Food security and sustainable resource use – what are the resource challenges to food security?

A Report for the Food Security Futures conference, 11-12 April 2013, Dublin, Ireland

Frank Place (ICRAF) and Alexandre Meybeck (FAO)

Executive Summary

Natural resources for food production to 2050

The demand for food is expected to increase by more than 60 percent over the next 40 years, as the global population reaches over 9 billion and as increased income drives dietary pattern changes towards more livestock products. Though this is a significant task, meeting the increased global demand in 2050 would be achievable with modest agricultural land increases and significant yield increases. According to FAO the area of non-agricultural land suitable for agriculture and not under forest, protection or settlement in 2012 is 1.4 billion ha (960 million ha in developing countries). The FAO assumptions have increased land area accounting for less than 20% of the increased production needed, with a 107 million ha increase in developing counties and a 37 million ha decrease in developed countries.

Instead of a reliance on land expansion, adequate food production in 2050 assumes productivity gains in crops and feeds. The FAO (2012b) report assumes constant growth in yields of 1.8 percent per annum in sub-Saharan Africa, perhaps on the optimistic side, though consistent with yield gap analysis. South Asia would see a more modest growth of 1.0 percent, with slower growth in all other regions. At the world level, the implied yield growth is 0.64 percent per annum. Part of the productivity increase will be from an expansion of irrigated area, estimated at about 20 million ha over the period to 2050. This is challenged by the fact that cereal yield growth rates have been decreasing and the cereal production to fertilizer use ratio has fallen dramatically in the past 40 years.

Certain regions will experience difficulty in achieving higher food production due to natural resource constraints, notably: lack of new land, low fertility soil and scarce water resources. New agricultural land is expected to be confined largely to sub-Saharan Africa and Latin America, and even then in only some countries. A considerable amount of the current or future agricultural land suffers from constraints such as ecological fragility, low fertility, toxicity, high incidence of disease or lack of infrastructure to connect it to consumers and input markets. A recent study based on trends in net primary productivity suggests that 24 percent of land areas have degraded between 1981 and 2003, including many areas that were not previously classified as degraded by the GLASOD study. Of the degrading area, about 20 percent is cropland, which occupies about 12 percent of surface area (Oldeman, Hakkeling and Sombroak, 1991; Bai *et al*., 2008). Most of the expansion of irrigation will also take place in selected regions such as East Asia, South Asia, and the Near East/North Africa. All of these factors will continue to generate imbalances in between demand and supply of food and agricultural

productivity among countries in 2050. And if problems such as land degradation, salinization of irrigation systems and access to inputs are not effectively dealt with, the attainment of adequate food production at the global level will be threatened.

There are further threats to food production which could further reduce the baseline scenario of food production and resource requirements of the FAO. One is the effect of climate change. Analyses have been made in terms of the impact of changing temperatures and rainfall patterns on crop yields, but the indirect effects through changes in ecosystem services, soil fertility and other resources are not well studied. A second element which could possibly impact food security is large scale biofuel and bioenergy production. Important bioenergy or biofuel development will require land and feedstocks and could require a greater level of land conversion or higher productivity growth rates than currently assumed. Finally, the degree to which developing countries future livestock consumption patterns will shift from assumed patterns will also impact significantly on total plant biomass and land resource needs.

The roles of forests, woodlands and aquatic resources in direct food provision are not insignificant but not well documented globally. The indirect contribution of non-farm land uses through provision of watershed protection, pollination and natural pest and disease prevention are also apparent, but undervalued.

Trends of natural resource health and productivity are mixed and geographically varied. Irrigation investment has been strong in Asia and crop input investment strong in N. America, Europe, South and East Asia. There is high incidence of specific soil management practices in certain regions or countries (e.g. conservation agriculture in S. America). Aquaculture and dairy investment is growing in developing countries. Principles and practices for improved resource management are well developed but adoption rates inadequate in many places, resulting in land degradation. In some regions, on the other hand, the use of chemical inputs or manure is excessive, causing damage to water resources.

Towards better assessment of the natural resource base

There are systems in place for tracking of key resources, such as FAOs periodic Forest Resource Assessment and State of the World's Land and Water Resources and annual monitoring of land use, but some gaps remain. These are primarily in terms of quality aspects of resources, such as soil or water quality. The more that specific quality parameters can be identified, e.g. soil acidity, the better can solutions be designed. Knowledge of thresholds of resource quality levels where more than incremental investment is required to restore resources is also limited. Finally, identification of high risk areas of future resource degradation would be valuable for targeting investments.

More research is required to better understand how to optimize resources, not only over scarce individual resources, but over an aggregation of resources. The pursuit of maximum yields would suggest a different combination of resources and inputs than would the maximization of output per unit water, output per unit labor or profits. Analyses are rarely made for multiple measures of efficiency. Thus, decisions over which combinations of resource management practices are best at field, farm or landscape scales to increase overall resource efficiency are not well informed. A complicating factor is

that “best fits” or “best practices” do depend on local context such as soil type, rainfall, topography and socio-economic factors as well as land - labor ratios and prices of inputs.

Better management of natural resources

If adequate food production globally is to rely on productivity increases and we are witnessing degradation of soil and water resources in a significant sized area, then improved management of natural resources in agricultural landscapes is of paramount importance. Principles for managing soils, water resources, rangelands, fisheries, wetlands, forests and woodlands are already well known in the scientific world and increasingly by development organizations. Contextualizing those into feasible practices on the ground has proven challenging and when done sector by sector, have found in some cases to be not well aligned with each other. There is much to do to encourage better integration of natural resource management practices, beginning at landscape scale but even to the level of the field, where opportunities for synergistic investments are often missed. Linkages must be strengthened vertically between farmers, field agents, R&D organizations and policy makers and also horizontally within these stakeholder groups to encourage the sharing of learning. In too many cases, there are competing approaches to management (e.g. high purchased input systems, organic farming, conservation agriculture) rather than understanding potential complementarities or conditions under which different approaches may be best. All stakeholders should pay more attention to the longer run health of natural resources and ecosystems to be able to rationally weigh choices.

Resource productivity varies highly across regions, countries and at sub-national level. Calculations are most commonly made for land productivity or crop yields. Yield growth has been positive over the past 30 years, but displaying a decreasing rate in developing countries and being stagnant in sub-Saharan Africa. Gaps remain in actual versus potential yields in developing countries, especially in sub-Saharan Africa. There are many reasons for the existence of yield gaps, but poor resource management is a key factor. Calculations of efficiency of use of other individual resources or combinations of them, are not systematically available. Nor are calculations at higher ends of the food chain – e.g. resource use per unit of nutrition consumed. As resources become more scarce – land area, phosphorus, water, e.g.— such information will be increasingly important to inform decisions related to resource management.

A significant portion of food produced is lost or wasted post-harvest with some estimates being as much as 30%. Losses in immediate storage and handling in sub-Saharan Africa are high but less elsewhere. Food waste is high at the consumption level notably in developed countries. Such losses increase the gross amount of food production needed and thus also the amount of land and other resources required to produce a given level of food consumed. Efforts to reduce loss and waste will be needed to improve resource efficiency.

Improved policies and governance for natural resource management

Science – policy interactions need to be increased and more use of evidence in policy making is required, especially at the national level. This is not to say that science has produced all the necessary outputs or that it is unified on key messages. There continues to be fragmentation and competition among

different agricultural research organizations and more cross-resource synthetic analyses needs to be done.

Many developing countries will need to increase funding for agricultural research, where growth in spending has been dominated by a few countries such as China, India and Brazil. Countries need to devote more funds to natural resource management research including broader areas of integrated NRM of landscapes and farms and on specific components such as crop-livestock integration, integrated soil-water management and agroforestry.

In order to have better natural resource management in agricultural landscapes, cooperation among the various sectors -- agriculture, environment, water, forestry – should be strengthened. This should be done at all levels of governance and devolution of authority over resource management to local levels should expand where appropriate. At local levels, greater involvement of stakeholders for collective management of landscapes is critical for solving competition and conflict over resources. There also needs to be more commitment to long-term food production goals in policy making and programming. Focus on short term targets leads to the promotion of short term inputs rather than longer term natural resource quality improvements.

Improved policies to promote the sustainable use of resources are needed. The use of some resources such as water is not properly priced and therefore will be over-used relative to their future values. The positive and negative externalities from different land use practices are only now beginning to be internalized through rewards or penalties. In most cases, externalities are widespread (soil erosion from poor vegetative cover, nutrient leaching into water systems, and carbon sequestration on the positive side) thus discouraging a more socially optimal level of practice. Much greater recognition and valuation of externalities needs to inform policies and regulations which will then provide appropriate incentives to create socially beneficial outcomes. Some of the incentives will come from improved resource tenure arrangements in areas where there is uncertainty of rights to resources (e.g. to carbon sequestered) or where insecure situations inhibit longer term investment (e.g. high level of short term land rental or threat of eviction). Other policies that would correct unfavorable conditions for natural resource management include strengthening of extension or dissemination systems to cater for knowledge intensive practices such as NRM and to expand opportunities for farmers to access long-term credit to undertake NRM investments.

In addition to policies to promote natural resource management on farms and in agricultural landscapes, policies are also needed at the post production levels. Management of pest, disease or rotting risks of harvested foods stored at farm and community level in agricultural programmes should be strengthened where the problems are significant. Food waste can be reduced or recycled through various instruments. Patterns of trade could be influenced by policies to make use of relative scarcities in resources; for example, water intensive products should flow from water abundant to water scarce countries.

Priority areas for research and knowledge generation

Current and future resource challenges to food security call for research and knowledge to better characterize availability of resources, at global and local levels and to provide ways and means to optimize sustainable resource management for food security in its four dimensions, including by improved governance. We therefore identify three main priority areas of action for The CGIAR and FAO along with their partners.

First of all there is a need to have a clearer picture of resource "availability' (land, water, biomass,…) and productivity and of how it can respond to growing and competing demands. Of particular importance is to have a better understanding of land use, land use and management changes and of their drivers. The increased demand for biomass, especially as feed for livestock, but also for bioenergy, calls for a better knowledge of grassland production, including rangelands. Reduced land availability and increasing nutrient scarcities (or/and imbalances) point to the need to reinvest on soil understanding and knowledge. Biodiversity in all its forms, from intraspecific diversity to ecosystems is both a resource in itself and a way to better use other resources. Better knowledge of its potential, of how to protect and sustainably manage it, is crucial for the future.

There is an urgent need to develop approaches and data banks that consider at the same time all aspects and impacts of resource management. This also requires to develop a knowledge base which is not restricted to the management of a single resource but embraces the relationship between them and with agricultural production and its various outcomes in an ecosystem approach, integrating landscapes and farming systems, forestry and fisheries. Assessing natural resource efficiency, devising ways to track this in representative sites and to develop integrated NRM approaches to improve efficiency are all important future areas of collaboration.

Improving governance for sustainable management of natural resources, at every level, requires shared understanding of the issues, adequate assessment and monitoring tools and appropriate institutions and policies to engage all stakeholders, including with adequate science/policy interfaces.