Index

Agrichemicals, defined, 3, 26-27 rationale for use of, 3, 81, 100, 102, 171, 191, 193, 253 use statistics and trends (See Agrichemical use data) Agrichemical applicators, 171-188 agricultural service firms, 176, 180-182, 231 certification and training, 17, 174, 178, 182-188,205 commercial (See also certification and training), 171-172, 173 data collection and management, 186-187 general use, 171-172, 173, 174 policy options, 228-230 private (See also Agrichemical applicators, certification and training), 171, 172, 174-176 restricted use (See Agrichemical applicators: commercial; certification and training) testing, 17, 183 Agrichemical dealerships (See also Technical assistance, agrichemical dealerships and supply cooperatives), 12, 176, 179-180,205,230-231 as point sources of contamination, 6, 32, 132 Agrichemical leaching chemical properties affecting, 43, 60, 103 mobility, 44, 60, 62, 131 persistence, 49,60,62 photodegradability, 48 natural factors affecting, 43, 63, 64, 81, 103, 108, 138, 139, 140bedrock/unconsolidated sediments, 53-56,65-66,67 biological characteristics, 50-53 climate, 49 depth to water table, 48-49 soil characteristics, 49-51, 140 topography, 47-48 vegetation, 48 human factors affecting (See also Hydrologic cycle, human influence on), 43 irrigation, 59 land use practices, 31-32 preferred pathways, 57 abandoned wells and drill holes, 58, 82, 136 agricultural drainage wells, 58-59 animal burrows and root cavities, 51,52,57-58 bedrock joints and fractures, 53-54 karst systems, 54-55,64,82 Agrichemical transport by air, 31,44 by water (See Agrichemical leaching) Agrichemical use data (See also Agrichemical applicators), 83, 101 collection and management, 68, 69, 227 need for, 5, 63, 69, 174, 227, 266 recordkeeping, 19, 194, 224-225, 227 Agrichemical use reduction (See also: ATTRA; Best Management Practices; Nutrients/Pesticides, application, formulation; Pest Control, nonchemical controls, integrated pest management; Cultivar Improvements; Agricultural

research extension and education, to enhance farmer decisionmaking), 8-9, 11, 84, 103, 106-107 Agrichemical waste (See also Farmstead Assessment Program),

14, 18,229 disposal practices, 134

mixing and loading areas, 131, 133 policy approaches to reduce, 20,264-266 storage, 132 through mismanagement (See also Pesticides/Fertilizers, application), 17, 20, 81 transfer systems, 133-134 Agricultural policies (See also Groundwater protection, voluntary, cross-compliance, regulatory; Agrichemical waste, policy approaches to reduce) environmental protection and, 20, 253-254, 255, 258-266, 282-283,313-315 goal setting, 262-264,266, 282,315 Agricultural programs (See also Groundwater protection, voluntary, cross-compliance) commodity programs, 300-306, 313 conservation programs (Conservation Reserve Program), 274, 294,306-308,309-310 criticisms of, 299-300, 313 cropland retirement programs (See Agricultural programs, conservation programs) disaster assistance (See Agricultural programs, risk reduction programs) goals of, 299 redirecting, 19-20, 299-315 risk-reduction programs, 308-312 Agricultural research education and extension adaptive, 84, 154-155 biotechnology, 124, 126,259,261-262 coordination of, 155-157, 297-298 criticisms of, 19, 218-222 Federal, 144-145,262, 274 interdisciplinary research, need for, 221-223, 259 Low-Input Sustainable Agriculture (LISA), 151, 153 prioritizing, 153-154 private sector, 145, 146 State Agricultural Research Stations, 145, 152, 153, 154 to enhance farmer decisionrnaking, 193-194, 210, 215, 217-226,235 to enhance policy and technology development, 18-19, 143, 144, 149-150 to enhance knowledge of agroecosytems (See Agroecosystems, understanding of) Agricultural service firms (See Agrichemical applicators) Agroecosystems, 147 agroecoregion, 154,288 complexity/variability of, 5, 81, 96, 254, 255 defined, 81 simulation modeling, 72 understanding of, 17-18, 150-153, 313-315 Appropriate Technology Transfer for Rural Areas (ATTRA), 206 Aquifer defined, 43,55-56 Ogallala, 43,46, 138 regional aquifer system analysis (RASA), 68 Best Management Practices (BMPs), 10,85,90, 107, 145-147, 155,218,234, 275,279, 292

Chemigation (See Pesticides, application technology) Computer-Aided Decision Support Systems, 225-226

Crop Management Associations (CMA), 209,212-213 Cropping flexibility (See Agricultural programs, commodity) Cropping patterns, 119-124 conservation plantings, 122-124 continuous, 120 intercropping, 122 rotation, 119, 120-122 Cross media pollution, 261 difficulty in addressing, 69-70, 146-147,281 understanding of, 149 Cultivar improvements, 124 herbicide resistance, 125 nitrogen self-sufficiency, 125-126 nitrogen-use efficiency, 126 pest resistance, 124-125 stress tolerance, 124 Data needs for groundwater protection, 18-19,63-74 extant data bases, 63, 65, 66, 68-69, 73 Current Research and Information System, 297-298 soil survey information, 65-66 Geographic Information Systems, 18,72-74,294 need for integration, rationalization, coordination, 69-72, 74 need to digitize, 18, 70-71, 73 Farm resource management (See also Best Management Practices; Crop Management Associations; Fertilizers, nutrient management; Pesticides, management; Resource Management Systems) crop (See also Agricultural programs, commodity), 118-126,212 conservation planting, 122-124, 274 cropping patterns, 9, 119-122 cultivar improvements, 9, 124-126 Integrated Crop Management, 85, 148-149,204 integrated farm management, 6, 9-10, 85, 147-149, 214, 215, 223,224 property rights and, 259 soil (See also Technical assistance, Soil Conservation Service), 126-128, 212 water (See Irrigation) Farmer decisionmaking (See also Farmer-to-farmer networks; Technical Assistance), 10-14 concern about groundwater quality problems, 11, 194-195, 1% economic analyses of alternatives/need for, 85, 191, 212, 227-228 enhancing to protect natural resources (See Agricultural research, education, and extension, to enhance farmer decisionmaking; Groundwater protection, voluntary approaches) factors influencing, 10, 177-178, 189-197 information (See also Technical assistance) needs, 11, 191, 192-193 sources, 11-13, 197,200 policy options to support improved decisionmaking, 226-235 risk perception, 191, 194 risk reduction (See Agricultural programs, risk reduction) technology adoption, 10, 218-220 research on, 189-191 Farmer-to-farmer networks, 11-12,209-212,220,226, 234 Farmstead Assessment Program, 7, 147 Fertilizers application, 6, 11, 265

precision, 82, 100 technologies, 8, 86,99-100 timing, 8, 83, 98-99 rates, 8, 82, 95-98 groundwater contamination by nitrate, 3,27,60-61,97 essential plant nutrients (See also nitrogen cycle), 50, 51,86 availability to crops (See also nitrogen cycle), 50, 51, 53, 86, 95-% avenues of loss (See also Agrichemical leaching), 51,85,86 nitrogen cycle, 87-88, 89 nitrogen sources and formulations. 88-95 commercial nitrogen fertilizer, 86, 88-92, 192 legumes, 8,86,98, 120-122, 192 manure (See also Livestock waste), 8,86,92-93, 135, 138, 192 sludge and wastewater, 51, 85,93-95 nutrient management, 81, 85-87, 90, 171, 192, 204, 205 Financial assistance (See also Agricultural programs), 13-14, 213-214,275 Groundwater definition, 27,43 contamination, 3, 6, 28,43 extent of contamination (See Water quality monitoring; Fertilizers, groundwater contamination by nitrate; Pesticides, in groundwater) sources agricultural nonpoint, 3, 4, 23, 27, 31, 171, 183, 258 point, 4,31,32,82, 132, 171, 183,258 natural, 60 non-agricultural, 26, 27, 31 impacts of contamination agricultural, 32, 34 ecological, 24, 32, 34-35, 104-105 health, 32-34 liability, 259-261 public perceptions (See also Farmer decisionmaking, concern about groundwater problems), 3,5,23,255-257 mediation, 35-36, 261 protection (See also Agricultural research, education, and extension, to enhance farmer decisionmaking; Water quality protection, agency roles) costs, 298-299 cross compliance programs, 278, 279-280, 281, 305-306, 313 obstacles, 254, 255, 257-258 rationale for, 5, 36, 63, 254, 261 regulatory approaches, 255, 260, 276, 277, 278, 280-281, 292 voluntary approaches, 222, 255, 278, 281, 294-295 quality standards (See also Water quality monitoring), 33,35, 36 Hydrologic cycle, 56-57,63 defined, 6,43 human influence on, 57-60 surface/groundwater relationships, 34, 43-47, 56-57, 59-60, 258 Integrated Crop Management (ICM), 13,85, 148-149,209 Irrigation (See also Pesticides, application, chemigation), 9 scheduling, 81, 130-131

tailwater, 130 technologies, 128-131 uniformity of distribution, 129 wastewater, used for, 95 Livestock waste (See also Fertilizers, nitrogen sources and formulations, manure), 7, 85, 134-141 livestock waste collection and storage, 92, 137-141 management practices and effects on groundwater quality, 92, 131, 137-141, 142, 143 manure production and distribution, 92, 93, 136-137 Low-Input Sustainable Agriculture (LISA), 10, 151, 153,258 Maximum Economic Yield (MEY), 146 Pest management, 100-118 Integrated Pest Management (IPM), 9,85, 102, 115-118 defined, 115 development and use of, 116-117 constraints to IPM use, 117-118 effect on pesticide use, 116 grower adoption of, 116 nonchemical controls, 6, 8-9, 11, 84-85, 102, 103, 113-115, 171 biological controls, 114-115,212 genetic controls, 114 mechanical controls, 100, 114 cultural controls, 7, 9, 100, 113-114 pest scouting, 17, 101, 102 pest prediction models, 113 pesticide resistance (See Pesticides, pest resistance) pesticides (See Pesticides) Pesticides application, 6, 11,82,83, 265 chemigation, 10, 112-113 precision, 8,82, 83, 103, 108-109 rates, 82, 108-109 technology, 109-113 timing, 7, 8, 82, 83, 113 biopesticides, 101, 103 definitions, 100 effects on non-target organisms (See Groundwater, ecological impacts of contamination) efficacy, 6, 11, 82, 103 formulation, 8, 107-108 general use (See Agrichemical applicators) in groundwater, 3, 23, 28-31 labeling, 17, 27, 132, 173, 183, 197 management, 107, 171, 204, 205 pest resistance, 103-104 restricted use (See Agrichemical applicators) secondary pest outbreaks, 105 use data (See Agrichemical use data) Point-source contamination of groundwater reducing potential for (See also Farmstead Assessment Program), 11,82, 107, 111, 112, 183, 192, 193,255 Resource Management Systems (RMS), 148, 149

- Technical assistance (See also Farmer-to-fanner networks; Farmer decisionmaking, enhancing to protect natural resources), 197-217
 - agrichemical dealerships and agrichemical-supply cooperatives, 207-208

agricultural advisory firms, 12-13, 209 Agricultural Stabilization and Conservation Service (ASCS), 13,200,204,209,231-232 Cooperative Extension Service (CES), 13,204-205,208,210, 216-217,232,278 coordination to enhance, 14-15, 17-18, 214, 216, 217, 232 county governments and local committees, 207 crop consultants, 13 farm size and, 198-199 farmer access to, 197 Soil Conservation Districts, 13,206-207,214-215 Soil Conservation Service (SCS), 10, 13, 200, 201-204, 216-217,224,232,274, 278 State Agricultural Experiment Stations, 201, 204 State Conservation Agencies, 205 State Departments of Agriculture (DOAs), 13,205 State Water Agencies, 204,205-206 Technology adoption (See Farmer Decisionmaking) Technology development and transfer (See also Agricultural research, education, and extension, to enhance policy and technology development), 144 Tillage (See also Farm resource management, soil), 81,99,212 conventional, 81 reduced or no-till, 81, 105-106, 265 Waste management, effects on groundwater contamination agrichemical (See Agrichemical waste) livestock (See Livestock waste, management practices) silage, 132, 141-143 Water Quality Initiative, 259-260,272,273,292 Water quality legislation, 254,260, 268-269 Clean Water Act (See Water Quality Act of 1987) Federal Insecticide, Fungicide, and Rodenticide Act, 24, 35, 173, 184, 186, 188, 270, 271 Food Security Act, 203-204, 207, 258, 266, 274, 279, 305, 313,315 legislative authority and flexibility, 285-288 Proposition 65.260 Resources Conservation Act of 1977, 273 Resource Conservation and Recovery Act, 134 Safe DrinkingWater Act, 33, 35, 271, 277 Water Quality Act of 1987 (Clean Water Act), 24,259,261, 272,277,292 Water quality monitoring, 3,66,68,232-233,258 detection limits, 28 EPA National Survey of Pesticides in Drinking Water, 30,271 interpretations, 28-30 need for, 63 USGS National Water Quality Assessment Program, 68,270 Water quality protection, organizational roles (See also Water quality legislation, legislative authority and flexibility) changes in roles, 277-278 confusion over roles, 283-285 Congress, 268-269,282-283,315 coordination, 273, 288-298 diversity of approaches (See Groundwater protection, voluntary, regulatory, cross compliance) Federal agencies, 269-272 leadership, 284-285 State and local, 275-277