Meridian Institute
Connecting People to Solve Problems

Potential Opportunities in Horticulture Production

Major transformations are required to create sustainable food systems, but near-term immediate actions can support longer-term, more fundamental transition to sustainability. For incremental steps to contribute to long-term changes, stakeholders should define sustainability, measure unsustainability, and understand what interests, ideas and institutions contributed to the current structures, ideas, institutions, policies, and practices. Such understanding will enable stakeholders to choose near-term actions that can lead towards sustainability.

The tables, below, are intended to provide a starting point for stakeholders who are working to build sustainable food systems and are considering a range of near-term interventions. Much additional experience and knowledge by farmers, peasants, indigenous groups and other practitioners should be consulted for a full understanding of these and additional potential interventions.

The following tables summarize mitigation opportunities, adaptation potential, and food system implications in horticulture production systems in two regions: Central and Latin South America, and North America. Although the opportunity tables focus on mitigation opportunities, the tables identify adaptation potential of most opportunities.

Opportunity Table: Horticulture (Intensive; USA)

Opportunity	Mitigation Potential	Adaptation Potential	Co-benefits	Challenges	Food System Implications
	Qualitative description plus quantitative if available (range of possible emission reductions?)	Qualitative description plus quantitative if available			Potential feedbacks and interactions
Amending soil with organic C	May help to reduce N losses in intensive vegetable cropping following harvest (Congreves et al. 2015), which can stimulate biological N immobilization after crop harvest. Congreves et al. 2015 found that organic C applied at rates of 5–10 Mg C ha-1 reduced the potential for N losses by 37 %,relative to a control of incorporated crop residue or fertilizer	May help sequester carbon	Water quality	Alternative strategies for crop residues if animals aren't in a system and fuel or burning is not an option or desired	For farmers, this would involve a significant management shift- sourcing organic C and managing crop residues differently. Could potentially reduce costs if less N inputs. Downstream effects could be positive for water quality.
Crop residue removal	Removal of crop residues following harvest could reduce N loss, but most crop residue removal studies have focused on field crops (Congreves 2015)	Crop residues can add carbon to systems, so removal alone might reduce SOC gains	Crop residues could be used as animal feed	Alternative strategies for crop residues if animals aren't in a system and fuel or burning is not an option or desired	Would potentially involve shift to integrated crop and livestock systems or regionally integrated systems to use crop residues as animal feed. Removal of crop residues without replacement might reduce SOC gains.
organic amendments with cover crops	winter cover cropping with manure application was particularly efficient in reducing GHG emissions, but these were mostly non-permanent because they were attributed to SOC increases (DeGryze et al. 2011)	water holding capacity increases	soil health, SOC benefits	longevity, also these emission reductions were modelled, so additional research needed	Need to better understand feedbacks within the system for GHG fluxes and SOC gains. Potential farmer and public benefits but additional research needed.
Nitrogen use efficiency (NUE)	Nitrogen use efficiency (Swarts et al. 2016) for tree crops, though in general perennial tree crops have lower emissions than other annual cropping systems.		Reduced costs for farmers, water quality benefits	policy, risk aversion	NUE could reduce demand for N inputs and affect pre-production emissions and agricultural industries, but reduce farmer costs. Rural communities could benefit from improved water quality. Many current policy structures do not incentivize reduced N use.

Improved drainage and compaction reduction	Improved drainage and reduction in soil compaction (Swarts et al. 2016) for tree crops, though in general perennial tree crops have lower emissions than other annual cropping systems	Could assist farmers with heavy rainfall and precipitation events in the future	Minimizes anaerobic conditions		Reductions in compaction and improved drainage can improve farm compaction, and potentially make farms more resilient to future extreme rainfall.
organic production	Organic production may use less energy (Smith et al. 2015), but could produce lower yields (Reganold and Wachter 2016). However, organic production used with other agroecological practices such as multi-cropping and crop rotations can reduce yield gaps (Ponisio et al. 2014) and provide mitigation and adaptation benefits	Can increase SOC, and when coupled with other practices spread future risk	Can provide greater ecosystem services, social benefits and farmer profitability (Reganold and Wachter 2016).	May result in yield reductions, but can be overcome. Certification can be costly for farmers, which is often necessary for a price premium.	Shift towards organic production would shift production from input driven to practice and labor driven, which would potentially increase agricultural jobs and require farmer training. If organic production results in price premiums, this could increase food costs for consumers, though in high-income countries organic product demand is growing.

Opportunity Table: Horticulture (Extensive; Central and South America)

Information to come.

Appendix: Methodology

Authors used a systematic approach to review the peer reviewed literature for mitigation opportunities along food systems. The approach followed five main phases and nine methodological steps.

Phase 1. Definition of variables and criteria

1. Identification of important food production systems globally. Cereals, horticulture and livestock were identified as important food systems according to previous reports data which highlighted it relevance for food security and as focus of GHG emissions worldwide (Burney et al. 2010; FAO 2016 a,b; Gerber et al. 2013; Herrero et al. 2013 and 2016; IPCC 2007; Jensen et al. 2012; Leff et al. 2004; Smith et al. 2007 and Weinberger & Lumpkin 2007). Fisheries and aquaculture are important production systems, but are not included in this report.
2. Identification of major food production systems across global regions. Authors made a first attempt to identify food systems categories across four selected regions: Central and South America (CSA), North America (NA), South Asia (SA) and Africa (A) based on existing food production systems reports for Cereals, Horticulture (Dixon et al. 2001, Annex 1) and Livestock (Steinfeld and Mäki-Hokkonen 1995, Annex 2). Major food production systems were defined in terms of coverage (percentage of population, food exports and imports, percent of employment in agriculture), use of resources (area harvested) and GHG emissions from Agriculture, Forestry and other Land of Use (AFOLU) for each of the four selected regions.

Phase 2. Search of technical and scientific information

3. Literature review of mitigation opportunities. A list of potential mitigation opportunities along the three food production systems and four selected regions was developed based on recent scientific and technical literature available until April 2017. Searches were conducted using key words regarding quantification of emissions from food systems worldwide (i.e. mitigation, GHG emissions, livestock, cereals, horticulture, CO2 quantification, Carbon foot prints, Life cycle assessment, etc.) in common scientific and technical database networks (i.e. Google Scholar, Cab Direct, Springer, Elsevier, FAOSTAT, World Bank, International Labor Organization, etc.). Peer-reviewed journals papers, national and international technical reports, books, and research dissertations were included and are listed in the reference section for consultation.
4. Identification of opportunities with mitigation potential. Across the literature review, opportunities were identified with any quantitative or at least qualitative attempt to measure mitigation potential over the emissions of one or several greenhouse gases (Carbon dioxide (CO_2), Methane (CH_4) and Nitrous oxide (N_2O)).
5. Identification of co-variables associated to mitigation potential interventions. In addition to the mitigation potential, the co-benefits, challenges and adaptation potential related with the implementation of the described opportunities, were reported when any qualitative description provide by the cited literature or in consultation with external experts.

Phase 3. Classification of the opportunities along the food systems

6. Identification of mitigation potential opportunities along food systems components and stages. The interventions with mitigation potential were addressed along the five different stages identified for the food systems: Pre-production, Production, Post-production, Consumption, and Waste. The interventions were also organized according to the particular stages (i.e. agronomy practices, grazing management, manure management, waste management, etc.) where interventions are expected to take place inside each food system component (i.e. inside Production stages).
7. Identification of mitigation potential opportunities across global regions. Interventions with quantified mitigation potential were also classified into the four previously selected global regions according the countries where measurements takes place. Data from Argentina, Belize, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Guyana, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Suriname, Uruguay and Venezuela, were available for Central and South America (CSA); data from India was available for South Asia (SA); data from USA and New Zealand were grouped as North America (NA); and data from Burkina Faso, Mali, Niger, Senegal, Ghana, Nigeria, Kenya, South Africa, Tanzania, and Uganda was available for Africa (A).

Phase 4. Identification of main patterns for intervention with Mitigation Potential

8. Analyses of the distribution of the number of interventions across food systems components. The resulting literature included over 160 potential interventions for mitigation along the three food systems and the four global regions. The number of interventions with any mitigation data were described in terms of the amount of research, expert confidence, cost estimate, implementation time, and scale and action category were summarized based on the specific information by region in consultation with other experts.

Phase 5. Input from Global Scientific and Technical Stakeholders

9. Presentation of the opportunities for mitigation along food systems in an international dialogue. The mitigation opportunities were presented during the 2nd International Dialogue: The Future of Food in a Climate Changing World a Climate Changing World organized by The Global Alliance for the Future of Food on 2-3 May 2017.