7 tons in Bihar, as compared to 7.7 tons in Punjab: Aggarwal, P.K.; Talukdar, K.K. and Mali, R.K. (2000). Potential yields of rice-wheat system in the Indo-Gangetic plains in India. Rice-Wheat Consortium Paper Series 10. New Delhi.

⁵⁵ The 2014/15 yield was 3.8 tons for rice and 4.3 tons for wheat in Punjab, and 1.9 tons for both rice and wheat in Bihar: Agricultural statistics at a glance 2016. Directorate of Economics and Statistics. DAC&FW. Government of India.

⁵⁶ Today the major migration stream is from Bihar to Delhi, but historically agricultural labor in Punjab was important: Datta, A. (2016). Migration, remittances and changing sources of income in rural Bihar (1999-2011). *Economic and Political Weekly*. 51(31): 85-93. For recent migration figures, see the Economic Survey 2016-17. Chp. 12. Ministry of Finance. India. We also know this from our own fieldwork in eastern Nepal, where landless laborers in the plains also used to travel to Punjab.

5.3.2 Adjustments to local conditions

One will need irrigation, fertilizers, *and* modern seeds to significantly increase agricultural yields. Irrigation will in many contexts be the critical factor as it allows for multiple crops per year, as well as the use of modern seeds and fertilizers. In Africa, however, we rarely observe that farmers use all three inputs at the same plot⁵⁷. Fertilizers and chemicals alone are, however, in use in some countries, particularly those with considerable input subsidy programs (in particular Malawi and Nigeria), and beyond cash crops these inputs are found also in maize production. The lack of a combined use of irrigation, modern seeds and fertilizers indicates that there is room for policy, potentially in the form of research and extension services to identify and advice on the optimal local mix. And the apparent importance of input subsidies also indicates that policy matters⁵⁸. We will get back to the issue of policy in chapter six, but here only note that we still have surprisingly limited information on what policies work, beyond general advice on research, extension services, and the potential positive effects of input subsidies. At this stage we conclude that most African farmers still use traditional technology, with the exception of uptake of fertilizers in some regions. Thus in most African countries there appears to be a large potential for adoption of new technologies, which we will discuss in the next section.

In South-Asia, irrigation allows for an early extra rice harvest at the beginning of the rainy-season, and a wheat harvest during the winter. The irrigated area in India, which allows for such double, or triple, cropping, has recently increased and thus contributed significantly to the recent increase in production of staple food⁵⁹. The green revolution in India has been quite successful when it comes to wheat, not necessarily in the sense that production has reached its maximum everywhere, the variation in yield indicates that this may not be the case, but in the sense that a few types of modern varieties dominate the market, and the growth of this dry-season crop

⁵⁷ The information on input use in Africa is taken from: Sheahan, M. and Barrett, C.B. (2017). Ten striking facts about agricultural input use in Sub-Saharan Africa. *Food Policy*. 67: 12-25.

⁵⁸ Some may be concerned that increased use fertilizers may have environmental consequences, but the use in Africa is still at a very low level as compared to Asia: de Janvry, A. and Sadoulet, E. (2010).

⁵⁹ Rada, N. (2016). India's post-green-revolution agricultural performance: what is driving growth? *Agricultural Economics*. 47: 341-350.

is fueled by irrigation in most places⁶⁰. Most of the wheat is produced in a few northern states (Uttar Pradesh (UP), Punjab and Haryana produce 67%), but with yields in UP being much lower than in the two other states.

The major staple food of rice is produced everywhere in India, with West-Bengal, Andhra Pradesh, UP and Punjab as the main producers (with about 50% of the production). The use of modern varieties and irrigation is less wide-spread, and the profitability of modern techniques seems to be more dependent on local conditions, which in turn explains why they do not spread as fast as for wheat⁶¹.

5.3.3 Factors that influence adoption

As indicated above, local conditions are the main factors that may explain why new, and improved, techniques do not spread as fast as we may expect. In many parts of Africa land is still abundant, which means that even poor people may have access to sufficient land for their own survival. Area expansion⁶² has in fact been a main source of growth in staple food production in Africa⁶³. As most people produce their own staple food, and there are long distances to the nearest towns, rural development will depend as much on non-farm economic activities, potentially including preparation and transportation of agricultural outputs⁶⁴. Although each farmer may have limited incentives, and means, to invest in new techniques, this may still be profitable for the society at large, both within staple food production and potentially for some cash crops. In South-Asia, there is also, as described above, a potential for learning, and uptake of improved techniques, across regions. Again both for the rice and wheat staples, but

⁶⁰ Shreedhar, G. et al. (2012). A review of input and output policies for cereals production in India. IFPRI Discussion Paper 01159; and: Munshi, K. (2004). Social learning in a heterogeneous population: technology diffusion in the Indian green revolution. *Journal of Development Economics*. 73: 185-213.

⁶¹ Munshi, K. (2004).

⁶² de Janvry, A. and Sadoulet, E. (2010). Agriculture for development in sub-Saharan Africa: An update. *African Journal of Agricultural and Resource Economics*. 5(1):194-204. This is the introduction to a special issue on African agriculture.

⁶³ Some may be concerned that expansion of agricultural areas may lead to a reduction in forest cover. This is the case in some places, but in general in Africa there is only a limited decline in forest area. FAO-statistics show that the percentage of agricultural land under permanent crops increased from 1.5% in 1961 to 3% in 2015, while the percentage of agricultural land in total land increased from 35% in 1961 to 38% in 2015. Regarding forest, the FAO only reports forest cover from 1990 onwards, which has declined from 24% to 21%, while agricultural land increased from 37% to 38% during these years. We discuss this issue in some more detail in chapter 6.

⁶⁴ Barrett, C.B., Christiansen, L., Sheahan, M. and Shimeles, A. (2017). On the structural transformation of rural Africa. *Journal of African Economies*. 26: i11-i35.

potentially also for high value products. The literature on adoption is increasing, and we will review some of the findings⁶⁵.

The lack of adoption in rain-fed areas may be a poverty trap, where people with less resources cannot finance the use of new techniques, cannot take the necessary risks, have longer distances to the markets, lack the knowledge, or the general level of education needed⁶⁶. Expansion of irrigated areas may, in itself, increase learning, as the payoff from modern seeds and fertilizers will be higher with irrigation. Similarly there may be progress also within the rain-fed regime, if more profitable, or less risky, methods were available. While lack of rain is a problem during winter, in the summer these areas may have the opposite problem of floods, in particular in the low-lying areas of South-Asia. A randomized trial of a new flood-tolerant rice variety in Orissa found that not only is the downside risk reduced, the farmers also invest more when they know that the downside outcome is less likely, which increases the outcome in the good years as well⁶⁷. Thus in this case, which may also be relevant for other rain-fed areas, the lack of adoption is basically the result of lack of appropriate (risk-reducing) technologies. It was also found that introduction of the new seeds by way of farmer field days was efficient, a method where early adopters shared their experience, and farmers could observe the crops in the field⁶⁸.

In sum, adoption depends on the profitability, and availability of new techniques. Thus there is a need for development of seeds that are more resistant to variation in weather conditions, as well as transfer of knowledge of new techniques to the farmers. This includes the adoption of so-called climate-smart agriculture⁶⁹. With

⁶⁵ There is a long history of agricultural experiments that we have not reviewed, the focus here is on uptake of any new technology, or technique, that may have been developed in the first place by use of agricultural experiments. The study of uptake may in itself be by use of experiments, but with the subjects being farmers, or extension workers, and not plots. Many such experiments are reported at: www.atai-research.org, and in: de Janvry, A., Sadoulet, E. and Suri, T. (2017). Field experiments in developing country agriculture. Handbook of Economic Field Experiments. Chp. 5. Vol 2: 427-466.

⁶⁶ This may result from multiple market failures: Sheahan, M. and Barrett, C.B. (2017).

⁶⁷ Emerick, K., de Janvry, A., Sadoulet, E. and Dar, M.H. (2016). Technological innovations, downside risk, and the modernization of agriculture. *American Economic Review*. 106(6):1537–1561.

⁶⁸ Emerick, K., de Janvry, A., Sadoulet, E. and Dar, M.H. (2016). Enhancing the diffusion of information about agricultural technology. Tufts University.

⁶⁹ For a broad introduction see: Dinesh, D. et al. (2017). The rise in climate-smart agriculture strategies, policies, partnerships and investment across the globe. *Agriculture For Development* 30: 4-9. For a more detailed discussion, including on the gender aspects of climate change and adaptation, see: Kristjanson, P. et al. (2017). Addressing gender in agricultural research for development in the face of a changing climate: where are we and where should we be going? *International Journal of Agricultural Sustainability*. 15(5): 482-500.

respect to the adoption of new techniques it appears that model farmers function better than extension workers in many contexts⁷⁰. With respect to development of new seeds, there is a need for improved research capacity, both at the global, and at the local level⁷¹.

In irrigated areas of India, farmers may adopt modern techniques for both wheat and rice. And as discussed, adoption of wheat has been faster than rice, basically because there is less to learn from your neighbor when it comes to rice production. Again we find that there is a perfectly rational explanation for why farmers do not adopt. In fact, it is found that farmers appear to take on extra costs to learn from own experimentation: if they decide to adopt modern varieties, then they allocate more than one should expect, based on cost estimates, of their land to the new seeds, allowing for more learning⁷². The lack of learning across plots imply a need for a different form of extension services, farmers may need to learn to adjust to own conditions, rather than learning a new technique that may have worked elsewhere. Thus in this context, there is an argument for localized extension services, but not necessarily local model farmers.

In general, the lack of adoption of new techniques may be perfectly rational, and variation in adoption similarly so. Farmers may have different costs and benefits of a new technique, and any correlation between new technologies and farm profits may be explained by factors beyond the year-to-year production decisions of the farmers. When a completely new technology, or produce, is introduced, then farmers do learn: some farmers will start, and if the neighbors see that it works, they will copy the technique within a few years⁷³. The leaders, or the model farmers we discussed above, may have more education, they are wealthier, and they have personality traits, including risk-preferences, that appear to matter⁷⁴. Risk, and in particular risk-

⁷⁰ This paragraph is to a large extent based on de Janvry, A., Emerick, K., Sadoulet, E. and Dar, M. (2016). The agricultural technology adoption puzzle: what can we learn from field experiments? FERDI-WP-178.

⁷¹ Barrett, C.B., Christiansen, L., Sheahan, M. and Shimeles, A. (2017).

⁷² Munshi, K. (2004).

⁷³ Foster, A.D. and Rosenzweig, M.R. (2010). Microeconomics of technology adoption. *Annual Review of Economics*. 2(1): 395-424.

⁷⁴ Ali, D.A., Bowen, D. and Deininger, K. (2017). Personality Traits, Technology Adoption, and Technical Efficiency. Evidence from Smallholder Rice Farms in Ghana. World Bank Policy Research WP 7959; and: Shimamoto, D., Yamada, H. and Wakano, A. (2017). The Effects of Risk Preferences on the Adoption of Post-Harvest Technology: Evidence from Rural Cambodia. *Journal of Development studies*. Forthcoming.

aversion, is an essential explanation, as some new techniques may increase profit and risk at the same time⁷⁵.

6. Agricultural policies

In the previous chapters we have discussed how increased productivity in agriculture will increase incomes for the rural poor⁷⁶, and thus improve food-security and nutrition. We have also discussed how agriculture can preferably be combined with rural non-farm economic activities, including preparation, transportation and sale of agricultural products. Higher rural incomes will benefit everyone, including people who are less likely to get work in the urban sector. Higher productivity will also release labor from the rural sector and fuel urban economic growth. We have seen that agricultural productivity is constrained by a number of factors, ranging from the immediate ones of lack of infrastructure (irrigation, roads) and modern techniques that are adjusted to local conditions (raising the need for agricultural research, extension services and access to modern seeds and fertilizers), to underlying factors (basic education, training, insurance, credit, control of land). In this chapter we will summarize the main policy implications, including sections where we summarize the implications for nutrition and food security, private sector and market integration, gender aspects, as well as climate and the environment.

6.1 Infrastructure and basic government services

We know that public goods will tend to be underfunded without government intervention. Local public goods, such as small scale irrigation, may be well organized by local user groups⁷⁷, but large scale irrigation, as well as roads, require government coordination and funding, in particular in poor rural areas. Insurance and credit markets also exist without government intervention, but regulation can improve both

⁷⁵ Barrett, C.B., Moser, C.M., McHugh, O.V. and Barison, J. (2004). Better Technology, Better Plots, or Better Farmers? Identifying Changes in Productivity and Risk among Malagasy Rice Farmers. *American Journal of Agricultural Economics*. 86(4): 869–888.

⁷⁶ And we know that the majority of the rural poor live in India, Nigeria and DRC, followed by a few other Asian countries, and a number of Sub-Saharan countries: World Bank (2015). *A measured approach to ending poverty and boosting shared prosperity*.

⁷⁷ This is, as mentioned earlier, well described by Ostrom, E. (2015).

access and price setting of these services⁷⁸. The same is the case for health services, which is basically also an insurance mechanism, while basic education tends to be underfunded both because people are poor, and may want their children to work, and because the benefits to the society, which need educated workers, may be larger than the family's own benefits.

6.1.1 Irrigation

We have seen how increased irrigation has been a main factor behind the growth in agricultural production in South-Asia. There is still room for improved irrigation, in particular in the eastern parts of the Gangetic plains, including Bihar, eastern UP and the plains of Nepal. India has extensive experience with irrigation and intensive use of inputs from other states, and is likely to manage well without external support. In Africa, only a small fraction of available agricultural land is irrigated⁷⁹. Even the extended areas that are equipped for irrigation constitute only 6% of the cultivated areas⁸⁰. These areas can, however, be doubled with the use of available simple technology⁸¹. This will, however, require government coordination and funding, and even with a doubling, or more, the irrigated area will still be limited. Thus, as we shall discuss below, there is also need for improved techniques for rain-fed agriculture.

⁷⁸ Asymmetric information is a basic underlying problem hindering competitive markets: insurance and credit institutions cannot fully observe farmers decisions or health conditions leading to a need for universal health coverage and well designed insurance mechanisms. There are similar information problems in the labor and land markets, which to some extent are solved by internalizing decisions within family farms. There is now a large literature on the implications of asymmetric information for labor, land, insurance and credit markets, as well as the provision of health services. This is all based on some underlying principles for the need for government interventions that is well described, although technically so, in: Greenwald, B.C. and Stiglitz, J.E. (1986). Externalities in Economies with Imperfect Information and Incomplete Markets. *Quarterly Journal of Economics*. 101(2): 229-264.

⁷⁹ Sheahan, M., and Barrett, C.B. (2014) Understanding the Agricultural Input Landscape in Sub-Saharan Africa: Recent Plot, Household, and Community-Level Evidence. World Bank Policy Research Paper 7014.

⁸⁰ You, L. et al. (2011). What is the irrigation potential for Africa? A combined biophysical and socioeconomic approach. *Food Policy*. 36(6): 770-782.

⁸¹ Xie, H., You, L., Wielgosz, B. and Ringler, C. (2014). Estimating the potential for expanding smallholder irrigation in Sub-Saharan Africa. *Agricultural Water Management*. 131: 183-193. For an introduction to the technologies considered, and projects implemented, see: <http://awm-solutions.iwmi.org/small-private.aspx>.

6.1.2 Roads

In particular in Sub-Saharan Africa there is a massive need for investments in rural infrastructure of all kinds⁸². For agriculture and food security, roads are particularly important. Staple food has to be transported to deficit regions, and we know that most African countries are in fact food importers⁸³. And staple and cash crops need to be transported to the markets to generate incomes for farmers who are able to produce a surplus. The importance of road transport is well illustrated by the fact that international oil prices have a larger effect on local maize prices than does the international price for maize⁸⁴. Thus fuel costs matter more than the external markets for the product itself.

Roads are potentially even more important for alternative non-agricultural income possibilities, both in terms of transportation of inputs and outputs, as well as for access to external labor markets. While the main highways are good in many African countries, rural roads are still in bad conditions⁸⁵.

6.1.3 Government services

In addition to physical infrastructure, there is a need for improved health and education services in rural Africa. There is an obvious need for improved quality of life, or life at all, as child mortality is still high in many African countries (about 8% die before age five), and child malnutrition is still high (about 35%)⁸⁶. But beyond improved lives, both good health, nutrition and basic education are necessary to build the human capital needed within the agricultural sector, as well as in the non-agricultural economic activities that will be needed to build both rural and urban sectors in poor countries. Within agriculture it is found that the level of education is a main correlate of take up of new technologies. Educated people may, of course, take up new technologies for completely different reasons, including curiosity and the ability to tackle risk and fund new investments. Education may thus not have a causal impact

⁸² Barrett, C.B., Christiansen, L., Sheahan, M. and Shimeles, A. (2017).

⁸³ de Janvry, A. and Sadoulet, E. (2010).

⁸⁴ Dillon, B.M., Barrett, C.B. (2016). Global Oil Prices and Local Food Prices: Evidence from East Africa. *American Journal of Agricultural Economics*. 98(1): 154–171.

⁸⁵ For a review of the literature on African roads, see: Beuran, M., Gachassin, M. and Raballand, G. (2015). Are There Myths on Road Impact and Transport in Sub-Saharan Africa? *Development Policy Review*. 33: 673–700.

⁸⁶ Data are from World Development Indicators.

on up-take. But for new technologies there is reason to believe that basic education will improve the learning process⁸⁷.

6.2 Private sector and market integration

Private sector development has become a catch-phrase in development policy. As most farms are privately run, although sometimes only based on user-rights and not ownership of land, agriculture contributes with the majority of private sector jobs in poor areas of the world, as described in the 2008 World Development Report. The private sector is also essential throughout the value chain for agricultural products, from direct sales by farmers to transport, processing and retail sales. All these markets function relatively well without government or donor intervention. We should, however, be aware of the dangers of large private actors, which we have discussed in the section on contract farming, as large buyers may get monopsony power. This may, however, be counteracted by farmer organization.

In many countries we observe that the private sector plays an important role in developing new value chains, in particularly for high-value products. This does not, however, imply that government or donor funding is needed. On the contrary, one may risk that governments subsidize competitors with less chances of success. The government should rather provide public goods such as infrastructure and basic government services, and contribute to a level-playing field where also small producers, transport companies, processing firms and retailers can compete⁸⁸. To summarize, the government should facilitate growth of the agricultural sector, which in most places is private. Roads and water-ways are essential for market integration, while farmer cooperatives may help farmers coordinate processing and sales, in particular in competition with large-scale private firms that may operate in the supply chain.

Market integration may also be important across borders, and in particular so for border regions and small countries, where trade may be essential for food security.

⁸⁷ For a discussion of the complicated relations between education, learning and new technologies, see: Foster, A.D. and Rosenzweig, M.R. (2010).

⁸⁸ See the conclusions on page 133 onwards in chapter five on "Bringing agriculture to the market" in the 2008 World Development Report.

There is, for example, extensive trade in rice between the South-Asian nations. While for Sub-Saharan Africa we shall expect domestic production to be the essential factor for many years to come⁸⁹.

6.3 Research and extension services

As discussed, the main constraint on improved agricultural production in many places is irrigation. Adoption of irrigation, and the complementary inputs of fertilizers and modern seeds, will in South-Asia normally imply adoption of techniques that are already well known within the country. For rice there is, however, a need for local adjustments all the way down to the plot level, while intensive wheat production is more easily adopted. This implies that extension services are needed all the way down to the local level, with local experts that can help farmers learn from the experiences the farmers have on their own plots. There is also a need for continued research on seeds, use of fertilizers, and pesticides within the intensive productions of South Asia, and there appears to be a well developed local capacity⁹⁰.

We focus here more on India than other South-Asian countries because India still has the largest number of poor people in the world. And they tend to live in the eastern states where people still depend on rain-fed agriculture. Irrigated areas are on the increase, but there is still a need to develop rain-fed rice production in the eastern states of Bihar, Orissa, eastern UP, and Chhattisgarh. There is a need to develop and spread information on seeds that are more resistant to drought and floods, reflecting the needs in different parts of the country. Rain-fed rice production will imply too much rain in some parts, and too little rain in other parts⁹¹.

While Indian farmers can learn from their neighbors either within the village, or further afield, Sub-Saharan African farmers will have very limited information on intensive farming. Some farmers, and most of them living in a few countries with input

⁸⁹ Barrett, C.B., Christiansen, L., Sheahan, M. and Shimeles, A. (2017). "On the Structural Transformation of Rural Africa". *Journal of African Economies*.

⁹⁰ For more details on India: Shreedhar, G. et al. (2012). A review of input and output policies for cereals production in India. IFPRI Discussion Paper 01159

⁹¹ For a paper on the problems of flood-prone rice production in India, see: Dar, M.H. et al (2017). Transforming rice cultivation in flood prone coastal Odisha to ensure food and economic security. *Food Security*. 9(4): 711 - 722. For a project on the problems of drought-prone rice production in the same state, see: www.povertyactionlab.org/evaluation/impact-drought-tolerant-risk-reducing-rice-yield-and-farmer-welfare-india

subsidy programs, will use fertilizers intensively, but very few farmers combine irrigation, fertilizers and modern seeds. There is still a large potential for R&D on localized techniques, as well as diffusion of knowledge. It is found that model farmers may be as important as local extension workers⁹². Farmers learn more from their peers, or at least farmers that appear to work under similar conditions. Extension workers, on the other hand, may promote yield maximizing techniques, rather than profit- or utility-maximizing techniques⁹³. An example of the latter may be the attempt to introduce the so-called SRI technique, an apparently very productive, but labor intensive and more risky, rice production technique, which is promoted in many countries of the world⁹⁴.

6.4 Subsidy and credit programs

Financial support can take many different forms, ranging from input subsidies to subsidized insurance and credit programs, which in the extreme form may be pure safety-nets, or transfer programs. Studies have shown that input subsidies are not the best use of funds allocated to agricultural development, roads, R&D and education appear to have larger impacts⁹⁵. The literature points, though, to a number of ways the input subsidy programs in Africa can be improved, in particular the combination with broader soil management systems. We focus here on Africa, although the findings are also applicable to rain-fed areas of South-Asia, from which some of the findings are in fact based.

One should target the farmers, and regions, that may benefit the most. Here there appears to be some trade-off. One may argue that fertilizer subsidies should go to farmers who would otherwise not purchase fertilizers, preferably by use of vouchers to build up the private supply channels⁹⁶. Potentially in contrast to this advice, it

⁹² de Janvry, A, Sadoulet, E. and Suri, T. (2017). Field experiments in developing country agriculture. Handbook of Economic Field Experiments. Chp. 5. Vol 2: 427-466.

⁹³ Very dedicated local farmers may be good role-models, but the neighbors will also observe the time and money they put in, as well as the variation in yields, and may be perfectly rational in sticking to the old ways.

⁹⁴ For one study from Africa, see: Moser, C.M. and Barrett, C.B. (2003). The disappointing adoption dynamics of a yield-increasing, low external-input technology: the case of SRI in Madagascar, *Agricultural Systems*. 76(3): 1085-1100.

⁹⁵ For a review, see: Jayne, T.S. and Rashid, S. (2013). Input subsidy programs in sub-Saharan Africa: a synthesis of recent evidence. *Agricultural Economics*. 44: 547-562.

⁹⁶ Jayne, T.S. and Rashid, S. (2013).

appears that fertilizers are most useful on otherwise fertile soil⁹⁷. Now, there is not necessarily a conflict, poor people may maintain other nutrients as well as the wealthy, but soil depletion is a serious concern in Africa. Soil carbon, balanced content of phosphorus and nitrogen, including through natural fixation, and micronutrients (zinc, iodine and selenium) are all essential for improved production, as well as nutritional content of the produce. There is thus need for a balanced soil fertility management that combine the use of inorganic fertilizers, supplemented with micronutrients, and traditional soil management⁹⁸. Management plans, and support, should be adjusted to local conditions, which again reinforces the need for local R&D.

It appears that access to credit is not a major constraint, people finance inputs from other income sources. Insurance appears to be a more essential financial product. People do self-insure, by selecting less risky techniques, and by way of village level mutual insurance mechanisms. Negative shocks that affect most people in the same area will however not be covered by informal insurance, and it appears that there should be a demand for formal insurance, including index insurance. Studies show, however, that there is not sufficient demand at actuarial rates, thus some sort of subsidy is needed for insurance programs to be implemented. But this, in turn, means that the focus should maybe shift from agricultural insurance, to more general social protection programs⁹⁹, whether these are pure emergency aid programs, or more general conditional, or unconditional, cash or workfare programs¹⁰⁰.

6.5 Nutrition and food security

Above we have discussed how agricultural policy is also good general policy as it fosters economic growth and poverty reduction, and we have discussed how general policies, such as investments in infrastructure, education, health and social protection foster agricultural growth. Access to markets, education, good health, development and

⁹⁷ Barrett, C. B. and Bevis, L. E. (2015). The self-reinforcing feedback between low soil fertility and chronic poverty. *Nature Geoscience*. 8: 907–912.

⁹⁸ Barrett, C. B. and Bevis, L. E. (2015).

⁹⁹ See again: Smith, V.H. (2016). Producer Insurance and Risk Management Options for Smallholder Farmers. *World Bank Research Observer*. 31(2): 271–289.

¹⁰⁰ It is beyond the scope of this report to discuss such programs. There are many reviews available, for one, see: Niño-Zarazúa, M., Barrientos, A., Hickey, S. and Hulme, D. (2012). Social Protection in Sub-Saharan Africa: Getting the Politics Right. *World Development*. 40(1): 163-176.

spread of knowledge, are all necessary for increased agricultural productivity. In remote areas we have seen that broad-based development programs are necessary to improve both agriculture and non-farm economic activities, which includes processing and distribution of agricultural products. And we have seen that these policies may have to be supplemented with social protection programs to ensure local income and thus food security¹⁰¹. We have also seen that increased agricultural production, and improved variation in the diet, may not be sufficient for improved nutrition¹⁰². This is likely to reflect unequal intra-household allocation of food, in particular while children are small, including the prenatal period when children depend on their mothers, who may themselves be malnourished. It is also likely to reflect poor sanitation and health conditions, which weakens the body, and in particular leads to low uptake of nutrients during bouts of diarrhea. Thus, also for nutritional uptake, broad development programs are needed, including investments in sanitation, health and education.

Within these sectors, some specific interventions appears to be effective, such as improved toilets, safe drinking water, and nutritional supplements (including via the soil¹⁰³). In time of crisis, there may also be a need for direct food-aid, but any such aid should support local food production, and avoid permanent inflows of subsidized food that may crowd out local food production¹⁰⁴.

6.6 Climate and the environment

In Figure 3 we showed how cereal production has kept up with population growth also in poor parts of the world over long periods of time. Despite pessimism in the early 1970s, following the Limits to Growth report¹⁰⁵, there has been a stable production of

¹⁰¹ For a recent discussion of the coordination of general and specific policies, see: Tirivayi, N., Knowles, M. and Davis, B. (2016). The interaction between social protection and agriculture: A review of evidence, *Global Food Security*. 10: 52-62.

¹⁰² Deaton (2013).

¹⁰³ Barrett, C. B. and Bevis, L. E. (2015). The self-reinforcing feedback between low soil fertility and chronic poverty. *Nature Geoscience*. 8: 907–912.

¹⁰⁴ The evidence for crowding-out, which we should expect according to theory, is not very strong, see for example: Abdulai, A., Barrett, C.B. and Hoddinott, J. (2005). Does food aid really have disincentive effects? New evidence from sub-Saharan Africa. *World Development*. 33(10): 1689-1704. But one should rely upon local, or regional, purchases adjusted to local seasonality in production: del Ninno, C., Dorosh, P.A., and Subbarao, K. (2007). Food aid, domestic policy and food security: Contrasting experiences from South Asia and sub-Saharan Africa. *Food Policy*. 32(4): 413-435.

¹⁰⁵ Meadows, D.H. et al. (1972). *The Limits to Growth*. Universe Books.

cereals per capita since then. Today the main threat is considered to be climate change with increasing temperatures and changes in rainfall, with the rain being expected to increase in some regions and decline elsewhere¹⁰⁶. The implications vary between regions of the world, depending on local agricultural systems and the possibility of adaptation to new weather conditions. Rain-fed agriculture in Africa will be particularly vulnerable to increases in temperature and a decline in rainfall, while areas with irrigation may benefit from increased rainfall in some parts of the world¹⁰⁷. The climate-change literature will, naturally, attempt to isolate the impacts of climate change on agricultural production, while rarely reporting the underlying increase in production. While we have to keep in mind that even if climate change leads to a decline in the trend, the total production of cereals per capita may still keep up with the population in the future:

FAO estimates that by 2050 the world needs to produce 50% more food, and concludes that: "Meeting the increased demand should not be a major challenge, if past achievements are a guide"¹⁰⁸. Prior to this conclusion the FAO report has a detailed analysis of the climate-change literature showing a decline in production due to climate change, which will thus be smaller than the increasing trend in production that is described in the following sections.

Poor farmers have continuously adapted to new conditions, including ever changing weather conditions, as well as new farming techniques and demand patterns. The role of agricultural policies should be to help the farmers in particular to deal with market failures that add to their burden of being poor, as discussed throughout this report. These policies include provision of infrastructure, such as roads and irrigation, and new knowledge by way of research and extension services. This will, in turn, include any new practices related to environmental degradation, such as integrated soil

¹⁰⁶ Other related environmental threats are water scarcity, including potential contamination of ground-water, and soil micronutrient deficiencies (Barrett, C. B. and Bevis, L. E., 2015).

¹⁰⁷ For reviews see: Porter, J.R. et al. (2014). Food security and food production systems. In: *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. And also see: Dell, M., Jones, B.F. and Olken, B.A. (2014). What Do We Learn from the Weather? The New Climate–Economy Literature. *Journal of Economic Literature*. 52(3): 740-798.

¹⁰⁸ FAO (2017). *The future of food and agriculture. Trends and challenges*. Rome.

management, irrigation, and so-called climate-smart agriculture, which all are variations on general good practices for smallholders.

Above we have discussed expansion of agricultural land, which has been a main driver of increased agricultural production in Africa. In theory this expansion may lead to less forest, which in turn may affect the climate and disturb the local environment, including wildlife habitats. In reality, however, the reduction in forest area has been minimal in Africa. This is illustrated by maps even in publications that focus on the negative implications of land degradation¹⁰⁹. From these maps we can see that most of Africa has either no forest, or no change in the forest cover. Most of Africa is covered by grassland, which also has been stable over time¹¹⁰. This does not imply that further growth in agricultural production must be by way of area expansion, on the contrary, also Africa will need improved yields in the future¹¹¹.

6.7 Gender aspects

Traditional gender roles are still maintained in most agrarian societies. Men tend to do more off-farm work, while women do more household work in a broad sense, including catching of water and fire-wood, production of vegetables and other produce from plots near the house, as well as preparation and small-scale sales of food. The relative role of women versus men in food production, and food security, is hard to measure. Detailed time-diaries are now included in some surveys, which helps. Agricultural policies that may help improve women's position are far from straight forward to identify. And some of the gender-programming promoted by international donors may not be helpful. A number of myths prevail as documented by Cheryl Doss and co-authors¹¹². Quite often policies that support women will be policies that help their

¹⁰⁹ See in particular figures 9.7 and 9.8 in: Nkonya, E. et al. (2016). Economics of land degradation in Sub-Saharan Africa. Chp. 9 in Nkonya, E. et al. (2016). Economics of Land Degradation and Improvement – A Global Assessment for Sustainable Development. Springer Verlag. Another map is found as map 8.2 in the 2008 World Development Report.

¹¹⁰ This is the case even if we go back to the year 1900, although with important exceptions, in particular in West-Africa: Aleman, J.C. et al. (2018). Forest extent and deforestation in tropical Africa since 1900. *Nature Ecology & Evolution*. 2: 26-33.

¹¹¹ de Janvry, A. and Sadoulet, E. (2010). Agriculture for development in sub-Saharan Africa: An update. *African Journal of Agricultural and Resource Economics*. 5(1):194-204.

¹¹² There are many papers, but see in particular: Doss, C. et al. (2017). Women in agriculture: Four myths. *Global Food Security*. Article in press. And also see: Doss, C.R. (2018). Women and agricultural productivity: Reframing the issues. *Development Policy Review*. 36(1): 35-50.

households in general, including any male members. Most poor agricultural households are joint production units. And the exceptions, where the adult men may be missing, are normally a heterogeneous group. In some households the men have migrated for work elsewhere, while remitting money, while in other cases the woman may be divorced or widowed. Policies to support these relatively small groups of female-headed households will differ between categories, and also differ from policies that may help women in male-headed households. And, as Doss discusses, some of the more effective policies will lie outside the domain of agriculture, including building of roads and water pumps, as well as providing health care and education.

7. The role of Norwegian aid

There is specialization among the donors, both regional and sectorial. Norway, in particular, tend to focus on three to five topic areas in each of the main countries of development cooperation. In chapter two we described how agricultural aid is primarily going to Ethiopia and Malawi. In Ethiopia there are four core areas, with agriculture belonging to the first: Climate change and the environment; humanitarian aid; good governance and human rights; and education. In Malawi there are five areas: Education; health; agriculture, climate and food security; democratic governance; and culture. More broadly, education and governance are core areas of Norwegian development assistance in many countries, with other sectors such as health, energy and agriculture being important in some countries. Norway also gives extensive aid to climate initiatives, refugees, and private investments (via the Norfund investment fund).

7.1 Geographic focus

With the division of labor among donors, it is not obvious to what extent, and where, Norway should focus on agriculture. An overarching goal of Norwegian aid is, however, poverty reduction, and as we have discussed in this report, investments in agriculture will be a main pathway to economic growth and poverty reduction in countries still highly dependent on agriculture. Most of these countries are in Africa, and include

DRC, the Central African Republic, Mali, Niger, Tanzania, Ethiopia, Ghana, Rwanda, Burundi, and Malawi. Outside of Africa it includes Laos and Nepal¹¹³. Among these countries, some are already on a good path towards low levels of poverty, in particular Ethiopia and Ghana, while the World Bank expects the world's poor in 2030 to live in DRC (64 mill), Malawi (15 mill), and Burundi (12 mill), and also in other countries with a large share of the poor depending on agriculture (but with a lower agricultural GDP share): Nigeria (62 mill), Madagascar (26 mill), Kenya (15 mill), and Zambia (13 mill)¹¹⁴. Regarding the poor countries most dependent on agriculture, we may thus conclude that if the target is to participate in a growth process leading to poverty reduction, then Ethiopia and Ghana may be good choices. If the target is to help very poor countries, then Malawi would be a good choice, together with DRC and Burundi.

7.2 Smallholders or large farms?

This far Norwegian support has focused on smallholder farming, in line with the poverty focus of Norwegian aid. Most of the literature reviewed supports this policy. This does not imply that restrictions should be put on large-scale farming, in particular not in land abundant countries. Work as a farm laborer on a commercial farm may be a good way out of poverty for many people. General policies, such as roads, education and R&D are expected to have positive payoffs for both the small and large farm sectors. The commercial large farm sector will, however, not meet all the same constraints as smallholders. Commercial farmers will tend to have access to credit and formal insurance, and as a result also to machinery and irrigation. There is thus a need for general good economic policies, including in R&D, but not necessarily targeted support for the commercial sector¹¹⁵. And there is a need for a set of policies targeting smallholders and other poor people in remote areas.

¹¹³ According to table A1 of WDR (2008) all these countries have an agricultural GDP-share of 37% or more, and a value added per agricultural worker of less than USD 300.

¹¹⁴ The numbers are from: World Bank (2015). A measured approach to ending poverty and boosting shared prosperity.

¹¹⁵ For two different views on the role of commercial farming that still are not so different in their general policy prescriptions, see: Deininger, K. and Byerlee, D. (2012). The Rise of Large Farms in Land Abundant Countries: Do They Have a Future? *World Development*. 40(4): 701-714; and: Collier, P. and Dercon, S. (2014). African Agriculture in 50 Years: Smallholders in a Rapidly Changing World? *World Development*. 63: 92-101.

7.3 Norwegian support to local agricultural policies

We have discussed in this report how good agricultural policy is to a large extent good general policy. Poor people live in poor parts of the world, where there is need for better infrastructure (roads, irrigation, electricity), government services (health and education), and new technology that is adapted to local conditions through R&D. Poor people also meet a number of additional constraints just because they are poor, and can thus not afford to make many of the necessary investments in education, health, other insurance, irrigation, transportation, land and technology themselves. Rural development programs should thus attempt to simultaneously solve multiple constraints. Donors may here contribute with funding of major sectors such as roads, education, irrigation and health. And donors may contribute with knowledge, in particular in terms of research and extension services. Donors should, however, be careful and not crowd out existing services, whether that is well functioning extension services, local technologies, or local capital. In each case a detailed analysis is needed of where donors can make a difference in under-funded sectors, or in sectors where development, or transfer, of technology may make a difference. And many of these general policies will benefit the rural economy as a whole, keeping in mind that non-farm sectors, including processing and transportation of agricultural products, are equally important for poverty reduction.

7.4 Investments in R&D

Norway has a long tradition of research on rural development. It ranges from research within the natural sciences on tropical agriculture, via social science research on the conditions under which poor people live in rural Africa and Asia, to more macro-based analysis of structural transformation and sound macro-economic policy. Some research funding is allocated via the Research Council of Norway, while other research is conducted by university professors, and thus funded over regular university budgets. There has also been room for direct support to research collaboration between Norwegian institutions and their partners in the South, as well as unilateral support to institutions in the South. More recently, such research collaborations have become more competitive, and have either been organized as separate research programs

within the Research Council (such as INDNOR), or by way of competitive bids organized by Norwegian embassies. There is also support to international research organizations (such as CIMMYT).

Research collaboration adds value in both countries. Research institutions in the South may have limited access to the international research community, and one additional channel of collaboration will add value. For Norway the continuous presence of researchers in the South provides a knowledge bank that ever changing case workers at embassies, in NORAD and in the Ministry of Foreign Affairs can utilize. It is thus essential that Norwegian researchers, and their collaborators in the South, do not only produce academic outputs, although that is also necessary, but also actively interact with decision makers in Norway and in the countries where the research is conducted.

Within the field of agriculture and rural development in poor countries there are a number of research groups in Norway. Research on tropical agriculture is mainly conducted at NMBU, with the main research groups within soil- (e.g. Vegard Martinsen) and plant- (Anne Marte Tronsmo) sciences, as well as the dedicated department for international studies, Noragric (Jens Bernt Aune)¹¹⁶. Research on rural livelihoods more in general is also conducted at Noragric (e.g. Tor A. Benjaminsen), as well as at the NMBU economics department (Stein Holden, Arild Angelsen). In the university sector more in general there is research on rural livelihoods in particular at anthropology, geography (e.g. Peter Andersen in Bergen) and economics departments, with the latter also focusing on macro issues. In the institute sector, CMI is leading on rural livelihoods (Sosina Bezu, Magnus Hatlebakk, Inge Tvedten), while NUPI (e.g. Arne Melchior on food prices) and PRIO (e.g. Halvard Buhaug on climate change) have more of a macro perspective.

With Norway's focus on poverty reduction, and the majority of the poor living in rural areas, there is a need to sustain, and develop, research based knowledge of the basic conditions for the main livelihood, agriculture, as well as the interaction between agriculture and other economic activities, including the complex relations between the rural and urban economies. New research normally become available to decision

¹¹⁶ Names are included as illustrations of people who do research in these fields, and to indicate the wide range of research conducted, but the list is, of course, far from exhaustive.

makers with a delay, a delay that is shortened in countries with active research communities. Norwegian researchers tend to have country knowledge within specific fields, which is useful for implementation of aid programs. Research collaboration also provides an avenue for learning local contexts that may be useful for the donor community beyond the research outputs themselves. Thus support to research collaboration will not only enable research, but also contribute directly to policy making, if funding is conditioned on regular interaction with decision makers in Norway and in the country of research.

8. Main conclusions

Norway's focus on smallholders in Africa is well placed, and in line with Norway's main aim of poverty reduction. Smallholder agriculture in Africa is rain-fed, with limited use of fertilizers, and even less use of modern seeds. There is some room for increased use of irrigation, but the potential is limited and we shall expect most of Africa to rely on rain-fed agriculture. It is thus essential to develop modern varieties that are drought resistant. Equally important are policies for maintaining and supplementing soil quality through integrated soil management systems¹¹⁷. The productivity of other inputs, such as fertilizers and modern seeds, depend on local soil quality. This means that research, development and implementation of new agricultural methods have to be localized, and link up with local extension services and model farmers. Research indicates that support to R&D and extension services, together with improved infrastructure (roads and irrigation), are more cost-effective than, for example, input subsidy programs¹¹⁸.

In addition to roads and irrigation, it is essential to invest in education and health. Health services are part of the general need for social protection programs that will allow farmers to take the necessary risks and invest in new and more productive technologies¹¹⁹. It is also essential to keep in mind that farmers handle risks, and add

¹¹⁷ Barrett, C. B. and Bevis, L. E. (2015). The self-reinforcing feedback between low soil fertility and chronic poverty. *Nature Geoscience*. 8: 907–912.

¹¹⁸ Jayne, T.S. and Rashid, S. (2013). Input subsidy programs in sub-Saharan Africa: a synthesis of recent evidence. *Agricultural Economics*. 44: 547–562.

¹¹⁹ Smith, V.H. (2016). Producer Insurance and Risk Management Options for Smallholder Farmers. *World Bank Research Observer*. 31(2): 271–289.

to their incomes, by diversifying into non-farm activities, including processing, transportation and marketing of agricultural products. Thus agricultural policies should support the general economic development of rural areas, and general rural development policies should take into account these interlinkages between agriculture and non-farm economic activities that most households engage in. Finally, although the focus on Africa is well placed, there are also parts of India and neighboring countries that are still heavily dependent on agriculture, and with many areas still depending on rain-fed agriculture, similar to Africa.

Appendix: Figures

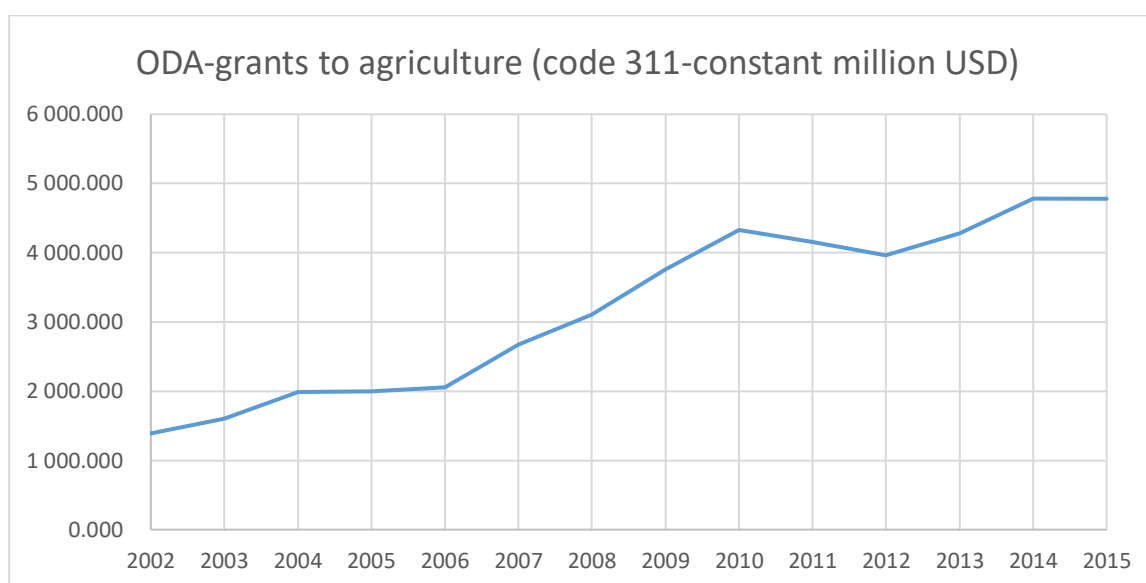


Figure 1. International aid to agriculture (OECD-DAC-statistics)

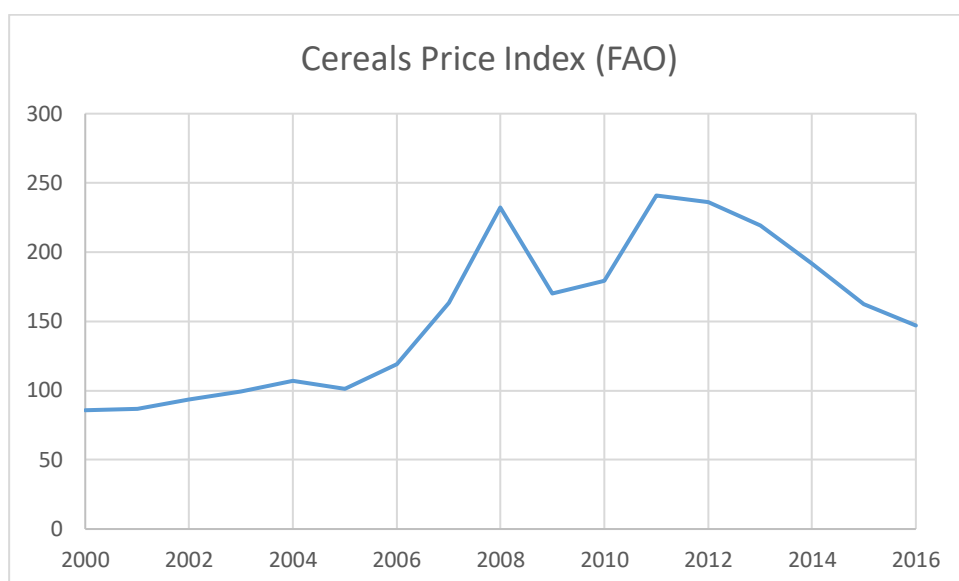


Figure 2. International food prices

Source: www.fao.org/worldfoodsituation/foodpricesindex/en/

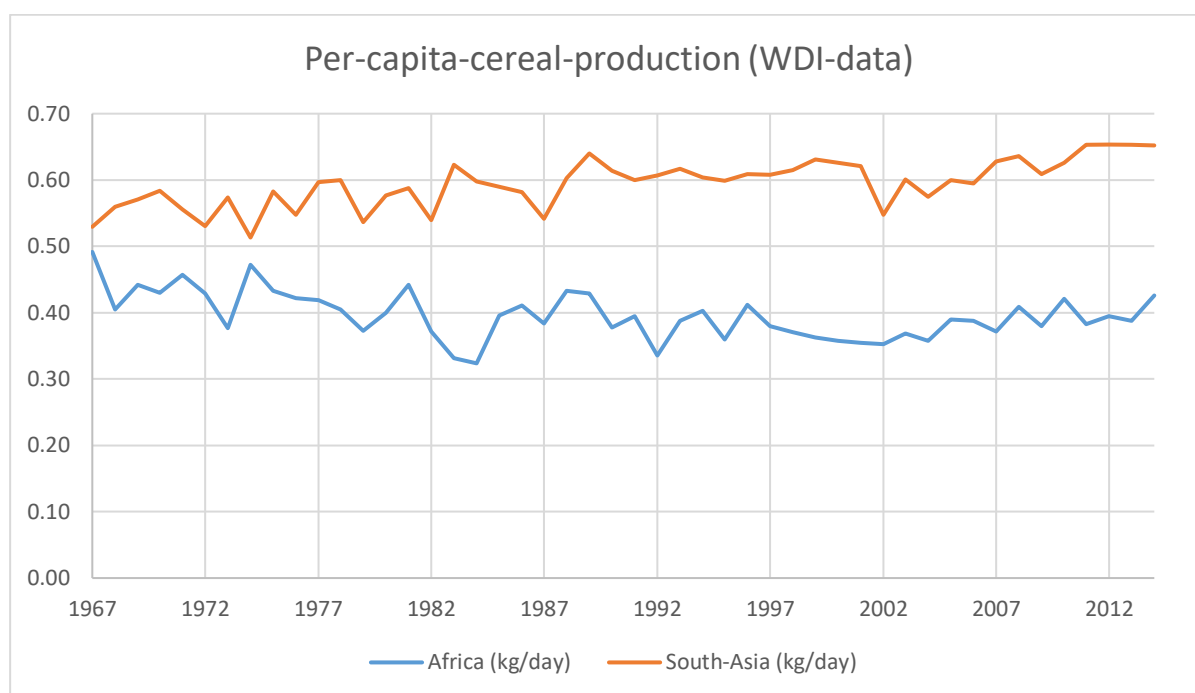


Figure 3. Staple food production (excluding high income countries in Africa).

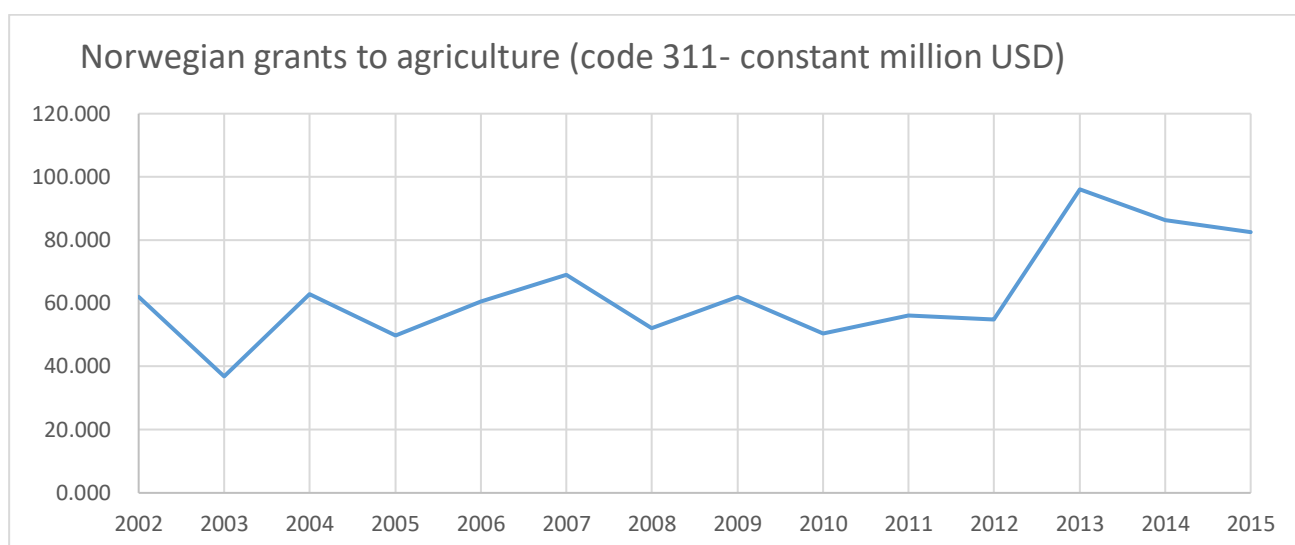


Figure 4. Norwegian aid to agriculture (OECD-DAC-statistics)

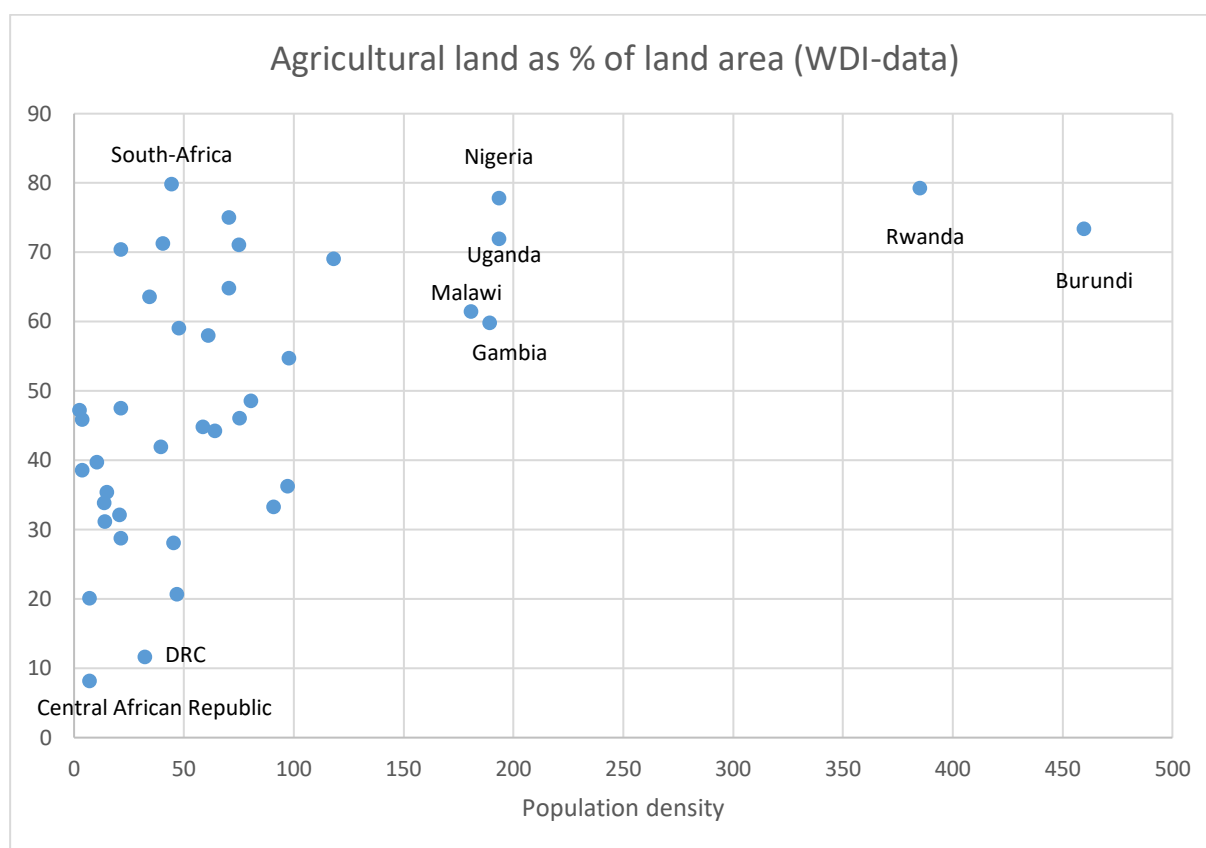


Figure 5. Agricultural land in Sub-Saharan Africa as a function of population density

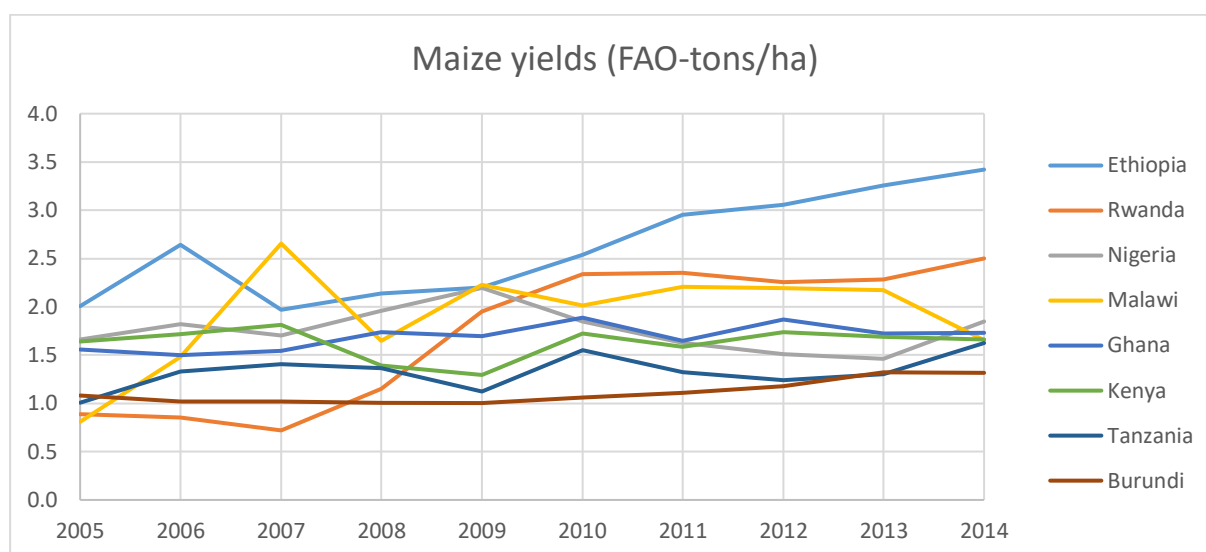


Figure 6. Maize yields in some African countries.

Source: www.fao.org/faostat/

The report reviews available research on the links between agriculture and the rest of the economy, with a focus on structural adjustment and the role of agriculture in economic growth and poverty reduction. Furthermore, the report discusses the links between agricultural production, nutrition and food security. The report discusses constraints on agricultural growth, both external constraints, such as roads and other infrastructure, institutional constraints that may reflect market failures, and more immediate constraints such as lack of modern seeds, fertilizers and irrigation. At all levels underlying market failures are identified, and relevant policy interventions are discussed. The report concludes that agricultural policies should be integrated with general policies for development in remote areas. Government and donor-supported safety nets may help in reducing the risks facing poor farmers, and thus allow them to invest in potentially more productive techniques. Such safety nets may target other sectors, with the health sector being potentially the most important one, since own labor is the main source of income for poor people. Emergency aid, or other social protection systems, will also provide villagers with the necessary safety nets. Beyond insurance and basic income support, there is a need to invest in roads, infrastructure, basic education, and training in improved agricultural techniques, including localized soil management systems. Training should be linked to localized research and extension services, including model farmers at the village level.

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