**Examining Options for Certifying Ecological Farming Principles: The Case of Integrated Pest Management**

**Abstract:**

**Introduction:**

Farmers, scientists, and civil society groups have developed and promoted many new frameworks for improving environmental and social outcomes from agriculture. Some of these strategies are associated with grassroots social movements, such as agroecology and the system of rice intensification (SRI), while others, like Climate-Smart Agriculture and conservation agriculture, are more associated with agribusiness and existing government institutions. Despite their differences, many of these strategies are conceived of as decision-making or design frameworks that can be adapted to a wide range of ecological and social contexts.

Defining these strategies as frameworks or sets of principles, rather than technological packages, presents difficulties for “Boolean” (True or False) classification of farms relative to a strategy. Organizations promoting such strategies face difficulty tracking their adoption and may counter-productively simplify a strategy into the presence or absence of a few well-defined techniques (Giller et al., 2009). Scientific inquiry can become divided between researchers who study a strategy as a “recipe” through controlled trials and those view it as a flexible set of principles to be examined through case studies of implementation on real farms. These divides are particularly large regarding Holistic Management Planned Grazing (Briske et al., 2008; Gosnell et al., 2020) and the System of Rice Intensification (Glover, 2011; Sheehy et al., 2005).

Ecological and social certification of farming systems require such Boolean classification. Such certifications have become increasingly prominent as part of the “neo-liberal turn” towards non-state governance in the late 20th century (Vogel, 2008). Between 1985 and 2000, most high-income countries developed frameworks for certifying organic agriculture, “Fair Trade” shifted from a set of grassroots relationships to a product label built upon certification and several environmental NGOs launched agriculture and forestry certification schemes. Since that time, numerous other production standards have been developed, whether by corporations seeking to “co-opt” the eco-label trend, producer organizations promoting better practices and product differentiation or NGOs seeking to promote sustainability.

Integrated Pest Management (IPM) is one of the most prominent frameworks for increasing eco-efficiency in agricultural systems. First formulated in 1959 (Stern et al., 1959), IPM is now promoted by a wide array of organizations throughout the world as a means of increasing yields while reducing harms from agrochemical use and ensuring the sustainability of food supplies. Like other ecological farming strategies, IPM is notoriously difficult to define (Bajwa & Kogan, 1996); it is alternately referred to as a “philosophy” (Sappington, 2014), “a way of thinking” (Maupin & Norton, 2010) or a ”decision-support system” (Kogan, 1998). Difficulties in Boolean classification of IPM have frustrated efforts to measure its adoption and impact (Castle & Naranjo, 2009; Ehler, 2006; Maupin & Norton, 2010; Sappington, 2014; Zalucki et al., 2009).

IPM is a concept that is broadly endorsed, but its exact meaning is highly contested. IPM is thus represented in a wide range of diversity of programs- certifications differ in their geographic scope, from small regions to international, and in their crop scope- from single commodity to any food commodity. Likewise, these programs differ in their origin and intentions, they may come from environmental or development NGOs, university extension services or some combination of the 3. Examining this set of certifications can give insight into the universe of possibilities for certifying and delineating alternative agriculture systems.

**Problems in certification:**

Ecological food certifications enable consumers to choose products that have un-observable characteristics that they favor, without having a personal relationship with the producer. These characteristics may be (believed to be) beneficial to the consumer, such as lower levels of pesticide residues, or conforming to the consumer’s ethical and political values, such as fairness to small farmers and workers or responsible stewardship of the environment.

Alternative food movements developed ecological and social certification of agricultural products as a tactic to strengthen their reach. The Demeter Biodynamic Farming certification was established in 1928 by a German biodynamic producers’ cooperative seeking to market to a substantial community sympathetic to Anthroposophy, the philosophical basis of Biodynamics. In the mid-late 20th regional associations of organic farmers in the U.S. developed certification standards to verify that products were produced in a manner consistent with organic principles. In the 1980s and 1990s, environmental and solidarity NGOs developed environmental and social standards for farming in low-income countries to sell certified products to consumers sharing their concerns. In all of these cases, certification was at an effort to enlist consumers in a social movement or to allow consumers to enlist their consumption within these movements.

To many, however, these certifications have not had the intended impacts. Anthropologists have documented perverse impacts from bureaucratic standards, including the fragmentation of traditional communities and exacerbation of local inequality (Bacon, 2010; Getz & Shreck, 2006; Mutersbaugh, 2002). As the scale and reach of organic agriculture has grown, simplified organic standards have encouraged “input substitution” rather than the re-design of farming systems among many new entrants to organic farming (Guthman, 2000; Rosset & Altieri, 1997).

Complexity and adaptation are a central problem for alternative food certifications. Many original certifications were developed to empower small farmers to continue and deepen their existing ecological stewardship through price premia and technical assistance. Certification, however, necessarily limits the actions that a farmer might take. This represents a problem given the widespread belief that organic (and other ecological) farming is not based on a “recipe” (Lyon et al., 2011) but is rather built on contextual and reciprocal relations with a particular local ecology (Bell et al., 2008; Jackson & Berry, 2009). This makes developing rules to sort farms into or out of a particular view of “ecological agriculture” extremely tricky. In the case of organics, this difficulty drove in rule-makers to collapse a complex philosophy into a set of record-keeping requirements and prohibited practices and materials.

Sustainable farming certifications attempt to achieve multiple goals. Early organic standards were primarily focused on connecting already-existing organic farms with consumers who wanted their goods, providing the farmers with recognition and a price premium, and consumers with products produced in a way that they demanded. Today, organic and other certifications often consciously work to expand their reach in order to increase conversion to sustainable practices and access to their products. This makes increasing the number of certified acres or amount of product sold an important goal of certification programs, creating tensions between realistically achievable and highly stringent standards. Numerous scholars have argued that this tendency has degraded stringency in standards in Organic and Fair Trade (Guthman, 2004; Jaffee, 2012; Jaffee & Howard, 2010). Different standards operating in the same areas adopt different positions regarding this trade-off; in sustainable coffee, Rainforest Alliance and Utz Kapeh have adopted looser, more-attainable standards to widen the breadth of their benefits as compared to Fair-Trade, Organic and Bird-Friendly (Raynolds et al., 2007).

Using IPM as a basis for certifying more sustainable agriculture poses a difficult problem. IPM’s branding as a decision-making framework and a toolkit make it difficult complicated to implement it as a dichotomous classification. As a decision-making framework, IPM is in-principle applicable in any farming system, no matter how biodiverse or input-intensive. Because the decision-making weighs multiple contextual factors, it may not be possible to determine adherence to IPM simply by looking at management decisions without knowing all of the factors going into them. Furthermore, as a toolkit, categorizing farms as “IPM Practitioners” could be extremely inclusive, counting farms that utilize any IPM tactics, or extremely narrow, only including those which use a wide range of tactics.

**Methods:**

A set of eco-labels for foods sold in the United States were assembled from the ecolabel index (cite). Inclusion criteria were: labels must be used (directly or indirectly) in the United States, and that the certification protocol must reference the framework of “Integrated Pest Management” in all, 23 certification programs were identified (Table 1). The certification protocols for these programs were inspected line by line and the criteria related to IPM were coded and categorized. Because some certifications included requirements relating to worker and environmental safety in handling and storage of pesticides under the rubric of IPM, these types of requirements were analyzed for all certifications.

Criteria were classified as “Requirements”: the applicant fails certification if the criterion is not met, “Improvement”: the applicant does not have to initially meet the criterion to pass, but after several years in the program, it becomes a requirement, and “Scorecard”: The criterion is assigned a certain number of points, and the applicant must achieve a certain number of points in total to pass.

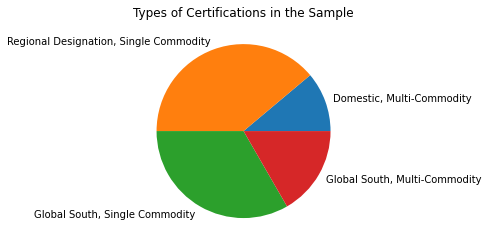
In addition to categories that were developed while coding the sample, criteria were coded based on their relationship to the 8 principles of IPM described by The EU Framework Directive 2009/128/EC:

1. Prevention and suppression
2. Monitoring
3. Decision-making based on monitoring and thresholds
4. Non-Chemical Methods
5. Pesticide Selection
6. Reduced Pesticide Use
7. Anti-resistance Strategies
8. Evaluation

Criteria could be classified as fitting more than one criteria, but criteria were not included if they advanced a principle only through another lower-numbered principle. For example, while prevention and reduced pesticide should also reduce resistance among targeted pests, criteria focused on prevention or reduced pesticide use are not classified as being about “anti-resistance strategies.”

Data cleaning and analysis were conducted in Python 3.8, and all graphics were made in the matplotlib graphics library(Hunter, 2007)

**Sample Description:**

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The scope of certifications is categorized across two dimensions, geographic and commodity group. Geographically, certifications were either for all areas within the United States, domestic but confined to a particular region, or focused on producers in the global south. In commodity scope, certifications were either for a single commodity/commodity group or for a wide range of commodities. Of the six possible combinations, only 4 were represented, there were no regionally specific multi-commodity standards and no domestic, nationally applicable standards for a single commodity group.

The organizations behind the programs differed- seven of 10 regional-designation certifications were developed by grower organizations in partnership with NGOs and/or Universities, while none of the other certifications had a high degree of grower engagement in their development. Four of the single-commodity global-south certifications were either primarily or jointly developed by businesses which market the final products. The remaining certifications were developed by Environmental and Socially focused NGOs.

**Results and Discussion:**

**Certification Structure:**

The criteria used within certifications were coded as being ‘affirmative requirements’, which farms must meet all of to pass, “scorecard criteria” where farms must earn a certain number of points to pass, and ‘improvement criteria’ which are scorecards where the farm’s performance must increase over time. 6 standards were classified as “primarily scorecard” with relation to IPM, 5 were classified as solely requirement-based, and 8 were “mixed” between requirements and scorecards and/or improvement.

**IPM Principles:**

Of the 8 principles of Integrated Pest Management, two, Monitoring and Pesticide Selection, were mentioned in at least one criterion for all certifications. 2 principles, Thresholds and Evaluation, were mentioned in less than half of standards, though participation in certification itself arguably constitutes a form of evaluation. Resistance Management only appeared in 13 certifications, and only was referenced more than once in three standards, but tactics from Principles 1, 3 4 and 6 all can contribute to managing resistance by reducing pesticide use.

**Overall Trends:**

Only two areas had criteria represented in all 24 certifications- record-keeping and training. The vast majority of certifications had at least one criterium relating to pest monitoring (22), planning (21), how pesticides are applied (21), materials management and storage (21) and workplace safety (21). 17 certifications ban the use of some pesticides, either based on their own list or one or more globally recognized treaty lists. Five certifications had no list of banned or restricted pesticides.

**Performance Standards:**

Three certifications, all regional-designation single-commodity, (Healthy Grown, Lodi Rules and Protected Harvest Citrus) utilized a toxicity-units model as a pass-fail criterion. These models are of the form:

For each pesticide p applied. Where TU is total toxicity units, is the toxicity score of pesticide p and is the mass of that pesticide applied. For each certification, a total TU cap is set, and farms must stay at or below that cap.

Figure X: % of Certifications, by Group, including criteria relating to different areas.

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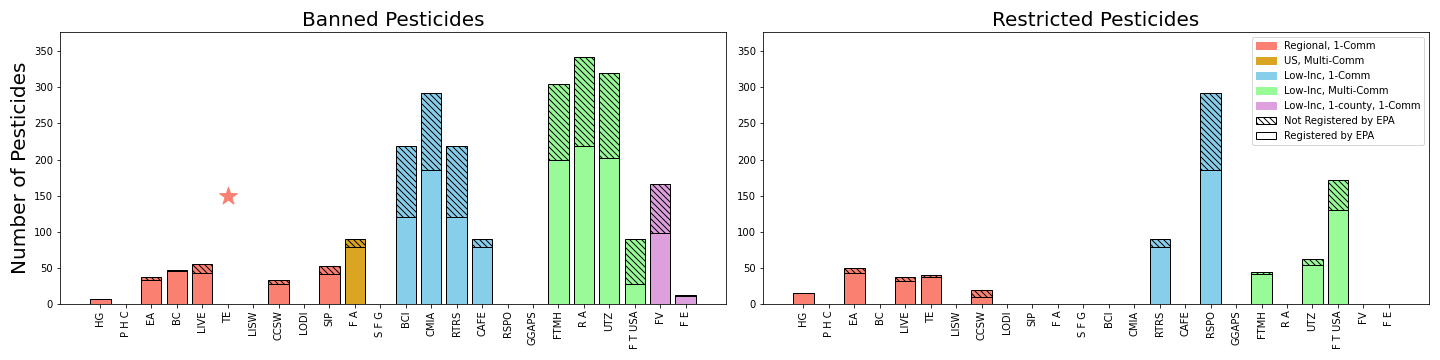
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Single-region single-commodity certifications stand out as different from other groupings. These certifications include the most criteria overall, more monitoring criteria, including action thresholds, more likely to promote Mode-of-Action (MOA) rotation, and included more criteria relating to biosecurity and sanitation. Further, these were the only certifications which specified the use of models for predicting pest pressure or pesticide toxicity models to measure performance. The difference in number of criteria is particularly stark for most IPM Principles (Table X).

For prevention, monitoring and non-chemical control most regional-designation certifications included multiple region-specific or crop-specific requirements or options, while the vast majority of other certifications simply mentioned the need to incorporate these areas in a general sense. Regional-designation certifications also included more criteria for pesticide selection; many include several different environmental considerations, including threats to water quality and beneficial insects. These certifications also include far more criteria for directly reducing pesticide usage, including requirements or options for ensuring correct spray coverage and use of spot-spraying or block-spraying for specific pests.

These differences likely reflect two factors. First, standards for a specific crop in a specific agroecological zone can be more exhaustive and specific. Several of the standards in this group contained monitoring and/or threshold standards for several different insects and diseases. Comprehensive description of monitoring and threshold techniques for “any pest, any crop, anywhere” is obviously not possible within a single guidance document. Similarly, the thresholds for an acceptable toxicity load in a toxicity model may be very different across different crops or agroecologies. Regionally-specific

Additionally, these differences in standards reflect the collective-action and public-goods aspects of IPM. In contrast to many other environmental problems in agriculture, chemical resistance in pests and the import of exotic pests and diseases are public goods problems that are spatially bounded and primarily impact the farmers themselves. The same applies to natural enemies, to a lesser extent. These issues closely resemble the types of problems successfully dealt with by informal “commons-type’ governance structures (Ostrom et al., 1999); individual efforts in these areas can have high positive externalities within the community of crop-producers, creating the potential for free-rider problems. As such, certification provides the opportunity not just for farmers to differentiate their products to consumers as ecologically friendly, but to coerce each other to better manage key public goods and bads. Resolving such collective-action problems has long been acknowledged as a key challenge and opportunity in IPM promotion (Bottrell & Schoenly, 2018; Parsa et al., 2014).

Certifications focused-on low-income countries were different in two respects. First, the number of banned and restricted pesticides tends to be much greater. This likely reflects the fact that many of the banned pesticides are not allowed for use on crops in some countries but not others. More interestingly, these standards place much more emphasis on worker safety and hazardous materials handling. This not only reflects the different missions of some of the certifications, which often foreground social concerns, but also the role that these certifications play in substituting for and supplementing legal standards in these areas.

One-commodity regional domestic certifications generally included some worker protections. Most of these commodities commonly utilize migrant agricultural labor. Wisconsin Healthy-Grown Potatoes is the only one of these certifications not including any worker protection criteria; migrant farmworkers do not commonly work in this crop-sector.

**Lessons:**

Regional-Designation certifications function very differently than others. They tend to be developed more closely with growers, pursue management of collective-action problems beyond simple marketing and codify regional best-management practices while also allowing growers more flexibility. This allows for certification standards to be potentially more rigorous without being overly constraining upon farmers’ flexibility. On the other hand, these standards can overlap, creating the potential for confusion; our sample includes three different sustainable winegrowing certifications for California.

Globally-focused standards face the tradeoff between stringency and flexibility more starkly. Employees of UTZ and Rainforest Alliance have described to researchers an explicit intention to create standards which accessible to any producer, to ensure that the standard can eliminate the worst environmental and social abuses from as many farms as possible (cite). The content of these standards relating to pest management generally focuses on worker safety, hazardous materials handling, bans on the most toxic pesticides, and general planning and record-keeping requirements. Preventing pests and disease, and cultural/ecological methods for managing pest populations are only enforced in a general manner.

In this manner, standards with broad applicability may partly follow after the organic standard- the bulk of the power within the standards focuses simply on practices to be banned, as prescriptions for sustainability will be too contextual to fit into a global standard. Becoming too strict in standards may not only reduce the economic viability of a certification, but also have perverse impacts if a banned tool or technique is occasionally the most ecological friendly option[[1]](#footnote-1). Requiring planning, record-keeping, monitoring and training may help farmers find opportunities to reduce their impacts, but is unlikely to resolve any inherent conflicts between productivity and environmental concerns.

**Conclusion:**

Twenty-four alternative food and agriculture certifications were analyzed for how they operationalize the concept of “Integrated Pest Management”, through their standards. These standards showed markedly different patterns based on their geographic and crop scopes- while standards developed in one region for one crop function as compendia of best practices with a high degree of specificity. Other standards tend towards enforcing a “floor” of banned materials and practices and requiring basic planning and record-keeping, which may assist farmers to improve their practices and impacts.

These results emphasize the difficulties involved with defining agricultural production systems in a rigorous and repeatable manner. While this study focuses on non-governmental labeling programs, these same problems can arise in any effort to dichotomously categorize farming systems. These results show that such classifications can most easily function to uphold basic standards on a broad scale or to codify a menu of well-known BMPs on a local scale. Broadly applicable checklists for classifying farming systems as using “Integrated Pest Management” or other holistic strategies are likely infeasible.

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1. For instance, organic agriculture’s ban on herbicides may promote unsustainable levels of tillage in some farming systems (Carr, 2017), while bans on synthetic pesticides may not result in lower total environmental impact from pest control in all crops (Kovach et al., 1992). [↑](#footnote-ref-1)