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Integrated Crop–Livestock Systems: Strategies to Reduce Risk and Increase Farm Resilience

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About the Author

Anna Herzberger is a fifth-year Ph.D. candidate at Michigan State University's Center for Systems Integration and Sustainability. Her dissertation research focuses on the environmental and socioeconomic effects of international soybean trade and utilizes a variety of interdisciplinary research methods, including international trade and agricultural economics, network analysis and farmer-decision making, as well as soil and microbial sciences and computational modeling.

Foreword

Integrated crop–livestock systems have experienced a rebirth as farmers, scientists, food and agricultural nongovernmental organizations, and government agencies tout the economic and environmental benefits of such farming systems.
This paper was written by Anna Herzberger, a Ph.D. candidate at Michigan State University's Center for Systems Integration and Sustainability, with support from AGree. The author provides a primer on integrated crop–livestock systems (ICLSs), which have been gaining attention for their potential economic and environmental benefits. The paper provides a brief overview of the historical context that led to the decline of ICLSs over time and discusses barriers to and strategies to increase the adoption of ICLSs by today's farmers.

AGree offers this issue paper to foster productive dialogue. While the concepts discussed in the paper are intended to enrich AGree's and others' discussions on food and agriculture policy, they do not represent official AGree positions.

We hope you find this paper to be a helpful resource.

Sincerely

Deborah M. Atwood
Executive Director, AGree

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Overview

Integrated crop–livestock systems (ICLSs) have experienced a recent rebirth as scientists, nongovernmental organizations, and government agencies tout their economic and environmental benefits. However, substantial roadblocks still prevent the widespread establishment and implementation of ICLSs. The first two sections of this paper discuss the context that led to the decline of ICLSs and compare ICLSs to conventional agriculture systems. The third section describes the major components of ICLSs, followed by a discussion on barriers to the establishment of ICLSs. The last section highlights possible strategies to increase the adoption of ICLSs.

Historical Context

Prior to the 1970s, government farm programs and policies were designed to manage supply. In response to Russian grain sales in the early 1970s, however, farm policy began a shift toward market-oriented production that aimed to capture international grain markets. Farm policies accelerated farm expansion and specialization, with farmers focusing on either crops or livestock. Over the next three decades, integrated crop–livestock farmers in the Corn Belt gradually reduced their livestock operations and shifted toward strictly crop production. Separated from integrated farms, livestock-only operations became bigger and specialized regionally, moving into feedlots and livestock house operations. This divergence led to separate, yet highly efficient, crop and livestock systems that lack economic and ecological diversity. The tendency for farmers to specialize production to only few commodities presents risks in the event of any type of shock (e.g., extreme weather, disease or pest outbreaks, price cycles, market fluctuations, etc.). ICLSs have been proposed as a strategy for potentially reducing on-farm risk and increasing the resilience of agricultural systems.

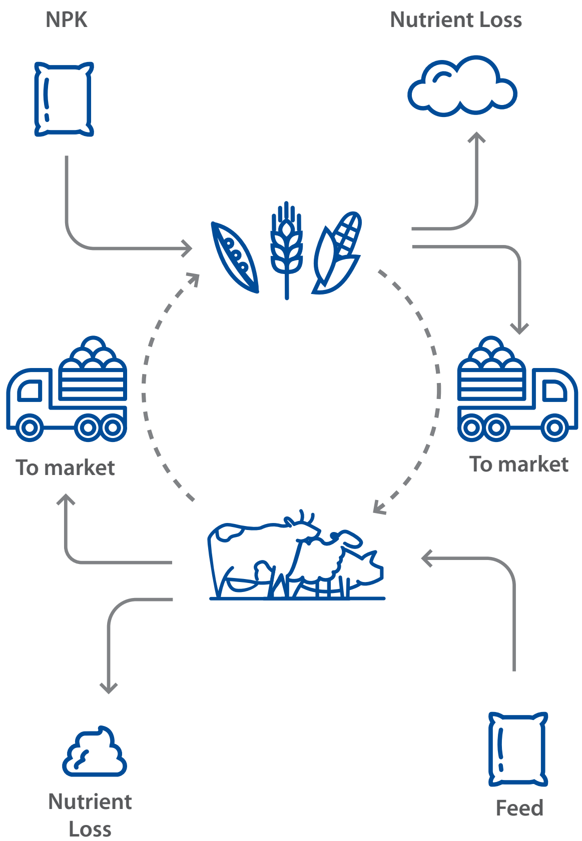
How Do ICLSs Differ from Conventional Agriculture Systems?

The goal of conventional agriculture systems—especially monoculture systems and confined livestock systems—is to maximize yield and deliver a limited number of commodities to the market consistently. Monoculture systems and confined livestock facilities are used to limit exposure to pests and disease and thereby increase the resources available for the production of grain or meat. Synthetic fertilizers and grain-based feeds are used to meet nutrient needs and maximize production, and the by-products are often lost to the environment in the form of pollution (e.g., greenhouse gas emissions, nutrient runoff and leeching; see Figure 1). The tendency for conventional crop and livestock operations to bring nutrient inputs (e.g., fertilizer and feed) from outside the system and to release nutrient waste outside the system has resulted in multiple environmental impacts and interrupted natural nutrient cycles.

By contrast, certain types of ICLSs (e.g., well-managed rotational grazing systems with frequent moves and moderate stocking densities; Pelletier et al. 2010) integrate crop and livestock production in a manner that improves the nutrient cycle, which has been shown to improve ecosystem function and increase ecosystem services and can also increase resilience to shock and diversify revenue sources. Depending on the conditions (e.g., soil types), some types of ICLSs may also result in beneficial nutrient flows by using the by-product from one system (e.g., crop residue or livestock manure) as a nutrient input into the other system (e.g., animal feed or crop fertilizer) (Henderickson 2008, Lemaire 2013, Soni 2013).

Figure 1 | Conceptual diagram showing both a conventional and an integrated agricultural system.

The solid gray arrows depict the flow of nutrients in a conventional system. The solid and dashed gray arrows depict the nutrient flows in an integrated system.



Major Components of Integrated Crop–Livestock Systems

The overall goal of ICLSs is to tighten nutrient cycles in order to improve water holding capacity and water quality; reduce nutrient inputs, leeching, runoff, and volatilization (i.e., greenhouse gas emissions); reduce costs; and maintain yields. The transition from a conventional corn and soybean rotation to an ICLS can be summarized by the following principles (Moseley 2019, Kane 2015, Lemaire 2013, Brown 2018).

- Limit soil disturbance to preserve the microbial community. Conventional tillage destroys soil structure and can lead to erosion. No-till and strip tillage practices should be used to limit soil compaction and preserve fungal hyphae networks, which can aid in root development and nutrient uptake.
- Armor the soil surface with plant coverage (e.g., cover crops/crop residues) at all times to limit erosion and provide carbon to fuel the microbial community.
- Grow a diverse aboveground plant and animal community that enhances ecosystem function by mimicking natural processes such as improved nutrient cycling and reduced pressure from pests. ICLSs encourage the use of extended crop rotations that incorporate small grains (e.g., rye, oats, ryegrass), legumes (e.g., soybeans, clover, alfalfa), and cover crops.
- Develop deep root systems that provide carbon to the microbial community, which in turn can improve nutrient uptake and water holding capacity and limit nutrient leeching and volatilization.
- Integrate livestock into the farm system. The grain as well as the crop residue contain valuable nutrients for livestock production and can offset feed costs. Legumes and livestock manure fix and retain nitrogen and organic carbon in the soil and build soil health. Allowing livestock to graze minimizes the energy and financial costs of harvest or cover crop termination and adds economic diversification to the farm portfolio. Adaptive grazing strategies utilize high livestock densities, frequent moves, and long recovery periods for paddocks. This approach improves soil health evenly across a field, limits soil compaction, and reduces nutrient overload and deficit due to concentrated manure deposits.

By investing in functioning ecosystems and diversified marketing opportunities, ICLSs can increase resilience to extreme weather patterns (e.g., droughts, floods, high winds) and price cycles (e.g., extended periods of low prices).

Barriers to the Adoption of Integrated Crop–Livestock Systems

Recent research appears to support the environmental benefits and economic feasibility of integrated crop–livestock production; however, significant barriers that prevent the widespread adoption of ICLSs still remain. One such barrier is government support for export-oriented production, which largely favors corn, soybean, and wheat operations. Nearly 70 percent of crop insurance premium subsidies, 90 percent of Agricultural Risk Coverage payments, and half of Price Loss Coverage payments are to corn, soybean, and wheat operations (USDA-FSA 2019; Congressional Budget Office 2017). This significant financial support for conventional agricultural can put farmers who use extended rotations or grazing practices at an economic disadvantage, at least in the near term (Henderickson 2008).

An additional side effect of the expansion and specialization that has occurred over the past five decades is that an entire generation of farmers lacks experience on how to appropriately manage and integrate livestock into their farm systems. Furthermore, academic, government, and industry research and development efforts since the 1970s have largely reinforced conventional agricultural systems. For example, livestock genetics have overwhelmingly been selected for feedlot gains and can perform poorly in a forage environment (Kleinchmidt 2019). The systemic support for conventional agricultural operations limits the adoption of ICLSs at a national scale.

At the farm scale, additional investment and labor capital requirements, compared to conventional agriculture systems, are also barriers to the adoption of ICLSs. In addition to direct costs for the seeding, planting, termination, and harvest of feed and forage crops, costs are incurred for additional infrastructure such as fencing, water, shelter, and spreaders (Williams and King 2018). The initial startup investment can be hefty, and the mechanisms for operating loans and insurance coverage are less developed. In addition to the financial burden, ICLSs require additional labor. Livestock need to be tended to daily, which can offer an operator additional income and work during the off-season, but can compete for the operator's time during the harvest and planting seasons as well as limit leisure opportunities (Kleinchmidt 2019).

Solutions to Increasing Integrated–Crop Livestock Systems: Strategies, Schemas, and Support Programs

ICLSs can vary in scale, ownership, and enterprise combinations such that implementation and management are feasible for a variety of farmers. In some cases, farmers can diversify their operations by adding livestock to the farm enterprise. If the increase in investment and labor capital makes that option infeasible, the first four principles of regenerative agriculture listed previously are still valuable steps toward a more resilient operation. While livestock integration does speed up the regenerative process, the transition to an ICLS is a lengthy and an uncertain process that may require incremental steps.

Marketing Strategies

Increasingly, consumers desire products that were produced in an environmentally sustainable way and are asking producers to reduce their fertilizer and pesticide use, lower greenhouse gas emissions, and protect waterways. Between 2012 and 2016, for example, sales of grass-fed beef increased more than 16 times, from $17 million to $272 million, of which only 15 percent was produced domestically and the remaining was imported (Fassler 2018). To capitalize on this demand, various marketing strategies exist, such as premium markets, management certifications, and eco-labels that can increase price and in some cases, reduce input costs (Kremen n.d. 2003).

Ownership Schemas

Decoupling land and livestock ownership is another way to facilitate the transition toward integrated operations; these options limit initial investment costs and ownership risks while delivering environmental and economic benefits to the farm. One example is contract grazing—a fee-based, seasonal arrangement in which the ownership of land and livestock are decoupled (Stockwell, 2019). The landowner provides pasture/field, water, and shelter access while the livestock owner supplies the cattle, sheep, or other animals. Through grazing contracts, row crop farmers are free to focus on grain production and diversify their farm enterprise without the added risk or labor burden of owning and managing livestock. Livestock operators are also free to specialize their production, offset feed costs, and rest their owned pastures.

This scenario allows both operations to achieve the economies of scale required to be competitive in the industry (Bishopp 2015). Furthermore, because grazing contracts are short-term agreements between two parties, there is limited initial investment required (i.e., producers do not need to invest in land or livestock because the other party has already), which mitigates risks and accelerates growth. Contract grazing can be appropriate for goats, sheep, bison, dairy cows, or beef cattle. Payment plans (e.g., flat rate, daily fees, or sliding scale rents) should be established prior to grazing and are designed to compensate for the production goal (Ekstrom 2013).

Support Programs

Transitioning toward an integrated production system requires a farmer to take risks, a proposition made more difficult when prices are low. While marketing strategies can provide new revenue streams, some certifications require years to obtain and new infrastructure to process, store, and transport foods targeting these new markets. Furthermore, in response to consumer demands, many companies require farmers to use more sustainable practices but are unwilling to pay the premium prices that would aid farmers in that transition. For example, a linchpin of integrated systems is the inclusion of small grains, for which limited markets exist. It is critical for the food industry to promote a diversity of grains that can be milled and sold in the supply chain, in order to provide farmers with new markets and support the transition to ICLSs (Moseley 2019). In addition, livestock contracts can limit risk, but contractors may dictate growing conditions, which can limit the potential environmental benefits from integrated livestock on the farm.

Due to the high level of uncertainty, farmers in transition may require additional support. Many of the current conservation programs available through the Farm Bill could support the adoption of and transition to ICLSs (Lilliston 2018). The Working Lands Conservation programs, for example, provide support to implement conservation practices (e.g., climate, water, and soil-friendly practices) on land actively being farmed. These programs include the Conservation Stewardship Program, which focuses on soil health, water quality, perennial grasses, sustainable livestock management, and cover cropping; and the Environmental Quality Incentives Program, which supports approaches to increase agricultural resilience from weather extremes and other shocks. Many of these programs are underfunded, however, and demand far exceeds the resources that are available.

Other opportunities include improving and expanding the Whole Farm Revenue Insurance program, which may support ICLSs by linking premium subsidies to farm practices that protect the land, water, and health and by providing revenue coverage for both crops and livestock in a single policy. (See the AGree issue paper *Specialty Crop Risk Management* by Cara Fraver, Scott Marlow, and Jonathan Coppess for more information.) And finally, greater access to Farm Service Agency loans could be used to encourage ICLSs and emerging markets (Lilliston 2018).

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AGree drives positive change in the food and agriculture system by connecting and challenging leaders from diverse communities to catalyze action and elevate food and agriculture as a national priority. AGree recognizes the interconnected nature of food and agriculture systems globally and seeks to break down barriers and work across issue areas. Through collaboration and frank discussion, AGree continues to encourage a broad coalition of interests to build trust, find common ground, and develop shared strategies for achieving transformative change.

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