Comments to Perfecto and Vandermeer from University of Minnesota

Comments from: Jeanine Cavender-Bares, Barett Colombo, Baishali Bakshi, John Sheehan, David Bael, Matt Burgess, Nathan Mueller and John Vincent.

Perfecto and Vandermeer's paper [4] finds that convergent agricultural systems (small-scale farming with mixed agricultural models) are better able to sustain biodiversity compared to conventional divergent systems (large-scale intensive farming), though they have the same yield compared to divergent systems. The latter is based on results of a study [1] that shows equivalent or higher productivities for convergent agriculture in different global case studies with respect to FAO average yields for a country (presumed to be predominantly conventional). One example of prior research on convergent systems is the forest transition model (FTM), which the authors improve on by factoring in ecological parameters like spatial aspects of conservation into agriculture by developing an 'agroecological quality matrix' . They find that convergent systems using this spatial matrix approach are able to conduct sustainable agriculture mainly owing to two features of small farms:

1. The paper's eco-agricultural quality matrix leads to a meta-community structure of the landscape under use. As a result individual plots or regions within this landscape are more connected and friendlier to biodiversity conservation through migration.
2. Small farms are able to conduct 'precision agriculture', i.e. as small farmers work with smaller amount of land, they have more precise information regarding their land with respect to its fertility and other agricultural/ecological parameters. Thus they are able to reduce uncertainty in crop success and yield that conventional agriculture is normally subject to.

The University of Minnesota comments on the Perfecto and Vandermeer paper centered mainly on the above two points and are listed here as follows:

1. Biodiversity conservation through convergent agriculture:
    a. Too simplistic: The paper's distinction between conventional(divergent) and convergent agriculture in terms of yield and biodiversity could be perceived as too simplistic and based on an improper comparison of pure agricultural models of heavily intense monocultures (without consideration for uncultivated pristine land) on one side and small scale mixed models that have small plots of agriculture interspersed with pristine land. (raised by Matt Burgess).
    b. Generality: The argument that small farms are friendlier to biodiversity cannot be applied universally. There are many species, especially predators who require large territories and home ranges to successfully hunt and raise young (raised by Nathan Mueller).
    c. Analysis of benefits from small-scale systems: If we were to make a completely numerical comparison, then it is possible to get the same number of species in a large system as it is in a small system through migration. This point is important as it was discussed in the previous session's presentation by Steve Carpenter with

respect to migration preventing local extinctions in frog communities. Thus local extinctions may not be important since they could be easily replaced by recolonization of the same habitat through migration. Even if migration does not occur, it is not certain that the death of existing biodiversity is final. There is evidence from Dan Janzen's [2] work on the regeneration potential of tropical forest fragments that shows that so called 'standing dead' trees in a converted biodiversity hotspot are actually species sources (not sinks) (raised by Jeanine Cavender-Bares). The upshot from all this is that the spatial aspect of agriculture is important as it involves specific migration pathways for biodiversity so the paper's consideration of the spatial aspect through its quality matrix is commendable. However, a more in depth analysis of the overall benefits of small-scale farming to biodiversity would have been more appreciated.

2. Small farmers are able to conduct precision agriculture
    a. Lack of evidence: The paper presented evidence from the inverse relationship between farm size and productivity to make their point about precision advantage of small farms. The U of MN seminar participants wanted to see more established proof of this point especially since it is not obvious. Precision agriculture is dependent on several other factors besides farm size, for example institutions, political regime, property rights existing in land, human density, poverty and economic disparity to name a few. Also the paper's reliance on case studies to compare yields of convergent and divergent systems does not make a satisfactory case for their hypothesis since individual plot yields in case studies may be subject to overestimation bias compared to regionally aggregated yields [3] (raised by Nathan Mueller).
    b. Economic efficiency of small farms: The paper did not really address the economic side of convergent agricultural systems as opposed to divergent ones beyond stating that convergent farms perform better on biodiversity conservation and equivalently in terms of yield. It is not clear that small farms are necessarily more sustainable (combination of ecological and economic efficiency) compared to larger ones, even if we accept their 'precision agriculture' aspect. In this context U of MN referred to Steve Polasky's paper [5], which provided a range of optimality options with respect to sustainability and economic efficiency on a concave 'efficiency frontier'. A particular farm could examine its overall sustainability in terms of its distance from this efficiency frontier and then could undertake economic/ecological measures to take it there. The present paper does a wonderful job of incorporating the spatial aspects of conservation with respect to agriculture but does not provide enough coverage on economic efficiency of such systems. This leaves a 'policy void'. Therefore, addressing the economic performance of convergent systems and specifying more clearly the policy

objectives with regard to both ecological and economic aims would be beneficial for the paper.

3. Desirability of small-scale farming with respect to meeting needs of growing population: Sustainability includes preservation of natural capital as well as provision of human well-being. Thus decreasing agricultural productivity by using convergent systems may not answer to the demands of world hunger even if they preserve biodiversity. Given current global consumption patterns, it is probable that existing production will not meet the demands of the incoming population. It is true however that a more important cause of world hunger is poverty as opposed to insufficient production (raised by Barett Colombo). However it is not obvious that adoption of small –scale agriculture will reduce economic discrepancies and promote a more efficient distribution of production across the world.

References

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5. Polasky et al 2008. Where to put things? Spatial land management to sustain biodiversity and economic returns. Biological Conservation 141(6), pp. 1505-1524.