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PERSPECTIVE

Mapping farm size globally: benchmarking the smallholders debate

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A new dataset (Samberg *et al* 2016) shows the geographical distribution of average farm sizes in Latin America, Africa and South, East and Southeast Asia, as well as the share of global production of key crops originating from regions likely dominated by smallholders. Farm size is a key component in the hot debates about the future of farms, food production, food security and smallholders, being strongly tied to multiple dimensions including land and labor productivity, income and poverty, energy return on investment, and linkages between agriculture and other economic sectors. The results shown by Samberg *et al* (2016) establish the strong role of smallholders in current agricultural production, while enlightening the regional and crop-specific patterns of this contribution. This provides a solid basis on which agricultural and rural development strategies have to build. The data presented also constitute a benchmark for global comparison and contextualization of studies addressing multiple issues such as the role of farm size in agricultural dynamics, the effects of different governance interventions aimed at rural development, food security, or balancing environment and development goals, the effects of the heterogeneity and inequalities in the internal distribution of land for different ranges of farm sizes, the evolution of average farm size over time, and others.

The recent letter by Samberg *et al* (2016) addresses the apparently simple but actually tricky questions of where are the smallholders distributed globally, and how much and what types of crops do they produce. Using a novel combination of micro-level census data and spatially disaggregated land use and production data, these authors propose a map of the mean agricultural area per farming household (MAA) by subnational administrative unit in three regions covering 83 countries, 90% of the world's farms, 55% of global agricultural land and 70% of global calories production. They then use this map to assess the contribution of regions having a strong density of farming households, and thus likely dominated by smallholders, to the global production of different crops.

The results enlighten the discussions on the future of farms, food security and smallholders, an arena with strongly contesting visions. Some praise large-scale mechanized farming, combined with accelerated economic development pulling smallholders out of agriculture, as the way forward to reconcile food production, preservation of natural habitats, and perspectives for jobs with lower drudgery and livelihoods improvements (Nordhaus *et al* 2015). Other argue for an agroecological path of smallholders working with labor-intensive techniques to create autonomous peasant farms largely independent of external inputs and of commercial relations (Altieri 2009). Between these two radical visions, the reality shows a range of complex dynamics. For the ultra-poor farming households completely disconnected from both agricultural markets and off-farm opportunities, staple crops intensification remains the key priority (Barrett 2014). But for many others, a more nuanced and portfolio approach is required to achieve the appropriate context-specific balances between raising income for a large group of rural producers and securing food provision for an increasingly urban and middle class population.

Farm size is a key component in these debates. An inverse relation between farm size and land productivity holds across the range of farms observed in developing countries (Henderson 2015), while labor productivity typically rises with increasing farm sizes (Fan and Chan-Kang 2005). In contrast, energy return on investment (EROI, the ratio of the usable energy delivered from a particular resource to the usable energy used to obtain that energy resource) is often larger in smallholder compared to large-scale farming in developing countries (Netting 1993, Pelletier *et al* 2011). With increasing farming population density and farm sizes decreasing below one hectare, tiny farms in many places become net food buyers, and unable to find their way in commercial supply chains due to a lack of entrepreneurial capacities and of the assets that are necessary for risk-taking behaviors, and due to the logistics of marketing (Barrett 2008, Collier and Dercon 2014). There seems thus to be a crucial role to play for emerging medium-scale commercial farmers that are able to foster labor productivity growth, wage labor income, and integration in retail value chains towards domestic and export markets, to provide employment, food security, and poverty reduction, such as evidenced in Thailand (World Bank 2013), Kenya (Neven *et al* 2009), Senegal (Maertens *et al* 2012), or Mozambique (Smart and Hanlon 2014). Positive spillovers can arise from the coexistence of large-scale and smallholder farming (Deininger and Xia 2016) or their interactions such as through outgrowers schemes (i.e. contract farming where companies establish contracts with smallholders surrounding their large-scale operations, typically by providing inputs and guaranteeing the buying of the produce while smallholders provide the labor) (Herrmann 2017), but large-scale investments often also result in smallholders' marginalization (Oberlack *et al* 2016). Region-specific dynamics point either to further reduction in average farm size, or to a consolidation, with manifold prospects (Jayne *et al* 2016). Overall, the evidence suggests that to improve food security and reduce poverty, yields increases have to be accompanied by increases in labor productivity that raise farmers income and laborer's wages, but are not too rapid as to create excess labor force (De Janvry and Sadoulet 2010). The appropriate balance depends, among others, on the context-dependent labor force absorption capacity in non-farm activities, and the pro-poor effects of agricultural development through linkages with other sectors.

The results presented by Samberg *et al* (2016) do not provide answers to all these issues, but they make at least two key contributions:

First, by quantifying and describing geographically and per crop the contribution of smallholder-dominated areas, they establish the strong role of smallholders in current agricultural production and provide a solid basis on which the above strategies have to build. With 70% of the food calories in the studied region produced in likely smallholder-dominated areas, which encompass roughly 383 million households, any strategy that neglects this hugely dominant role of smallholders in ensuring food supply and food security, and therefore the immense challenges involved in both substituting for their contribution and providing them for alternative livelihood opportunities, sets itself a high bar for credibility (Li 2011). Conversely, the results also show that for some regions and important products, agriculture can hardly rely only on a smallholder-based vision.

Second, the results establish a reference for comparative analyses of different issues, dynamics and policies in different contexts. Further studies could investigate how areas with comparable mean agricultural area per farming household (MMAs) correspond or differ in terms of agricultural dynamics, and social and environmental contexts and challenges. We could use these data to compare the effects of different governance interventions aimed at rural development, food security, or balancing environment and development goals, across a range of MMAs. Further research should also explore the heterogeneity and inequalities in the internal distribution of land within different units with distinct MMAs, as well as the evolution of MMAs over time. For these questions and others, the data presented by Samberg *et al* (2016) constitute a solid benchmark for global comparison and contextualization.

This work can also feed a broader range of scientific inquiries. Global models incorporating land use, such as Integrated Assessment Models and Earth System Models, are improving their accounting of the complex biogeophysical and biogeochemical effects of heterogeneous land management practices within broad land use classes (Erb *et al* 2016). The map by Samberg *et al* (2016) and follow-ups may contribute to this, when combined with knowledge about parametrization of the practices of different farming agents. Modelling exercises can shed lights on the Earth System impacts of different farming systems and on the prospects for smallholder farming evolution under global societal and environmental change. Also, the letter focuses on smallholders, but the data can also be used to investigate the contribution of large-scale farming to land use and agricultural production. Combining these data with other datasets allows investigating issues such as how small, medium and large-scale farmers are positioned in terms of agroforestry systems (Zomer *et al* 2016) or impacts on forests (Hansen *et al* 2013, Godar *et al* 2014, Meyfroidt *et al* 2014).

Some issues remain. One, acknowledged by the authors, is that the interpretation is vulnerable to the 'ecological fallacy', i.e. drawing inappropriate conclusions on the individuals based on the aggregate data. Smallholders likely produce the bulk of the crop production within the smallholder-dominated units, but an unknown share may come from largeholders disseminated therein. Further, geographic selection biases make it impossible to directly draw conclusions on the productivity of smallholders versus other farming agents, without further research to explain the location of smallholder-dominated units against the others.

The letter by Samberg *et al* (2016) provides a strong contribution to the discussions about the evolution of farming, and opens an avenue for further works combining micro-level census data with spatially disaggregated land use and production data.

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