In country farms, as in people, a plain exterior can reveal hidden riches.
Aldo Leopold, *Round River*

**The changing agricultural landscape**
- “Green Revolution” resulted in substantial changes in agriculture
- Yields have increased 2% per acre each year since 1948
  * Corn: 38.5 to 118 bushels/acre/year from 1930 to 1985
  * Wheat: 16.7 to 37.5 bushels/acre/year
  * Milk: 5,314 to 13,786 lbs/cow/year

**Increased production has occurred with shrinking labor force**
- In 1930, 30% of U.S. population was involved in food production....
  in 1950, 17%
  in 1995, 2%

**Increased production is a result of:**
- Improved understanding of animal husbandry & farming
- Substantial increases in the use of fertilizers
- Substantial increases in the use of pesticides
- Reliance on monocultures

**Fertilizers:**
- Three principle plant nutrients:
  * Nitrogen
  * Phosphorus
  * Potassium
- Total U.S. use of fertilizers increased from:
  * 8 million tons in 1960
  * to over 19 million tons in 1990
How farmers maintain Nitrogen (N):

Historically, crop rotation

Currently, N applications

*Corn applications have increased from 57 to 110 lbs/acre from 1960 to 1990*

Pesticides:

Total pounds of pesticide active ingredients in U.S. farms have increased 170% from 1965 to 1985

Farmers have specialized to maximize their productivity:

Historically, farms were small and diverse, creating a heterogeneous landscape.

Today, most farms are large monocultures.

Number and size of farms:

• Number of U.S. farms has declined from 5.9 to 2.0 million, 1945 to 1990

• Total acres harvested has remained constant at about 340 million acres

• Average farm has tripled in size

Cultural as well as biological consequences

There are two spiritual dangers in not owning a farm. One is the danger of supposing that food comes from the grocery, and the other that heat comes from the furnace.

*Aldo Leopold, 1949*

To live, we must daily break the body and shed the blood of Creation. When we do this knowingly, lovingly, skillfully, reverently, it is a sacrament.

*Wendell Berry, 1981*

Impacts of agriculture on wildlife:

• Negative effects:
  * Direct habitat loss
  * Habitat fragmentation
  * Habitat degradation
  * Ecological shifts
  * Poisoning
Habitat loss:

- Slash and burn agriculture
  - the primary immediate cause of tropical deforestation is ag (esp. cattle & soy production)
- Mangrove forests
  - mangrove forests are one of the most imperiled habitats on earth, and they are increasingly lost for conversion to shrimp farms
- US Native grasslands
  - tall-grass prairie has been reduced to less than 2% of its original extent
  - short-grass prairie is reduced to 18% of its historic range
  - both prairie reductions are the result primarily of agriculture, especially grain crops
- Wetlands
  - many wetlands have been drained for agricultural use (e.g., prairie pot-hole region, California’s Central Valley has only 1% of its original valley-riparian forests)
  - however, some wetland agricultural systems (e.g., rice cultivation) can be well integrated with waterfowl management
- Eastern deciduous forests
  - agricultural area has risen and fallen in last 200 years – recovery???

Habitat degradation at the farm scale:

- Landscapes with fencerows, woodlots, and shelterbelts have yielded to…
  - landscapes with single-crop fields bordered on all sides by more fields.
- California’s varied topography and high-priced fruits have slowed this trend relative to other states.

Habitat degradation at the farm scale is especially damaging in landscapes with little other habitat.

- California Central Valley
- Grain belt of the Midwest

Physical disturbances in farms habitats are commonplace

- Plowing or discing at least once per year to rotate crops and reduce weeds
- Forage crops usually mowed or hayed at least twice per year
- Nest destruction and/or direct mortality of adult wildlife often result – ecological traps

Agricultural effects on water quality, a few points

- Agriculture is the largest nonpoint source of water pollution, accounting for up to 50% of all contaminated water
- Water from irrigation and precipitation leaves agricultural areas carrying:
  - Sediments
  - Nutrients
  - Pesticide residues

Sediments, Nutrients, Pesticides……

- More sediment = less clarity; reduced aquatic vegetation
  - Florida Bay sugar-cane run-off
- More nutrients = algal blooms; decay, and O₂ depletion
  - Salton Sea
Sediments, Nutrients, Pesticides……

• More sediment = less clarity; reduced aquatic vegetation
  *Florida Bay sugar-cane run-off*

• More nutrients = algal blooms; decay, and O₂ depletion
  *Gulf Coast “Dead Zone”*

  eutrophication contributes to hypoxia

Sediments, Nutrients, Pesticides……

• Mineralization & salinization can increase selenium concentrations and waterfowl die-offs
  *Kesterson Wildlife Refuge*

Integrating wildlife and agriculture successfully

Five ways, by creating and/or maintaining:

1. Field borders
2. Food plots
3. Shelterbelts
4. Fencerows and “odd areas”
5. Alternative cultivation practices

Field borders

Planting or maintaining permanent vegetation on field borders

• enhanced vertical and horizontal habitat diversity
• nesting cover for small birds & mammals
• can reduce soil erosion and improve water quality

Food plots

Leave or plant 3-10 meters of grain crops along field borders to provide food for wildlife

**Cover**

**Food plot**

**Crops**

Best where adjacent to existing cover

Pesticides residues have caused declines in wildlife populations, especially fish-eating birds.

• DDT banned in 1972
• but still produced in U.S. and used in other countries
• Parathion, Fenthion, and others continue to kill wildlife

Kesterson Wildlife Refuge
**Fencerows, shelterbelts, and “odd areas”**

**Alternative cultivation practices**

- Conservation tillage; multi-cropping
- Organics
- Community supported agriculture

*Do these systems support more wildlife?*

**Alternative cultivation practices**

**Conventional tillage**

**Alternative cultivation practices**

**Conservation tillage**

- Leave previous year’s crop residue behind
- Good for soil, but do these practices affect wildlife directly?

**Alternative cultivation practices**

**Organic farming**

- Few to no agrochemicals
- More edges & smaller farms

**Integrating wildlife and agriculture successfully**

Average size of farms (2002 census):
- US = 441 acres
- California = 346 acres

Percent of farms family-owned:
- California = 81%
- Humboldt County = 88%

Percent of farms applying “significant” agrochemicals:
- US = 60%
- California = 59%
- Humboldt County = 19%
Alternative cultivation practices

Subtle changes in ag. practice timing can have big effects on wildlife

- Killdeer nest mid-March through mid-April (first brood) and even into May and June for later broods. Minimizing disturbance during this period will allow successful fledging.

- Mourning dove nest cycle is 28 days; farmers who enter their fields at intervals greater than this will allow some nests to be successful.

Habitat and biodiversity differences between matched pairs of organic and non-organic farms containing cereal crops in lowland England were assessed by a large-scale study of plants, invertebrates, birds! and bats. Habitat extent, composition and management on organic farms was likely to favour higher levels of biodiversity and indeed organic farms tended to support higher numbers of species and overall abundance across most taxa. However, the magnitude of the response varied: plants showed larger and more consistent responses than other taxa. Variation in response across taxa may be partly a consequence of the small size and isolated context of many organic farms. Extension of organic farming could contribute to the restoration of biodiversity in agricultural landscapes.

If environmentally friendly ag practices reduce yield,

then more total land must be devoted to cultivation to meet food production needs.

“wildlife-friendly farming” vs. “land-sparing” strategies (more later)
Farm Bill (2002) programs that encourage better farm practices

• First passed in 1949
• Up for renewal—every 5 years (2002, 2007)
• Originally established in New Deal era of legislative philosophy—intended to protect farmers and stabilize rural economies
• Beginning in 1985, the Farm Bill (technically “Food Security Act”) contained several conservation programs (which now offer $17 billion)

Conservation Reserve Program (CRP)
• Passed in 1985 under Federal Food Security Act (the “Farm Bill”).
• Farmers get paid to plant permanent cover crops (sometimes native species) on erodible land for 10 years.
• By nearly all accounts, this program has benefited soil and wildlife….and most farmers.

Modern “Set-Aside” Programs (Farm Bill 2002)

• CREP (Conservation Reserve Enhancement Program) – like CRP but more flexible and offers “bonus payments” for specific practices
• WHIP (Wildlife Habitat Enhancement Program) – landowners develop plans with NRCS biologists
• EQIP (Environmental Quality Incentive Program) – financial incentives to improve sustainability of agricultural practices

Payment for Ecosystem Services (PES)
• “Ecosystem services” are natural processes that help sustain and fulfill human life (water filtration, pollination, pest control, etc.)
• PES still theoretical in most places (except Costa Rica, and for most services (except carbon sequestration)
• Could have profound influence on the environment in the next century

“Wildlife-friendly farming” strategy versus “Land-sparing” strategy

Green et al. 2005, Science
Organic agriculture and the global food supply

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Renewable Agriculture and Food Systems: 22(2); 86–108

If yield diminishes slowly and/or modestly with increasingly ‘wildlife-friendly’ practices, then they are the better strategy.

If yield diminishes quickly and/or dramatically with increasingly ‘wildlife-friendly’ practices, then land-sparing is the better strategy.
Lessons of “wildlife-friendly-farming” vs. “land-sparing” strategies

Wildlife-friendly farming is best especially if:

- wildlife friendly farming sacrifices little/no yield
- farm yield/biodiversity curve is convex
- substantial long-terms costs of intense cultivation
- non-cultivated land unlikely to be “spared” for biodiversity

### Table 1: Average yield rates (tons/ha) for various crops and countries

<table>
<thead>
<tr>
<th>Food category</th>
<th>World</th>
<th>Developed countries</th>
<th>Developing countries</th>
</tr>
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<tbody>
<tr>
<td>Crop products</td>
<td>Y</td>
<td>A</td>
<td>N</td>
</tr>
<tr>
<td>Cereal crops</td>
<td>37</td>
<td>1,312</td>
<td>0.06</td>
</tr>
<tr>
<td>Soybeans and sunflowers</td>
<td>2</td>
<td>1,000</td>
<td>0.27</td>
</tr>
<tr>
<td>Crops and vegetables</td>
<td>15</td>
<td>1,010</td>
<td>0.07</td>
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<tr>
<td>Fruits, incl. wine</td>
<td>7</td>
<td>2,000</td>
<td>0.03</td>
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<tr>
<td>Oil crops and seeds</td>
<td>286</td>
<td>2,325</td>
<td>0.06</td>
</tr>
<tr>
<td>Meat and fish</td>
<td>8</td>
<td>0.008</td>
<td>0.01</td>
</tr>
<tr>
<td>Milk, incl. butter</td>
<td>8</td>
<td>0.014</td>
<td>0.04</td>
</tr>
<tr>
<td>Eggs</td>
<td>1</td>
<td>0.060</td>
<td>1</td>
</tr>
<tr>
<td>All agricultural products</td>
<td>97</td>
<td>1,360</td>
<td>0.16</td>
</tr>
</tbody>
</table>

### Cost

- Corn ethanol
  - + foreign affairs
  - + emissions
  - - for land

- Sugarcane ethanol
  - + foreign affairs
  - ++ emissions
  - - for land

- Refined biodiesel (from oil)
  - + foreign affairs
  - ++ emissions
  - - for land

- Cellulose ethanol (from switchgrass etc.)
Analyses of intensely growing food plants for fuel underestimate environmental costs

For example:

• Growing fuel-grade corn (& soy) “efficiently” uses about as much (or maybe more) fossil fuels than are saved when these biofuels are used as a substitute for gasoline. Take your pick... fuel your car with foreign crude oil, or with ethanol grown via domestic coal & natural gas.

• Corn production in the U.S. erodes soil about 12 times faster than the soil can be reformed, and irrigating corn consumes groundwater 25 percent faster than the natural recharge rate of ground water.

“Abusing our precious croplands to grow corn (or other food plants) for an energy-inefficient process that yields low-grade automobile fuel amounts to unsustainable, subsidized food burning.”

The Senate is currently considering the 2007 Farm Bill, and neither Feinstein nor Boxer has yet revealed publicly where she stands. For those interested in reforming American food policy, the new bill shows promise, but it continues to deliver huge subsidies for grotesque overproduction of major commodity “crops” (few of which, ironically, are fit for direct human consumption, instead they’re fed to animals confined on feed lots or ultra-processed into food additives). The new bill does offer some tasty dishes: it enhances funding for conservation and nutrition programs, and California farmers will benefit from provisions for “specialty crops” such as fruits, nuts, and vegetables (which are special in the sense that we can actually eat them). The bill also contains small gestures encouraging organic production, farmers markets, and grass-fed livestock – all important industries here in Humboldt County. However, those measures amount to little more than sugar intended to sweeten the bitter taste of massive payments to big, unsustainable agribusiness. It is imperative that the US redirects its agricultural policy to encourage more sustainable and nutritious food production by abandoning our out-dated payments for corn, soybeans, wheat, cotton, and rice. Subsidies only favor the current broken system. Simply yanking subsidies away from these farmers is of course unfair (and would ironically increase production still further as farmers could only stay afloat by growing more of the stuff), so I am in favor of the FRESH Act offered by Senators Richard Lugar (R-Ind) and Frank Lautenberg (D-NJ), which offers insurance against price drops for commodity crop producers. Call or email Senators Feinstein and Boxer to ask them to vote against the bill if it fails to offer a well-balanced agricultural policy.

Matt Johnson, Eureka