

ENVIRONMENT

Timeline of events:

1960s

- Environmentally conscious thinking, largely backburnered since FDR and the end of WW II, began to re-emerge.
- Ralph Nader wrote 'Unsafe at Any Speed' attacking auto industry and air pollution.
- 'Silent Spring,' a core book of the reviving environmental movement, links environmental concerns to human health.
- Land use patterns showed (1) declines in grassland pasture and range; (2) increases in cropland idled and used for pasture; and (3) increases in non-agricultural uses of land (i.e. urban, transportation, defense, recreation and wildlife).
- Urban area acreage increased 36 percent (but still less than 3 percent of all land).
- Food and Drug Administration discouraged the use of litter as cattle feed.
- Decline of predatory birds in U.S. was linked to agricultural pesticide use.
- National Environmental Policy Act was passed in 1969 establishing general environmental policies including regulation of large farms and ranches requiring major construction.

1970s

- Landmark environmental legislation, new institutions and innovations appear.
- Land use patterns continued to show (1) declines in grassland pasture and range; and (2) increases in non-agricultural uses of land. However, reversing the 1960s trend, crop acreage idled and used for pasture began to steadily decrease.
- Better forage quality and improved productivity of grazing lands. Fewer sheep and draft animals.
- Urban area acreage again increased 36 percent (but still less than 3 percent of total land).
- Lagoon waste management systems were increasingly used by large operations.
- Decline of predatory birds in U.S. was again linked to agricultural pesticide use.
- Series of environmental bills, and creation of new institutions included
 - Environmental Policy Act of 1970 required the Federal government to analyze and report environmental impact of its activities.*
 - Council on Environmental Quality was created to oversee Federal conformity to this Act.*
 - EPA was created in a government reorganization, combining several bureaus.*
 - Clean Air Acts of 1970, 1977. Minor impact overall on agriculture.*
 - Federal Water Pollution Control Act (Clean Water Act) passed in 1972 to define water quality.*
 - Marine Mammals Protection Act, 1972.*
 - Endangered Species Act passed in 1973 and was amended in 1978.*
 - Resource Conservation and Recovery Act, 1973. Strengthened waste disposal regulation.*
 - Clean air and water laws were strengthened and amended in 1977.*

--*Surface Mining Control and Reclamation Act, 1977. Protected surface and groundwater.*

- DDT was banned in 1973 by an EPA administrative order.
- Oil shortage of 1973 (prompted by OPEC price hike) increased energy conservation awareness.
- Solar energy and alternative fuels were researched.
- Public awareness of toxic waste grew with the Love Canal toxic sludge incident.
- Recycling begins to take hold amidst debates around state bottle bills.
- Federal Land Policy and Management Act of 1976 recognized continued deterioration of public rangeland and instituted federal management of rangeland for sustained yield and multiple use.
- Public Rangeland Improvement Act (PRIA) of 1978 instituted Experimental Stewardship Program incentives for grazing fee permit holders. Environmental and wildlife organizations argued that the voluntary incentives were soft on pollution and had them overturned in court. The PRIA also established the (public land) grazing fee formula that lasted into the 1990s.

1980s

- Reagan administration slowed progress and funding of environmental innovations and institutions (e.g. solar energy research slowed, and budget for the Council on Environmental Quality was halved).
- Superfund (CERCLA) had been established in last months of Carter presidency to fund cleanup of thousands of toxic waste sites.
- Rate of expansion of urban areas slowed 18-26 percent (down from 36 percent in 1960s and 1970s).
- Forty-six percent of new urban development came from cropland and pasture, 1982-92.
- FDA issued statement leaving to the states any regulation of litter for cattle feed. No state regulated private use or exchange of litter, but many states regulated litter on commercial market.
- As animal industries concentrated and specialized, manure was in essence becoming separated from cropland. Integration of crop and animal production has always been (and remains) critical to manure management.
- Amendments to further bolster the Clean Air Act stalled in Congress.
- Half of the fish kills off South Carolina coast were attributed to pesticide contamination.
- Management objectives for public grazing land are established in 1981 BLM plan.
- Domestic and international attention grew regarding industries' impact on public health, for example
 - 1983: *Times Beach, MO was evacuated due to dioxin contamination.*
 - 1984: *Bhopal, India had 3000 deaths from Union Carbide poisoning.*
 - 1985: *Ozone hole was discovered over Antarctica.*
 - 1986: *Chernobyl nuclear plant exploded.*
- Sierra Club membership doubled (to 350,000) from 1980-85. Audubon Society reached 450,000 members and other groups grew also.
- Recycling of glass and paper became mainstream.

- Asbestos was banned by EPA in 1989 (ban was overturned in 1991).
- Compliance approach to conservation originated in the 1985 Food Security Act. Major soil conservation programs (Conservation Reserve Program, Sodbuster, Swampbuster) were integrated with commodity programs and given title status. Regulatory definition of wetlands also evolved from this legislation.
- In late 1980s, conservation focus expanded beyond soil conservation to multiple environmental concerns including ground and surface water problems; fertilizer, pesticide animal waste, and sediment; and sustainable agriculture.
- Water quality trends indicated that increased in-stream loadings of nitrogen and phosphorous were, in part, strongly correlated with increases in concentration of the livestock population in a watershed according to the U.S. General Accounting Office and Environmental Protection Agency.
- Manure management from confined animal operations grew in importance as the industries became more concentrated. As operations grew more specialized, they tended to lack sufficient cropland on which to spread manure.
- *Cryptosporidium* caused a gastroenteritis outbreak in Carrollton, GA in which 13,000 people were sickened.
- Concentrations of agricultural water pollutants (nitrate, phosphorous, sediment) in surface water decreased slightly in most U.S. regions 1980-90, according to the Economic Research Service.
- EPA codified methods of human health risk assessment to estimate potential harm from environmental threats, 1986.
- Conservation expenditures steadily increased by USDA and related State/local programs.
- 1988 was the hottest year on record to that time. High temperatures and mid-continent drought resulted in a 30 percent decrease in grain yield that year. U.S. production dropped below consumption for the first time in 300 years. Canadian production also dropped 37 percent that year.
- Farmers were beginning to become alienated from consumers. Transportation and trade replaced the concept that nature dictates the food available in a specific area. Also, the chemical “revolution” in agriculture undermined some consumers’ faith in producers.
- Only 23 million acres--or 33 percent--of U.S. public grazing lands were in good condition, according to U.S. BLM report in 1990. Rangeland carrying capacity and quality of narrow streambank habitats were seriously diminished (Worldwatch Paper 103).
- Range conservation enforcement laws went largely unenforced across the U.S. West until the early 1990s, according to Worldwatch Institute. Grazing fees were also low. The government charged ranchers \$2 per head/month, one-fifth of the private land rate and about one-third of the government cost to manage the land.
- Regulations to protect remaining wetlands stirred controversies regarding private property rights and compensation to private land owners.
- EPA in 1988 exempted industrial ash from hazardous waste laws if it was to be used in fertilizer. Zinc fertilizer is produced with hazardous waste from secondary (auto recycling) steel mill ash.
- Selenium supplements in livestock feed were identified as potential environmental pollutants, based on an incident of selenium toxicity in aquatic birds at a CA wildlife

refuge.

- Florida Dairy Rule involved producers in experimental cost-sharing projects to structurally alter their dairies. New facilities performed well financially and with respect to manure handling, demonstrating that environmental compliance and improved production are not necessarily conflicting goals.

1990s

Legislation

- Since 1990, manure management has received increasing attention from state, Federal and county policy makers including, for example, provisions that certain large animal feeding operations be required to obtain discharge permits.
- Coastal Zone Act Reauthorization Amendments (CZARA) of 1990 first established regulations toward nonpoint source pollution from agriculture.
- Competition between agriculture and endangered species was heightened due to the Endangered Species Act. Agricultural development and grazing threatened the most species on the list. The list was expanded by 50 percent in 1992.
- Weak Clean Air Act amendments passed Congress after stalling more than a decade.
- Vast new areas of land, wilderness, old growth forests and wetlands were opened to coal, timber and oil mining.
- Federal Agricultural Improvement and Reform Act of 1996 created a new Environmental Quality Incentives Program (EQIP) and other new programs to protect wildlife and grazing lands.
- Clean Water Act reauthorization debate focused on applying (1) new mechanisms for dealing with non-point pollution from agriculture, and (2) impaired watersheds as the basis for identifying which farmers must adopt new methods.
- There is virtually no regulation of fertilizers in the U.S. Washington State may become first state to limit toxic chemicals in fertilizer and require labeling of ingredients.
- Federal policy-makers re-examine resource programs including grazing, mining and timber harvesting.
- Gubernatorial commission in Maryland recommended that every farm in MD have a nutrient control plan in place by 2002.
- Manure management inspections for large producers become reality in NE, SD.
- Criminal and civil penalties in South Dakota are possible for operations that violate environmental regulations. Other states debate these.
- Safe Drinking Water Act Amendments of 1996 connected two environmental issues, watershed protection and safe drinking water. Linked stronger drinking water standards with monitoring of community water systems.
- North Carolina banned new hog farm construction in 1997, and it was expected that zero discharge of nutrients from NC agricultural facilities would be mandated in 1998.
- Financial incentives including tax credits (VA) and low-interest financing (DE) are used by states to subsidize purchases of more precise nutrient and pesticide application equipment, and/or to improve waste management systems.
- California Senate votes to give farms more protection from urban sprawl by reducing property tax assessments on lands kept in agricultural, open space or compatible uses.

- Burial pits for dead poultry are outlawed in Arkansas and Alabama.

Technology

- CFC (Chloroflourocarbon) production was phased out nationally.
- Pollution emphasis shifted in U.S. to reducing emissions, rather than treating waste.
- CZARA mandated waste systems' inclusion of retention ponds, solids separation basins, and vegetative practices such as filter strips between surface waters and production.
- Studies in WI and MN indicated in 1994 that the vast majority of farmers (1) did not have their manure analyzed over the last 5 years, (2) did not calibrate their manure spreader during that time, and (3) underestimated the nutrient value of the manure.
- Self-monitoring by feedlot operators of groundwater, surface water and air quality increased from 1990-95, especially among larger operations. Concerns over environmental issues caused 20 percent of small producers and 70 percent of large producers to develop or change a manure management program in that period.
- Nationally, farmers spent \$470-620 million more annually on fertilizer than was necessary due to failure to credit the nutrients in manure and legumes (NE Center for Rural Affairs).
- Large-scale livestock confinement systems that use anaerobic lagoons or liquid slurry pits for waste removal contribute greater amounts of greenhouse gas than do smaller operations using non-water based manure management.
- National Pork Producers Council completes in 1998 a Comprehensive Environmental Framework for Pork Production, a voluntary set of guidelines to enhance environmental performance and guide government regulation of the industry.
- Pit-holding waste management systems were used most by swine operations with total confinement farrowing facilities (*Table 3.1*).¹ Anaerobic lagoons without covers were used most by the largest swine producers (*Table 3.2*). Below-floor slurry or deep pits were used most by medium and small swine producers.²
- Some pork producers now building manure-storage areas with concrete because of concerns about long-term integrity of earthen basins. Also, manure storage areas are increasingly being built beneath hog barns to reduce odors.
- Better feed efficiency reduces manure production. University study (Iowa State) found that feed efficiency improved from 4.8 feed-to-gain in 1950 to 3.5 feed-to-gain in 1997.
- Dead animals and disposal practices also are seen as creating a public health risk.
- Industries further attempt to more aggressively market value-added uses of manure. For example, poultry manure is used to varying degrees for plant nutrients, composted fertilizer, horticultural markets, animal feed and methane gas.
- Manure storage facilities on larger hog operations were generally located farther from houses, wells and surface water than those on smaller operations (ERS, AREI Update).
- Dietary additives and manure amendments are being researched as a means of reducing nutrient excretion. For example, phytase is an intestinal enzyme that can potentially reduce phosphorous excretion by almost 40 percent.
- Odor control products are being researched to improve odor of manures or liquids.
- Poultry composting becomes the preferred means for disposing of dead birds.
- Actual irrigation of manure--that is, using water to apply manure nutrients in the field--is a

very common practice (though it may become less acceptable in the future).

Public perception: new research and events that shape perception

- Amount of animal manure produced in U.S. is 130 times greater than the amount of human waste.....a total of 5 tons for every human being in the country. 1.37 billion solid tons of animal waste are produced each year.³
- A single 50,000 acre hog facility being built in Utah would potentially produce more waste than the city of Los Angeles.³
- Agriculture was reported as the leading source of impairment in rivers and lakes, and the third largest source of impaired estuaries (ERS, EPA, GAO). Other lesser source categories were Municipal Point Sources; Urban Runoff/Storm Sewers; Industrial Point Sources; and Natural Sources).⁴
- EPA concluded that states' groundwater condition is generally good however many local areas have experienced contamination. According to EPA, agriculture is one of the main sources of groundwater pollution.
- According to the Organic Market Overview, the U.S. organic foods industry grew more than 20 percent annually 1988-94.
- Acid rain (from industrial production) gained public attention.
- Global warming and reducing greenhouse emissions are addressed in world summits in 1992 (Rio de Janeiro) and 1997 (Japan). The American Farm Bureau said the global climate-change agreement drafted in 1997--and new government regulations--would seriously raise agricultural production costs.
- Cryptosporidium, a pathogen found in bovine manure and other sources, infects 400,000 Milwaukee residents in 1993.
- Property rights movement, led by politically conservative groups, grows and demands compensation to landowners whenever a regulation reduces property value.
- Fertilizers made from steel mill dust are found to have high levels of dioxins. Worst case scenario, according to dioxin expert, is where dioxin goes on pasture lands where cattle graze. Reason is that cattle consume about 5 percent of their diet in dirt (Seattle Times).
- Over 40 animal waste spills killed 670,000 fish in Iowa in 1997. In the early 1990s, improper disposal of feedlot waste was the leading cause of Iowa fish kills.³ Manure spills from large hog operations in Western Illinois, including one 1994 spill that killed 160,000 fish, brought added attention to a state experiencing rapid growth in corporate hog production.
- Pfiesteria-caused fish kill (the "Cell from Hell") off Maryland coast is linked to excessive loads of agricultural nutrients in the water. Research is ongoing to determine if nutrient runoff from animal agriculture causes or facilitates Pfiesteria growth. General agreement apparently exists that livestock farms contribute heavily to Chesapeake Bay pollution.⁵
- U.S. Senator Harkin released Senate report, "Animal Waste Pollution in America: An Emerging National Problem." Congressional hearings are expected in Spring 1998 to address waste problems created by intensive animal production.
- Role that beef cattle may play in contributing (methane) to global warming received much attention in early 1990's. Media distortion of university research created perception that

- researching cattle, methane and global warming was wasting tax dollars.
- EPA data indicated that nationally, one-third of agricultural polluted runoff comes from animal waste from feedlots, pasture lands, and other animal holding areas. EPA further estimated that confined feedlots may cause 13 percent of all water quality impairment in rivers and streams.⁶
- No major improvements are seen in the nation's rivers, lakes, ponds and estuaries since 1990, according to the EPA in 1995, although surface-water quality improved since 1972 primarily through reductions in point source pollution.
- Links between global trade and environmental issues are noted in finalizing the 1994 General Agreement on Tariffs and Trade, and in developing the charter for the World Trade Organization.
- Fish consumption advisories issued by states increased from 1992-94. Mercury, PCBs, chlordane, dioxin and DDT--and their public health dangers--caused most of these. Bacterial and viral contaminations also closed shellfish beds in 15 states. Causes were improperly treated sewage and urban runoff, and animal waste.
- Thirty-two jurisdictions reported 1,454 fishkill incidents during 1992-93 (ERS, EPA).
- Studies in 16 watersheds found that manure was the largest nitrogen source in 6, primarily in the Southeast and Mid-Atlantic states according to the Economic Research Service.
- Odor is the limiting constraint to use of manure as fertilizer in many places.
- Ice shelves surrounding Antarctica are melting more quickly. Warmer Antarctic seas and temperatures initiate "conveyor belt" effect that affects worldwide weather patterns and raises temperatures, according to a National Public Radio report in January 1998.
- Commercial fertilizers are increasingly seen as problematic because of their potential to leach into groundwater.

Legal Battles

- Litigation and proposed legislation at the municipal, county, State and Federal levels. Underscores need for agricultural producers to effectively communicate with governments.
- Idaho lawsuit asks BLM to bar cattle from 1.3 m acres of public grazing land, until an approved management plan is in place, to stop water pollution caused by livestock grazing.
- Several "citizen suits" are filed involving agriculture, e.g. in New York neighbors filed suit complaining liquid manure leaked from dairy lagoons and spread on local fields had polluted their ground water.
- County governments in many states are debating controversial permit requests from large hog, poultry or feedlot operations. Residents fear water quality problems, noxious odors and flies, declining residential land values, and dominance of corporate agriculture. Lawsuits abound in multiple states (e.g. IA, NE, and CA).
- Use of local zoning ordinances increases, for environmental reasons and also to restrict corporate agriculture supplanting the family farm.
- Moratoriums on livestock and poultry expansion are debated in multiple states (e.g. MN, CA, SD), at least until needed environmental research is complete.
- State task forces debate manure application by farmers and how best to determine when

- phosphorous levels in a field reach a point that endangers watersheds.
- California considers strengthening “fugitive dust” regulations for livestock operations. Debate in CA may be a strong indicator of future debate for the rest of the nation.

Federal Role

- USDA program spending related to agricultural waste systems increased significantly from late 1980s levels.
- The 1990 Farm Bill focused the Soil Conservation Service on pesticides, nutrients, animal waste, and agricultural pollutants in surface and groundwater.
- Wetland Reserve Program (piloted 1992) showed potential for accommodating economic activity while protecting resource values. USDA acquired hundreds of thousands of permanent easements for wetlands restoration, and farmer interest far exceeded the pilot’s goals.
- The EQIP (created 1996) combined several programs to become USDA’s largest conservation program, with an annual budget of \$200 million or more authorized through 2002. Designed to conserve resources and improve environmental protection on land while it remains in agricultural production. Provides cost-share assistance for practices including grassed waterways, filter strips, and manure management facilities.
- In 1996, over half of USDA’s conservation expenditures were for rental or easements payments on lands in conserving uses.
- Wolves were reintroduced to Yellowstone Park.
- Harkin’s proposed Animal Agriculture Reform Act would require USDA to monitor waste management plans on large operations.
- EPA increased its regional grant awards to states for agricultural nonpoint source programs and water quality initiatives.
- State pollution control agencies are sometimes understaffed and underbudgeted to inspect and adequately ensure environmental compliance by livestock operations.
- A Federal role is being debated regarding establishing a phosphorous standard to allocate nutrients to soils or crops, rather than the commonly used nitrogen standard. (Phosphorous contributes to eutrophication of surface waters or contamination of groundwater.)
- EPA considers banning agricultural pesticides known as organophosphates--similar in chemical structure to nerve gas--due to possible health threats to children from pesticide residue on fruits and vegetables.

Trends

- More public attention will be focused on agriculture and its impact on the environment. The public expects agriculture to perform many tasks: environmental stewardship, production of safe and inexpensive food, preservation of rural cultures, and engine for rural economic growth.
- The need for waste management has intensified because larger concentrations of livestock are located on increasingly smaller acreages of farmland (*Table 3.3*).
- Approved waste management and nutrient control plans for most animal operations will be

- required--by localities and states across the U.S.⁷
- Ranch or watershed plans will be increasingly required to ensure proper grazing use and management.
 - County and local governments have increasing clout in regulating environmental impacts of animal agriculture, including where operations may be located.
 - Partnerships involving cities and agriculture are important for survival of animal agriculture. A thorough understanding is needed regarding issues at the ag-urban edge, and in the populations there.
 - Federal regulation of livestock and poultry operations' environmental impact is coming, beginning with swine.^{3,8,9} Environmental standards will be established on a national level with discretion to strengthen those standards locally.
 - Animal industries are mobilizing to discuss options to achieve regulatory relief and certainty amidst enormous environmental pressures.
 - Population growth has intensified competition for all natural resources, water and land in particular. Efficient and uniform use of irrigation water is crucial to manure management. There is pressure to divert water from farm uses to serve urban and environmental needs.
 - Agriculture has lost much of its influence on society. Urban and suburban interests have significantly displaced agricultural interests in Federal, state and--increasingly--local legislatures.
 - The U.S. public understands there is a connection between animal agriculture and public health.
 - The belief that agriculture can and should provide environmental amenities--scenic landscapes, a rural "escape" for city dwellers, biological habitat in harmony with nature--remains strong.
 - Non-point sources of pollution are considered the next frontier in protecting water quality.⁴ Non-point pollution, unlike discrete sources such as drainage pipes or smokestacks, is not easily traced to a specific point of origin.
 - More comprehensive research (\$) will be undertaken to fully understand animal agriculture's environmental impacts. In some cases, state-funded research may be required before moratoriums on livestock or poultry expansion will be allowed.
 - Research and product development will increase for odor control, waste disposal, nutrient application, feed additives, etc. Producers will pay for these improvements and at least some costs will be passed on to consumers.
 - The economics of environmentally-sensitive waste disposal will squeeze farmers. As farmland becomes scarcer at the ag-urban edge, there is less contiguous acreage. Not all of the land for spreading manure is near the livestock, so changes are required in operation, equipment and labor use. Manure must be hauled farther out to land where it can be used properly. Hauling creates odor, noise, traffic and potential spills.
 - Farm acreage is increasingly lost to urban expansion and large-lot development, although formalized agricultural and open space preserves will become more prevalent.
 - Animal agriculture is needed to consume the forage that utilizes the nutrients coming from animal and human waste.
 - Society is becoming increasingly antagonistic to private profit-making use of public resources, especially when private uses require public subsidies or conflict with ecosystem

- management.
- Commercial fertilizer ingredients and their environmental impact will be more closely scrutinized.
- Local opposition to corporate farming--and the resulting loss of family farming values--will be linked with environmental concerns in opposing further expansion of large operations.
- The USDA role in resource conservation will continue to grow. Total funding committed to USDA conservation programs will grow by more than \$2 billion, or \$300 million per year, over 1996-2002 as a result of the 1996 Farm Act. During 1996-2002, USDA will provide technical assistance, education, cost-sharing, and incentive payments to producers.
- State environmental enforcement capacities, however, will probably remain under funded.
- Conservation easements are the preferred tool of the present and the future because they keep land in private uses while achieving conservation objectives.
- Public perception will probably remain strong that it is not acceptable to put sewage sludge (human waste) on land used to produce food for humans.
- Animal industries have begun to develop and begin adopting construction, monitoring and management practices--and educational programs to support those--that will minimize environmental problems such as odor (Tables 3.4 and 3.5).
- Environmental issues will seriously impact the way animal agriculture operates, and potentially its structure.

Uncertainties For The Future

- What will we do with all the manure? Can so much manure effectively be channeled into markets for fertilizer, feed, fuel or other products? Can creative solutions be found to reduce nutrient pollution? An American Farm Bureau official said, "In seeking economic alternatives, we are limited only by our imaginations."
- In the conflict between agricultural profitability and environmental stewardship, will sustainable agriculture gain hold as a way to meet both needs? Or will one of the two conflicting sides come to dominate the other? This is a debate to define what is the optimal balance between economic and environmental costs of food animal production.
- Will experience show that smaller or larger animal operations are best suited to properly manage animal waste material in an environmentally sensitive manner? If the cutting-edge technologies are affordable only for facilities that achieve certain economies of size, then over time the trends toward industry concentration--and away from the last bastions of family farming--would intensify.
- Which corrective approaches to nonpoint pollution sources will win out: voluntary programs of education and financial incentives; or strict regulations and enforcement of environmental standards; or measures requiring producers to internalize environmental costs--for example, taxing inputs and using the revenue to control pollution. Environmentalists' satisfaction with past enforcement will be a factor, and the predominant approach taken will affect the relative roles of Federal and State agencies (i.e. EPA or USDA as the primary Federal player).

- Can opportunities for “win-win” nutrient management be developed and implemented? For example, some U.S. regions (e.g. Southeast) have both high fertilizer spending per acre and high manure nutrient production per acre. Eliminating this redundancy could lower input costs and reduce threats to water resources.
- To what extent will environmental considerations become part of international trade agreements? Will the U.S. or other trading partners use trade as leverage to heighten awareness and improvement of environmental practices?
- Will future federal support for agriculture promote activities that balance food security with improving environmental quality?
- Can agriculture change the image of manure into a desirable good rather than an environmental liability?
- Who will pay the **costs** of environmental protection--farmers or the public? Will food prices increase regardless? Certain costs are unavoidable, however some analysis has shown that numerous management practices to reduce agricultural nonpoint source pollution are not costly to implement, and may even increase net returns (ERS, AREI).
- Who will pay for increased regulatory activity by governments? For example, new Illinois legislation requires the state Department of Agriculture to annually inspect waste lagoons servicing 1000 ‘animal units’ or greater.
- How will county and local governments land on this issue? These governments are debating jobs and tax bases versus quality of the environment in which they live. Primary tools wielded by these entities include land use zoning and moratoriums on expansions above a certain size.
- Will growing environmental and population concerns alter producers’ economic incentives such that production moves back into more traditional production areas or expands into new areas that are seeking economic growth opportunities?
- Will ecosystem and environmental planning be incorporated holistically into ag-urban planning for future growth and development? If yes, there will be less potential for future conflict. If no, the future should be rife with conflict.
- To what degree can firm boundaries be established at the urban growth boundaries, thereby controlling sprawl and providing land use certainty and land market stability? Can better and more integrated planning mitigate some of the future conflict over environmental issues?
- Will the legal system’s role continue to increase due to more litigation? Will local zoning and nuisance suits constrain livestock producers?
- Will the property rights movement protect farmers or lead to a backlash of more regulation?
- What will we do with the increasing human waste? The most environmentally and economically sound method is to put it back on the fields where forage for livestock is grown and where it recycles nutrients. However as farmland disappears, urban areas have fewer places to put their waste.
- Will environmental practices and standards be critically linked to the institutions and rules of international trade? How will environmental policies affect agricultural trade? Is there economic justification for using trade measures to protect the environment?

- Which manure management and disposal technologies will become most acceptable and cost-effective in the future? For example, incinerating manure for fuel has shown mixed results. Dairy wastewater lagoons are common but may not remain acceptable. Solid-liquid separators create huge piles of solid manure. Irrigating with a water-manure mix also may not remain viable. Biotechnologic innovations have been touted by some (e.g. William Reilly, former EPA Administrator) as having potential to greatly reduce environmental stresses, however environmentalists are wary.
Examples of areas for further research and on-farm technology include
--*predictive tools for nutrient cycling in cropping;*
--*determination of nutrient composition of waste water, to facilitate crop nutrient management;*
--*buffer strip designs;*
--*treatment of waste that is cost-effective and low-maintenance;*
--*improved litter systems to reduce leaching and runoff;*
--*investigation of salts in the soil from manure applications; and*
--*cost-effective transportation of manure out of the area.*
- Will agro-environmental research be identified as a public polity priority? Will there be more or less investment in research and extension to develop integrated systems approaches? Will the outcomes of this research be supported by public policies under which agriculture can be a model of how an industry can adapt to environmental demands, support the restoration of natural systems, and encourage long-term economic stability?
- Will accelerating climate change affect growing seasons, thereby disrupting farm activity and natural resources in some areas while leading to gains in other areas?
- The critical period for the global agricultural system, according to Resources for the Future, is roughly the next 60 years during which world population will significantly increase. “If the system can sustainably meet the increase in food demand over that period, it probably will be indefinitely sustainable.”
- Will the increased scrutiny on commercial fertilizers result in increased regulation or taxes on those products, leading to changes in the commercial fertilizer industry? Nitrogen, for example, is currently among the most unregulated of inputs.
- Will the role of meat in the human diet be rethought? According to Worldwatch, if livestock are to live in balance with the environment again, First World consumers will need to eat less meat while developing world consumers will need to keep their meat consumption low.¹⁰
- Do the world’s oceans hold significantly more untapped potential than land-based alternatives to feed a growing world population? According to the Henry A. Wallace Institute for Alternative Agriculture, responsible seafood production results in less environmental impact than does animal agriculture.¹¹

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ENV 1

