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ISPC Commentary on the Synthesis Report for the CGIAR Foresight Study on Trends in Urbanization and Farm Size in Developing Countries: Implications for Agricultural Research

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The Independent Science and Partnership Council (ISPC) aims to strengthen the quality, relevance, and impact of science in the CGIAR.

Foresight Studies analyze emerging issues and trends with the objective of quantifying research challenges and the potential impact for agricultural research.

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Background to the Study

The ISPC seeks to identify emerging issues of importance to agriculture that are likely to influence the CGIAR's future agenda. Consistent with this role, the ISPC has been asked to provide input of a strategic nature to the CGIAR Consortium as it develops an action plan for its revised Strategic Results Framework. Two topics of expected high relevance to the CGIAR as it considers its priorities for agricultural research over the next 20 years are (i) farm size dynamics and (ii) urbanization and food demand. Farm size trends will in part determine what kind of farmer will be adopting outputs of agricultural research 20 years hence (Wiggins 2009, Collier and Dercon 2009, Hazell, 2012). Concomitantly, urbanization trends and associated infrastructure development will determine opportunities for small farmers to gain market access to sell surplus products (Reardon 2007, McCullough, Pingali et al. 2008). Both trends have implications for CGIAR research. At the ISPC 5 meeting in Delhi (March 2012), Council members agreed to undertake a study examining the ways in which major trends and issues linked to changes in farm size and the increasing importance of urbanization in the developing world – in particular South Asia and Sub-Saharan Africa (SSA), are likely to impact the choices to be made by the international public research system. Using the best available scientific knowledge, this review seeks to understand key developments in these areas and their implications for the design and prioritization of agricultural research within the CGIAR. While these are not the only changes that will confront the international system, they are among the most important.

This study was led by a recognized expert in agricultural development (Will Masters of Tufts University) who prepared a 'synthesis' document that drew on three key inputs: (i) five ISPC-commissioned papers analyzing and summarizing the issues and trends on data on farm size and urbanization¹ (ii) deliberations by some 20 experts on these topics during a two-day workshop in January hosted by Tufts university² and (iii) Master's own analyses and integrative assessment of the salient issues, drawing on subsequent rounds of comments from workshop discussants. A draft synthesis report was presented by Masters at the ISPC 7th Meeting in Cali in late March 2013. Subsequent revisions were made by the author and the final version submitted to the ISPC on 13 May 2013.

Professor Masters did a superb job in pulling together the multi-faceted data and analyses from the five background papers and from different viewpoints across a wide range of disciplines represented at the two-day workshop in Boston including economists, agronomists, demographers, geographers, gender analysis experts, and livestock specialists. In particular, he extracted the key lessons for the CGIAR based on his reading of the available

¹ The analytical review papers were meant to provide a diversity of perspectives, different disciplinary strength and relevant regional knowledge. Lead authors on these review papers (which are available at <http://www.sciencecouncil.cgiar.org/sections/strategy-trends/en/>) were Tom Reardon (Asia), Thom Jayne (Sub-Sahara Africa), Agnes Andersen-Djurfeldt and Magnus Jirstom (geography & demographics), Cees de Haan (livestock) and Peter Hazell (issues cutting across regions).;

² Workshop participants covered a broad range of disciplines and/or had SSA and South Asia regional expertise. In addition to the authors of the five background papers they included: Awudu Abdulai, Deborah Balk, Derek Byerlee, Cheryl Doss, Ken Giller, Margaret McMillan, Clare Narrrod, Jerry Nelson, Kei Otsuka, Carl Pray, Agnes Quisumbing, Bharat Ramaswami, Anita Regmi, Steve Staal, Steve Wiggins and four ISPC members.

evidence. This effort was enormously helpful, represented a major contribution, and will be valuable to the ISPC in thinking through future research and scientific challenges facing the CGIAR system.

Major findings and recommendations from the synthesis and ISPC's comments

The synthesis report recognizes the broad diversity of farm types in rural SSA and South Asia and proposes a generic framework that identifies distinct target domains of rural farming communities based on access to markets and degree of commercialization. The broad categories of farm types as described by Masters represents a synthesis of Reardon's characterization of "dynamic versus hinterland zones" and Hazell's "subsistence, transitional and commercial farm typologies". Equally important, and of particular relevance to the Strategy and Results Framework Action Plan, Masters highlights the need for more detailed characterizations of current farm types and their trajectories by respective CRPs in the areas where they work to inform theories of change and better identify major players along impact pathways. A key point is that heterogeneity extends beyond agroecology and farm size; important dimensions of heterogeneity also extend to the categories of commercialization, remoteness from markets, and input intensity. An implication is that categories such as "smallholders" are themselves often too broad to be useful for targeting beneficiaries of CGIAR research outputs.

The study's characterization of diversity will be very useful to the CRPs as they seek to target research more effectively and efficiently and derive the needed interventions for broad classes of beneficiaries (targeted populations) and to prioritize those with the highest impact potential. This in turn should be useful in defining impact pathways and intermediate development outcomes for such target domains, as they need to be differentiated by continent, agro-ecology, country, etc.

The synthesis report identifies six conclusions, from which it derives six corresponding recommendations that follow from the data and analyses in the five background papers and the subsequent workshop discussions. For the most part, the ISPC endorses these conclusions and recommendations. Each of these is summarized below, followed by specific comments from the ISPC. Prior to looking at each of the conclusions and implications, there are some overarching issues that the ISPC would like to emphasize and that could be viewed as qualifying some of these conclusions and recommendations to provide additional context.

The focus of the analysis in both the background and synthesis papers was on the geographically heterogeneous pattern of changes in farm size and structure and the increasing importance of urbanization in SSA and South Asia. Farm size is, on average, decreasing in Africa while in Asia it appears to be at the start of a transition towards consolidation, with average farm size increasing slightly in recent years as rural populations have finally started to fall in absolute numbers. This stylized fact is useful in setting the overall context, but it is increasingly recognized that the "size of the farmland holding" in and of itself is becoming less relevant as a category within which generalizable points can be made easily. The trend of declining farm size is obviously of most concern and relevance where household labor is still largely tied to agriculture, i.e., the scope for rural non-farm employment (RNFE) is low, where agriculture is the dominant source of household income and where households are located in fairly remote areas (with low market demand). However, focusing too much on farm size misses the implications of the dimensions of commercialization taking place across and within countries in Asia and increasingly in Africa. It also ignores the changing RNFE dimension, i.e., a given decline in the land/rural population ratio need not always translate into a corresponding increase in farm intensification. So, as the transition to the dynamic and intermediate zones takes place, the relative importance of the farm size variable decreases as other factors become more important.

The report argues that ‘household-size’ farms - those that can be operated for the most part with family labor – will continue to dominate agriculture in developing countries (and in fact in rich countries) and should therefore be the focus of CGIAR research. The ubiquity of family farms is widely understood in the agricultural economics literature as a solution to “principal-agent” problems pertaining to supervision costs of hired labor. But not all family-managed farms are small. With capital equipment, family farms can reach a very large scale without relying on hired labor. Furthermore, new technologies have opened up numerous opportunities for large non-family farms to overcome some of the problems of monitoring and supervision of labor. Many of the emerging “precision agriculture” technologies move in this direction. One can envision a scenario where satellite monitoring, crop models and other ICT technologies overcome costs of labor supervision and site-specific management, undermining some of the forces that have in the past led to diseconomies of size. There is evidence this is already happening in the large commercial farms of Latin America. So, from a strategic foresight perspective, it’s not clear that one can easily predict in the distant future the size (measured in land area or labor units) of a “typical” farm, nor can one easily guess which model of farming will be most successful. Masters points out, however, that at least in the short- to medium-term (10-20 years), Africa and Asia will continue to have many millions of farms operating at very small scale, and median farm size will remain very small in both regions.

Related to this is the future role of farm mechanization technology which although not the focus of this study merits greater consideration. While it is true that many small farms – especially in sub-Saharan Africa – will remain entirely dependent on human labor for the next two decades or more, there are rapid changes taking place in the nature, size, and functionality of farm machines. The very nature of farm machines is changing in large-scale agriculture in developed countries, with miniaturization and internet connectivity driving changes in the design and function of nearly all types of machines. At issue is how to incorporate these innovations into smaller-scale, affordable, and energy efficient equipment suitable for low-income small-holder farmers. These changes may have major implications for smallholder farms in highly commercial systems although many in the hinterlands may be left behind altogether, continuing to farm with rudimentary hand tools and draft animals. Nevertheless, the ISPC questions whether opportunities might also exist for some degree of mechanization among small and relatively poor farmers in transitional or even in hinterland zones. This would allow them to use their labor off-farm and to reallocate labor on-farm to uses previously precluded by labor constraints. Considering the range of possibilities and how they might alter the structure of and returns from a more mechanized small-size farming operation would be important in developing research priorities for the CGIAR. This is clearly an area where further analysis and scenario planning is required to fully understand the implications for CGIAR research.

The synthesis paper describes a continuum between the hinterlands and dynamic, highly commercialized zones. Reardon’s paper elaborates further in defining a distinct category between these two poles, i.e., an intermediate zone³. The explicit designation of ‘intermediate zones’ is useful for purposes of exposition and considering priorities as these zones typically have high potential but currently low performance. They may in fact have the greatest potential as a CGIAR target, both in terms of research outputs reaching the greatest number of rural poor and addressing sustainable agricultural productivity targets. This also relates to a perennial debate – one that the CGIAR has revisited in one form or another, explicitly or implicitly, over the years – relating to tradeoffs inherent in the choice between targeting productivity growth in better endowed regions versus targeting poverty reduction in more marginal environments. This issue is discussed further under Conclusion #3 below.

³ Reardon describes these intermediate (or missing middle) zones as having favorable agro-ecologies but hinterland aspects such as distance from cities or poor roads or inadequate provision of other infrastructure like irrigation or services. This “low performance but high potential” zone was much discussed in the CGIAR literature in the late 1980s and early 1990s. It is likely that this “missing middle” zone has high potential for rapid change were it to be linked to markets and thus demand, both in Africa and Asia. Examples include central-eastern Uttar Pradesh and parts of eastern India and the Sudano-Guinean and sub-humid zones of Africa.

While urbanization and other key trends in Asia and Africa were discussed in the synthesis paper and much in-depth analyses and discussion provided in all five background review papers, more must be said about the implications for CGIAR research. The ISPC believes urbanization is a fundamentally important trend and will have a major bearing on CGIAR priorities – in particular, raising the question about how quickly demand for livestock-sourced foods (LSF) is likely to grow both in Asia and Africa. The background paper by de Haan suggests a fairly steady growth and predictable pattern ahead for demand of LSF as both urbanization and increased income drive higher meat and milk consumption (fish too). These trends result in sharp increases in derived demand for animal feeds, not only for Asia but Africa as well⁴. The obvious implications for the CGIAR are, all else equal, greater priority given to livestock production research (for productivity and environmental sustainability) and greater attention to coarse grains.

Equally important are the increases in income and structural dietary shifts that will drive growth in demand for higher value commodities, e.g., fruits, vegetables, and oils, even among poor urban and rural consumers. This has huge implications for the CGIAR at the system and CRP levels in terms of balance of effort across different commodities and markets, especially quality issues. Many of the CRPs are cognizant of and have responded to the trends in urbanization associated nutrition transition, but more effort is needed in carefully monitoring these changes and understanding the implications for priority setting. Getting access to relevant national and sub-national consumption and income data and their analyses is fundamental in this respect and is rightly emphasized under Conclusion #6.

Clearly the big challenge for African agriculture is to meet the diverse needs of a highly differentiated agricultural sector, with different objectives in different parts of the sector. Broadly, those objectives relate to ensuring an adequate or even abundant supply of food in commercial markets, to generate improvements in productivity for those in near-subsistence, and to protect the environment within the context of sustainable agricultural development pathways.

Finally, both urbanization and potential for increased mechanization, even for small farms, in production and post-harvest operations draws attention to a number of important implications for gender roles and climate mitigation in farming. Research on these issues is needed to inform technology development and policy interventions.

Conclusion 1. Urbanization and economic development have made global agriculture increasingly differentiated, creating new opportunities for millions of farmers in commercially dynamic zones, even as millions more remain isolated in less accessible hinterlands.

→ “Research priorities for the CGIAR must be increasingly tailored to this diversity, helping to spread agricultural dynamism while lifting the productivity of lagging farmers.”

ISPC comment: The paper rightly emphasizes heterogeneity – across Asia and Africa, across agricultural zones (dynamic and hinterlands) and within agricultural zones (farm size distribution). The different characteristics of the three farm types identified in the background review paper by Hazell (commercial, transitional, subsistence) suggest, as Masters indicates, that research priorities – technological, policy and institutional – need to be increasingly tailored to this diversity. The ISPC agrees, but would like to highlight two issues:

⁴ Others have challenged these projections, noting that the relationships between income/urbanization and consumption of animal foods have generally been drawn from a time period when animal foods were relatively inexpensive and were declining in price. While the exact magnitude of the future trends in consumption of LSF may be debated, most would agree that demand will significantly increase in both absolute and relative terms.

a. More emphasis should be given to innovations and policies that are relevant over a large domain and can be widely adopted– the international public goods argument. This means we need to define farm type/agro-ecological domains that correspond to a particular research agenda and priorities (notwithstanding some degree of heterogeneity within them), yet recognize that there are a number of these farm type/agro-ecological domains across the CGIAR canvass.

b. It is not evident that the suggestion to tailor research to the specific needs of an increasingly diversified global agriculture is markedly different from what the CGIAR is doing now. The real work remains to be done – in defining the specific research domains and relevant information, suitably contextualized, e.g., corresponding to specific farm type/agro-ecological zones, and allocating resources according to the potential to achieve greatest impact on CGIAR system level objectives (SLOs). The ISPC recognizes that at this general level, it is not possible to be very specific about system priorities.

Conclusion 2. Agriculturally dynamic zones often extend quite far from towns and cities, along transport routes that carry a “quiet revolution” in the commercialization of crops and livestock. In these areas, farms are served by specialized agribusinesses that exploit economies of scale in provision of farm inputs and marketing of farm outputs, even as crop production remains dominated by household enterprises with both farm and nonfarm activities.

→ “Research priorities in dynamic zones should recognize the intermediary role of agribusinesses, and provide the new technologies and institutional innovations needed for competition among the diverse firms that serve farm households.”

ISPC comment: This important conclusion implies that the CGIAR needs to understand much better the characteristics and roles of agri-businesses that provide agricultural inputs and market output services, and in that context reconsider where its research priorities are for these dynamic zones that are so important for ensuring food security. The relevance of CGIAR international public goods is likely to vary depending on the complex and evolving nature of agri-businesses in each region.

The role of agribusiness in the development of the dynamic zones and transformation of agriculture throughout Asia and increasingly Africa was emphasized strongly in Tom Reardon’s paper⁵. Reardon highlights how the transformation of both input supply chains and output marketing (storage, processing, etc.) has been led by the “private sector” (not governments) and that these agri-businesses are dominated by millions of small and medium sized firms that play roles before and after the farm in the supply chain. Large multinationals actually have a small share of the food systems in Asia or Africa. A key question for the CGIAR, therefore, is to what extent research should focus on the input supply and post-harvest service sectors by targeting efficiency gains for both producers and consumers and thereby achieving one or more of the SLOs.

These considerations raise the issue of the changing role of the private sector, and how it relates to what the CGIAR should be doing. When one considers how rapidly the private sector emerged in Brazil, India, and China in the last 20 years – it is natural to ask whether this trend will continue for other developing countries. If so, the CGIAR will need to have a two-pronged strategy focusing on: (i) technologies of relevance to specific kinds of environments and farm sizes where the private sector is unlikely to invest (being unable to capture benefit

⁵ While dynamic zones are also arising around African towns and cities, along the main transport and communication routes, the magnitude of the transformation is much smaller. It is useful to ponder what constraints impeded this strategically important development.

streams from research investment) but where prospects for agricultural productivity are still good; and (ii) more basic biological research that underpins the relevant input supply (including the management practices) that the private sector uses and disseminates as well as the development and dissemination of the models (biological and socioeconomic) that can be used by both the public and private sectors.

The emerging role and position of agribusinesses in the dynamic zones, and their likely growing importance as a partner of the CGIAR still leaves considerable scope for the CGIAR to target the producers themselves in these dynamic zones, e.g., with improved varieties and NRM technologies and policies. But it also means choices will have to be made and a balance maintained across various end-users and target beneficiaries. This should be underpinned by a clearly defined strategy informed by an understanding of the current and expected agribusiness landscape in each region and on explicit assumptions about trends and rates of change in farm size, urbanization, market access, and opportunities for RNFE.

It is also important to acknowledge there are issues of perception and public relations around the CGIAR's interactions with the private sector. Although agribusiness plays an important role in marketing inputs and outputs, the interests of agribusinesses do not fully align with those of the CGIAR. It is therefore important to the CGIAR's long-term credibility to not be perceived as an agent for private sector interests.

Conclusion 3. Isolated hinterland zones offer agricultural households limited opportunities for either farm or nonfarm activity, due to low productivity and high transaction costs. Those living in these lagging areas often face worsening poverty due to population growth and resource depletion overlaid by climate change. With limited resources other than labor, hinterland farmers often have no choice but to farm even as they remain net food buyers, using income from scarce nonfarm employment to supplement what little they can grow.

→ “CGIAR research priorities in hinterland zones should recognize those farmers’ resource constraints, and provide the new technologies and institutional innovations needed to raise the productivity and stability of their agricultural systems, reducing poverty and supporting a gradual transition towards dynamic agriculture and off-farm employment”.

ISPC comment: Addressing the poverty, food security, health and nutrition and environmental sustainability needs of farm households in the isolated hinterlands is of paramount importance. The question concerning the CGIAR is ‘what is the scope for addressing those needs through agricultural research?’ Conclusion 3 itself provides insight – there are limited opportunities for farm activities of agricultural households living in isolated hinterland areas due to low productivity potential and high transaction costs. As discussed below, it is not evident what sort of CGIAR research strategies could help subsistence farmers living in hinterland zones become either commercial farmers or move to predominantly non-farm activities, as suggested in the synthesis document (and Hazell’s paper), without complementary, strategic public sector (infrastructure, education, etc.) investments.

In the early years of the CGIAR there was a debate about whether to focus research efforts towards outputs that would help the poorest regions. The choice was made to emphasize productivity gains in relatively well-endowed environments. With the benefit of hind-sight this was a very good decision both for productivity and poverty reduction, not least because the technologies were not strongly factor- or farm-size biased.

Times have changed and the CGIAR now has an explicit goal of reducing rural poverty (SLO #1). A key question for the CGIAR today is how much research attention should be given to the needs of farm households living in the poorly endowed hinterland areas (directly addressing rural poverty) versus focusing on the more

dynamic/commercialized as well as the ‘intermediate’ zones (c.f. Reardon). This in turn depends on the scope for realizing sustainable productivity gains from research in each of these zones. Much of course depends on zone definition and setting boundaries but it would appear that the ‘intermediate zones’ hold considerable promise for realizing returns from research and development efforts in terms of promoting sustainable capital-led intensification, RNFE, and at the same time building the infrastructural base to connect to sources of demand, mainly in the growing cities and towns and even to rural-urban areas especially for Asia but this may well apply to Africa (Reardon, 2013).

A stronger research focus on the dynamic and intermediate zones would signal a more direct effort towards the goal of meeting the overall food security needs of developing countries (SLO #2) via lower food prices⁶. If successful, this would have a major impact on spurring the general economy and raising income levels across the board thereby contributing significantly to the overall welfare of the poor⁷. This strategy could also, indirectly, be a more effective way of addressing the needs of some of the rural poor (although probably not the same rural poor if one wanted to directly target rural poverty in the hinterland zones), a win-win strategy.

The CGIAR should try to be as explicit as possible about the perceived tradeoffs in following a dual strategy. In the opinion of several of the experts attending the Boston workshop, it is not clear how much the CGIAR should focus its efforts on searching for technologies for the poor living in the isolated, low agricultural potential hinterlands where infrastructure is poor and aggregate demand is low – need alone is not sufficient justification. The prospects for agricultural research to deliver tangible outputs leading to adoption of improved technologies and policies in these hinterland zones must be assessed against the alternatives for achieving CGIAR SLOs. Providing domestic market access via roads to distant towns and cities would appear to be the key to achieving rural poverty alleviation in the hinterlands, which would in turn stimulate demand for and adoption of new agricultural technology⁸. Governments (and private sector) can help to shift a zone’s status by its investments but this will not be feasible everywhere. A more systematic discussion on where the CGIAR should focus (in the context of these zonal areas) and their implications for achieving the best combination of SLOs is long overdue. This debate could well be informed by the collection and analysis of extensive up-to-date datasets on key variables such as the number and socio-economic profiles of the poor living in specific agro-ecological/geographic areas, knowledge about the dominant cropping and farming systems and other livelihood occupations, infrastructure and market information, etc., combined with some measure of the realistic prospects for research raising agricultural productivity in those target areas, i.e., the relevant ‘big data’ collection exercise suggested under Conclusion 6.

Conclusion 4. Farm sizes vary widely within each area, reflecting heterogeneity among households as well as differences in land quality. Households bring a variety of assets to their farm operations, leading to a distribution of cropped area and livestock herd sizes that shifts over time in each location. Typically, the poorest households have the smallest farms and herd sizes; whereas, the wealthiest landowners may accumulate so much that the productivity of their land falls. Cost of production for most field crops is lowest on whatever farm sizes are cultivated by self-motivated family members. Economies of scale sufficient to justify supervising hired workers typically arise only for crops processed on farm such as tea and sugar, greenhouse operations, or for

⁶ Many if not most of the rural poor are net buyers of food, so bringing down food prices helps them too.

⁷ Analysis by Muhammad et al. (2011) show that increases in food prices in particular adversely affects spending on medical care – with obvious negative consequences on the most poor and under-nourished.

⁸ A set of studies conducted in the late 1990s in Africa showed that use of chemical fertilizer, but also of manure and soil conservation measures, was higher for small farms selling into markets, usually for commercialized food crops; farms focused on subsistence were less able to invest in soil conservation practices (Reardon et al., 1997).

livestock, since remote monitoring of field operations remains costly despite the spread of GPS devices and variable-rate technology.

→ “For most CGIAR mandate crops, research tailored to the needs of household-sized operations for self-motivated family farmers has the highest probability of commercial success.”

ISPC comment: The ISPC generally agrees with this recommendation with the caveats and limitations of using farm size or household-size farms *per se* as a typology, as described in our introductory comments. What really matters is capacity to prioritize research effectively (drawing on the ‘big data’ statistical tools that pull together the key elements in the heterogeneity of farm types) that in the judgment of scientists and research managers has the best prospects for generating innovations and policies that collectively generate the largest outcomes for low-income, food insecure producers and consumers.

A focus on household-size operations reflects an assumption that the CGIAR’s main channel of impact will be through the productivity of smallholder farmers. If a major aim of the CGIAR is to drive down food prices for the poor – to achieve food security – then that may not be an optimal strategy. Large farms may be relatively few in number, but they typically account for disproportionate shares of marketed output. In those cases, the CGIAR could have a much larger effect on food prices through improving the productivity of large farms than by trying to wrestle marginal increments in productivity out of smallholder systems. Determining which approach will have larger impact on poverty is neither simple nor straightforward, and would probably entail making value judgments across different target groups of poor people. Hence, the conclusion above sidesteps a fundamental confusion that the CGIAR continues to face about whether the goal is to increase the aggregate supply of food or to increase the incomes of poor farmers. While it is possible to do both, as suggested in Masters’ synthesis paper, that is not the same as saying such a strategy is optimal for achieving poverty reduction and food security objectives. However, when we increase smallholder production of food staples, we increase the supply of food and also increase the surplus of those farmers, which is indeed a “win-win” proposition. But it artfully dodges the question of whether there could be a bigger impact on food prices by doing something different; e.g., by supporting large farms to produce big surpluses and supporting small farms to produce cash crops. Which strategy is likely to be most effective will depend on the characteristics of the geographic region, its socio-economic profile, and the scope for agricultural research—either alone or in combination with targeted infrastructural, market and institutional public sector investments—to achieve food security, poverty alleviation or both (win-win). Unfortunately, there are no generic solutions that can be applied across the board. As such, a balanced effort may be the best course – while keeping a focus on the challenge of raising productivity on ‘household size’ farms to help reduce rural poverty, the CGIAR should also examine and take advantage of research opportunities that could more effectively raise food production and help achieve food security by targeting “other size” households, whether directly or indirectly through agri-businesses, in both the dynamic and intermediate zones.

Conclusion 5. Changes in average farm size depend on rural population growth, which in turn depends on natural increase minus migration from rural to urban areas. As the rate of natural increase slows, rural populations eventually reach their peak and begin to decline, so average farm sizes can begin to increase. Asia as a whole will soon reach this turning point, but for almost all of Africa it is decades away. A related transition occurs in livestock based in part on the cost of labor relative to capital as well as veterinary technologies, driving increases in herd and flock sizes in Asia that are now starting to be seen in some parts of Africa.

→ “CGIAR research should anticipate the effect of demographic trends on average farm sizes; in most African countries farm sizes will continue to shrink for several more decades, so innovations that are

land-saving and readily divisible to serve smaller plots will have the highest probability of commercial success, whereas in much (but not all) of Asia innovations to increase farm size are increasingly attractive. For livestock, the emphasis should be on increasing efficiency with respect to land, water and other resources, as well as the mitigation of health and environmental externalities.”

ISPC comment: It is true that the average farm size in Africa will continue to fall, if only as an arithmetic inevitability linked to relatively fixed land area and continuing increases in rural population⁹. But this average is based on an aggregate around which there is considerable heterogeneity. There is much less certainty about these trends for any given country or areas within a country, and we may begin to see both rising and falling farm sizes (bi-modally distributed) within the same region. How extensive that phenomenon will be is open for debate – but it is already happening in parts of some African countries, e.g., along transport corridors and in previously under-utilized regions where investors bring in lots of nonfarm capital to develop large farms. Indeed, ‘disruptive forces’, e.g., rapid discovery and exploitation of newly discovered oil, gas and mineral reserves in SSA, could open up large areas of the hinterlands, significantly raising prospects for small farm agriculture development and ultimately transforming them into dynamic zones. This points to an important caveat that cuts across many of the findings of this study – that there is uncertainty around agricultural futures in developing countries with respect to changes in the physical, institutional and economic landscapes many of which are beyond control of the CGIAR. Despite this uncertainty, the CGIAR should prioritize its research portfolio based on explicit assumptions about trends in urbanization and farm size and how these trends affect uptake and impact of research outputs on intermediate development outcomes and SLOS. At the same time these assumptions should be rigorously tested as research is implemented to allow flexibility to modify research priorities and modify target regions, populations, and commodities as new information dictates. Likewise, research thrusts that are relevant to a wide range of future scenarios should be given high priority.

The point is that a falling average farm size may still be consistent with the emergence of a large commercial farm sector producing substantial fractions of “marketed” output of food for urban areas, generating important multiplier effects between urban and rural areas. So even as average farm sizes shrink at an aggregate level, one can imagine many smallholders finding it advantageous to move out of staple food production into higher value commodities -- at least in places where food can be purchased at relatively lower cost and reliably. Nevertheless, at least for the next two decades, shrinking farm size will dominate farming in Africa, and such trends should be monitored (at national and sub-national levels) for major reversals or indications of turning points in this time frame. At issue for the CGIAR is that an exclusive focus on very small farm sizes may well miss key opportunities for achieving food security and poverty alleviation by targeting research and development activities that have the best potential for raising agricultural productivity, even if that comes from medium and large farm size operations.

A point made quite emphatically in several of the background review papers is the rapid growth in urbanization in Africa. For example, while rural population in Africa is expected to grow by about 50% between 2011 and 2050, urban population is expected to grow by more than 300% (UN, 2011). This has important implications for CGIAR research, in terms of ensuring adequate food supplies to urban areas (helping to reduce heavy dependence on imports from outside the continent), but also for aspects related to dietary transitions (increasing demand for high value fruits, vegetables and livestock products) and natural resource constraints (e.g., competition for water).

While large farms that are expected to increase in number along key corridor routes will help meet the rapidly growing demand for food in large African cities (much of which is being met by sharply rising food imports each year), household-size farms will likely remain the major source of food production. More thought and analysis

⁹ There is some debate about the degree of confidence in the estimates of the future rate of population growth in rural Africa, which uses decadal projections based on UN past trend data (Potts, 2012).

needs to be given to whether the CGIAR focuses only on land saving technologies for the ever shrinking farm sizes in remote rural areas, where constraints to raising productivity – due to lack of roads and markets – are quite formidable. Furthermore, as now observed widely in Asia, many small holders in Africa are not engaged full-time in farming, and some might be well served from adopting labor saving technologies, to allow them more time for engaging in other remunerative non-farm economic activities – where such opportunities exist. Thus, an alternative strategy would be one where the CGIAR target its efforts at fostering a dynamic smallholder sector with expanding farm size to better utilize available land resources. This would require the CGIAR to do more research on labor saving technologies, land markets and business models to link smallholders with agribusiness. This type of ‘inclusive agribusiness growth’ would require, among others, new institutional arrangements for improving productivity of smallholders operating in spot markets, various types of contract farming arrangements, and large-scale farms that generate jobs and/or include community equity shares (Byerlee and Haggblade, 2013).

The analysis on page 6 (para 3) of the synthesis report and several places in the Andersen-Djurfeldt and Jirstrom study suggests that the gender and age composition of the growing rural population will undergo major changes with urbanization. The result will be more female-headed households as young males continue to migrate for urban employment opportunities. Anticipating such demographic trends has major implications for the CGIAR in terms of targeting suitable technological and other interventions.

The growth of urban markets also raises numerous issues around food processing, food quality, food safety, and health. Some of these are primarily regulatory issues, but there are also potential targets for science. For instance, emerging commercial processing sectors may create demands for grain that is uniform or has other milling characteristics, and simple tests for fungal or bacterial contamination of foods will help ensure better health and nutrition for urban (and rural) consumers. The CGIAR already plays an important role in breeding for these characteristics, but even greater efforts are needed with increasing urbanization and higher income growth.

Conclusion 6. Due to the increasing diversity between zones (“dynamic” versus “hinterland”) and within a given zone (farm sizes and level of commercialization), and changes over time (shifts in farm-size distribution) and by gender or other social group, effective targeting of agricultural innovations increasingly requires “big data” statistical tools.

→ “CGIAR programs should continue to expand their investment in spatial models of global climate, land use, migration and economic development, to predict changes in what types of crop or livestock innovations are needed at each location to sustainably increase productivity and reduce poverty.”

ISPC comment: The synthesis report has emphasized the heterogeneity within countries that calls for differentiated strategies, with research activities guided by the systematic use of large-scale geo-coded datasets, the “big data” statistical tools. As pointed out by Masters, the CGIAR’s international mandate gives it a particular comparative advantage in this kind of “big data” research, including simulation modeling and impact assessment. Unpacking this heterogeneity within the frameworks proposed by Hazell and Reardon implies that systematic characterization efforts should be carried out to properly understand how to provide benefits to target groups of rural and urban poor and the food insecure through CGIAR research and complementary efforts. Critical dimensions of this characterization will include, among others, identification and location (and numbers) of the poor by different dimension of poverty, their cropping/farming systems, income sources (relative dependence on agriculture), farm size, extent of production, marketing and institutional constraints they are facing as well as

geospatially explicit data on daily weather, soil properties, and actual yields obtained by farmers and their variability over time.

It is critical too that the CGIAR be involved in generating the data; not just manipulating it. Data generating bodies are typically national; only the CGIAR has the potential to collect a wider range of data globally in a systematic way (FAO collates but doesn't collect) and then make it available as a global public good. Unfortunately, neither the old structure based on Centers, or the new structure of CRPs, can do an effective job of the needed global data collection, even of kinds of data that the Centers already collect. The issue of how to acquire and maintain such a large geo-spatial dataset most efficiently and cost effectively within the new CGIAR needs further consideration and careful planning. This is a place where a truly central operation, perhaps at the Consortium level, might be useful.

Building on existing programs such as the IFPRI-led Harvest Choice, ASTI initiative and the CGIAR CSI Geospatial-network, a new CGIAR Consortium led initiative should lead the drive to develop a truly global agricultural geo-spaced database as a basis for deriving system level priorities. Sentinel site survey data would feed into the database. To move forward on this key priority for the CGIAR, a well coordinated and well funded operational plan is essential.

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