Chapter 5

POLICY

Chapter 5.-POLICY

TABLES

FIGURE

Chapter 5

POLICY

Introduction

It should be clear from the technical analysis presented in preceding chapters that there is no single "biomass" energy system. Rather there are many technologies that provide means of converting plant matter and animal wastes into usable forms of energy. Some of these technologies, such as wood-burning stoves, are well established in the marketplace, others are being developed, and still others hold promise only for the distant future. This report focuses attention on four fuel cycles, selected according to their technological readiness and their potential to contribute significant amounts of energy. Each of these involves different raw materials, produces different kinds of fuels, and may therefore be expected to respond to different incentives. Accordingly, policy options appropriate to each fuel cycle are discussed in detail in separate sections that follow. All biomass energy forms, however, have some common advantages, and encounter some common difficulties; these are reviewed first.

Consider the advantages. Biomass energy forms are **renewable;** their use can help to relieve pressure on depleting fossil fuel resources. They are also **domestic** and can be expected to reduce American dependence on insecure imported oil, enhance the U.S. balance-of-payments position (except where agricultural exports are reduced), and reduce America's vulnerability to supply interruptions. Insofar as biomass fuels are imported from abroad, they will likely come from non-OPEC countries, such as Brazil, thus diversifying the energy supply pattern. In addition, some biomass energy sources **contribute to the solution of important pollution or waste disposal problems** and most of them are likely to **contribute less to the long-term buildup of carbon dioxide** (CO_2) in the atmosphere than the fossil fuel systems they replace, because biological growth processes consume CO_2, balancing, at least in part, the release of this gas in combustion. *

Depending on the technologies that are adopted and the scale of production chosen, biomass energy **may provide the basis for the growth of small business enterprises** and the **decentralization of economic activity, both of which are valued by many Americans. Finally many of the most important biomass energy technologies are already in use; hence an expansion** of U.S. energy supply from these need not await costly and time-consuming R&D activities.

Despite these clear advantages, biomass fuel cycles face several serious difficulties. Some of these stem from the character of the technologies and their dependence on diverse source materials; others stem from the incompatibility of the fuel cycles with existing energy distribution and production systems.

Perhaps the most serious general problem confronting biomass energy development is that the source materials upon which the fuel cycles rely— wood and agricultural commodities— are often already in use for nonenergy purposes. Demand for these materials for conversion to energy will have important, but difficult to measure, impacts on existing markets. So will the sale of coproducts, such as distiller's grain, that are currently important in assuring the economic viability of bioenergy. Biomass energy forms are thus linked to existing nonenergy markets in a way that most fossil fuels are not. This creates uncertainty regarding economic viability that is unrelated to the adequacy of the technologies themselves. It also complicates the design of policy options because the commodities involved are already affected by laws and regulations that

*Under certain circumstances, such as where deforestation or reduction of soil organic matter occurs, there could be a net CO_2 increase.

have purposes unrelated to, and often conflict with, the goal of energy development. Moreover, in the case of wood and most agricultural products, established Government agencies are involved and their perspectives, administrative preferences, and longstanding procedures must be considered carefully if policies are to prove successful.

The existence of nonenergy markets for biomass also means that in many cases it will be difficult to implement policies that apply only to bioenergy uses of these commodities. For example, if subsidies were offered only for biomass grown on certain lands or only for resources managed according to environmental guidelines, it would be almost impossible to prove which products were grown on those lands or in accordance with those guidelines. Consequently, many policies will have to be implemented throughout the forestry or agricultural systems.

At the other end of the cycle, many biomass technologies produce an energy in quality, form, or quantity that does not readily fit existing energy distribution or consumption systems. This difficulty is enhanced by the fact that bioenergy comes from diverse, small-scale, or dispersed sources. A variety of different, site-specific means of processing, distributing, and consuming the resulting fuels must often be developed to make the energy commercially attractive. All of these add to uncertainty in commercialization and to the burden of planning and administration that accompanies the operation of the Nation's energy system at all level s.*

The economic and technical complexity of biomass fuel cycles and the certainty that they will have extensive, but difficult to predict, impacts on food, fiber, fertilizer, and energy markets, among others, suggest the need for both care and flexibility in the design of policies to promote them. In most cases, their economic attractiveness and impacts can be tested only by experimenting with them and living with them. To be avoided are those policies that commit the country heavily to particular technologies prematurely, or that provide hidden subsidies that obscure the full costs of alternatives and perhaps repress, indirectly, ones that might be more attractive.

The energy markets in which biomass must compete already are very complex, and are affected by layers of regulations, subsidies, and direct and indirect controls that will influence the attractiveness of new products significantly. Thus, in evaluating the actions that might be taken to promote and regulate biomass energy, a first step is to review those policies that currently favor— directly or indirectly–fossil fuels and nuclear energy. These include price controls, special tax treatment for depletion and drilling costs, R&D support, and many other subsidies. A recent study, for example, has concluded that in the years since 1918 the Federal Government has spent more than $217 billion in subsidies and incentives to stimulate the development of conventional energy sources. However, fossil and nuclear fuels are also subject to extensive regulatory requirements designed to protect public health and safety and the environment. In most cases, bioenergy conversion will escape these costs, but harvesting of most biomass resources has a significant potential for environmental damage and occupational injury.

A second step would be to review existing policies that subsidize or discourage the production of biomass source materials, feedstocks, or byproducts. Price supports for agricultural products are an example of these policies. In general, too, any policies that increase the price, or slow the development, of domestic or imported conventional energy sources, can be expected to improve the prospects for biomass. Several existing policies have such an effect, but the most important is phased deregulation of oil and gas prices.

In addition to policies that support biomass energy indirectly, there are a number of initiatives that might provide more direct assistance. Among the most important of these are policies that promote information dissemina-

* Many of these issues will be addressed in greater detail in OTA's forthcoming study of dispersed electric generation

[1] Battelle Memorial Institute, "An Analysis of Federal Incentives Used to Stimulate Energy Production," December 1978, and see Gerard M Brannon, *Energy Taxes and Subsidies* (Cambridge, Mass Ballinger, 1974)

tion and commercialization. information dissemination is especially important in promoting biomass energy because many technical applications are attractive only under site-specific or supply-specific conditions. This is a problem for many renewable energy technologies. The circumstances that make crop residues attractive in a farming community in Arkansas, for example, may be duplicated only in another community in Idaho. How can the information about the different technologies or processes, and their relationship to market conditions, be brought to these disparate operations? With respect to this goal, the experience with the Agricultural Extension Service suggests a useful model,

Commercialization of new technologies is even more difficult. Policies that support commercialization usually are justified on the grounds that technical, economic, and environmental uncertainties, some of them due to Government policies, delay the adoption of many technologies, especially those requiring large capital investments, until increases in energy prices have made them overwhelmingly attractive,

Commercialization policies may take many forms. Some are designed to help establish supply infrastructures, some to assure the availability of capital, and some to reduce the risks associated with conversion to new energy systems. Standard policy instruments to achieve these goals include technical assistance, tax credits, loan guarantees, and the adjustments of regulatory requirements to facilitate the sale of energy or the adoption of new technologies. In some cases incentives such as guaranteed markets or prices have been advocated as well.

In assessing commercialization policies, it is important to distinguish between: 1) those in which the taxpayers absorb initial risks and the Government clears hurdles to the demonstration of technical and commercial feasibility, and 2) permanent subsidies. The first are temporary supports, based on the assumption that bioenergy will stand on its own once it has been introduced, The goal is to bring technologies online more rapidly than would otherwise be the case, with the public paying the price required for a limited period of time. For these policies, attention to specific time and scale limitations is critical in the formulation of legislation.

Outright subsidies, whether direct or indirect, are more controversial and must be weighed with greater care. Subsidies have been, and continue to be, important instruments in energy policy. Proponents of domestic, environmentally acceptable, renewable energy often argue in favor of permanent subsidies on the grounds that they are granted to other energy forms and that the external costs of conventional energy systems make them far more expensive than their market prices suggest. Whether biomass fuel cycles should be subsidized, and if so, how much support is needed to counter the effects of subsidies to fossil fuels and nuclear energy, are political choices that the country must make, The point here is that the country must choose with the understanding that competition among different energy technologies, according to the efficiency and cost of each, will be impaired by permanent subsidies. The Federal Government's lack of experience with commercialization also should be taken into account. Where possible, therefore, it would appear best to promote commercialization with self-limiting subsidies, and then, if they are desired, to choose permanent subsidies that al low different renewable energy forms, including biomass energy, to compete with each other in relatively open markets,

Finally, increasing reliance on biomass for energy usually means tying energy supply to complex markets and to raw materials that either are heavily dependent on weather and climate or can be bid away for other uses. Consequently, fluctuations in the supply of these materials are inevitable and may become a serious problem as biomass begins to account for a larger portion of the national energy budget. Under these circumstances, it would appear appropriate for the Federal Government to explore means, such as establishing buffer stocks of raw materials or even of fuels such as alcohol, to assure continuous and reliable supplies of food and other products used as feedstocks, of coproducts, and of energy.

The following sections review policy options for the production and use of energy from wood, alcohol fuels, grasses and crop residues, and animal manure. Of these, the most complex, and therefore the longest, is the section on alcohol fuels, which describes the substantial body of laws, regulations, and programs that affect the American agricultural system as well as those governing soil erosion and air and water quality, and the analysis of options for liquid fuel end uses. Thus, although both wood and crop residues can be converted to methanol, policy considerations affecting the resource can be found in the sections on wood and crop residues, respectively, while those involving methanol production and use are reviewed in the section on alcohol fuels. The last section of this chapter contains a summary of the key policy alternatives for bioenergy development.

Appendix A reviews the key technological developments that may help bioenergy reach its full potential, while appendix B describes the computer model used to project the effects on the agricultural economy of producing ethanol from corn.

Wood

Introduction

A careful review of the wood resource base and the technologies that are now, and might in the future, be employed to convert it to useful energy suggests that a significant expansion of the contribution of wood to the energy supply stream in the United States is possible in the next two decades. Moreover, it may be possible to accomplish this while protecting the environment and forest resources and enhancing the overall production of commercial timber suitable for nonenergy uses. If this expansion is to occur, especially to the higher figures that might be achieved with a careful development of the resource base, public policy support and guidance will be needed to assist in the development and deployment of technologies; to help new users overcome obstacles to converting to wood energy; and to manage the social, economic, and environmental impacts of greater reliance on forestland for energy as well as for fiber, timber, and recreation.

The primary contributors to an expansion of the use of wood energy will be determined largely by geographic location and by the availability of reliable conversion technologies and stable, competitively priced supplies. Approximately 1 million homes currently use wood as a primary heating fuel and as many as 4 million others may be using wood as supplemental fuel. It appears that as many as 10 million homes may rely partially or totally on wood fuel by 1985, consuming perhaps as much as 0.4 to 0.8 Quad/yr in the process.[2] By taking population growth into account, this figure might reach 1 to 2 Quads/yr. The continued growth of fuelwood consumption for residential heating depends on the continued availability of low-cost firewood and the willingness of consumers to convert to wood use and sacrifice the convenience of oil, natural gas, or electric heating. The development of inexpensive automatic wood-fueled furnaces that use woodchips or pellets might increase the attractiveness of such conversion.

Although it is not widely known, the major use of wood energy in the United States today occurs in the forest products industry, where onsite combustion to produce electricity and process steam contributes over 1.2 to 1.3 Quads/yr, or about 45 to 55 percent of the industry's energy needs. With continued escalation in the price of imported oil, it is possible that the forest products industry would approach energy self-sufficiency by 2000. It would then be using between 2 and 3 Quads/yr of wood energy. If, as seems probable, the forest products industry should double its output in the next two decades (assuming some increases in efficiency), it would be using as much as 4 to 5 Quads/yr. As is the case with residential combustion, this increase appears likely to occur as a result of price incentives alone, and may require few additional stimuli. The rate of conversion depends heavily on the speed at which old oil and gas capacity can be replaced economically and on the commercial availability of intermediate-Btu gasifiers for retrofit on existing oil and gas boilers.

If wood energy use is to grow beyond the level of about 4 to 5.5 Quads/yr, however, wood combustion must be adopted by many users not now familiar with this fuel, especially by those "next to the woods" (other than the forest products industries), and thus within reach of a large supply of fuelwood. It is difficult to estimate the likely market for wood here, but the potential clearly is large, particularly where gasifiers can be used for process heat or added to equipment designed to run on oil and gas, thus adding flexibility as well as a cheaper fuel stream. Also important for the expansion of this market is the establishment of reliable wood fuel supply arrangements — a theme which is returned to in the dis-

[2] Booz, Allen and Hamilton, Inc., *Assessment of Proposed Federal Tax Credits for Residential Wood Burning Equipment* (Washington, D.C.: Department of Energy, 1979).

cussion of policy alternatives. * The introduction of methanol to the Nation's liquid fuel system would create still another source of demand for wood. Depending on the price and availability of imported oil, and on the cost and availability of coal-based methanol, the demand for wood for conversion to liquid fuels may also be very large.

To summarize, the United States may expect to produce at least *4* Quads/yr, and most probably about *5.5* Quads/yr, of energy from wood by **2000.** This assumes world oil prices of at least $30/bbl and no substantial change in current policy orientations, and can be expected to occur primarily as a result of the expansion of wood use in homes and in the forest products industry. Although this represents more than a tripling of current use, it is nevertheless a minimum; much more energy could be obtained from this resource. Steeply rising oil and gas prices, carefully designed incentives, and the rapid commercialization of efficient and reliable gasifiers — all would contribute to this. Under these conditions, between 8 and 10 Quads/yr might realistically be obtained from wood by 2000, provided it is harvested as part of an effective forest management program. Note that OTA estimates that the practical maximum is approximately 10 to 11 Quads/yr (table 18). Much of the expansion beyond 4 to 5.5 Quads/yr would have to take place in the commercial/industrial sector outside the forest products industry and, depending on private and Government decisions concerning liquid fuels, in the transportation sector (wood to methanol and perhaps later to ethanol).

*Currently, utilities produce between 60 and 70 MWe (Mitre, 1979) from wood, and an additional 100 MWe or so are on the drawing boards The overall utility market is limited, however, by the very large amounts of wood required by individual plants and by the need for very secure supply sources

Table 18.— Wood Energy Use in the United States (Quads)

Sector	1979	2000: Business as usual	2000: Vigorous support and high energy prices
Residential	0.2-0.4[a]	1.0	2.0
Forest product industries	1.2-1.3	2.5-4.5[b]	5
Other commercial and industrial	—	0.5-1[b]	3-4
Total	**1.4-1.7**	**4-5.5**	**10-11**

aEstimates of current residential use of wood vary considerably The Wood Energy Institute, on the basis of a survey conducted by the Gallup Organization, has estimated that as much as 50 million cords (0 8 Quad) of wood were burned in 1979
bNonadditive

SOURCE Office of Technology Assessment

Current Policies

Although interest in solar energy of all kinds has grown rapidly in recent years, current Federal programs give wood energy little emphasis or coordinated direction. Nevertheless, wood combustion is likely to be the most important, and perhaps the most cost effective, of the solar conversion technologies in the next two decades. The relative lack of interest in wood energy reflects, first, the continuing Federal emphasis on large-scale, centralized, technically sophisticated energy systems, and second, the belief of many policy makers that, among the solar technologies, wood combustion is well understood and likely to grow anyway, while other technologies are more dependent on direct Government assistance if they are to make a contribution. Thus, funding for current wood energy programs is low– and in some instances declining — and wood energy activities have been poorly coordinated in and among the agencies involved. This orientation has changed to some extent in recent months, especially with respect to program definition and interagency coordination, but plans for funding and staffing suggest that basic priorities have been altered only slightly.

In the following pages, major current policies and programs that affect wood energy are briefly reviewed, beginning with forest policy— largely the responsibility of the U.S. Department of Agriculture (USDA) and its Forest Service– and then energy policy–the responsibility of the Department of Energy (DOE).

Forest Policy

Forest Service policies and programs are especially important in the Western United States where a majority of the forestland is federally administered. In managing this land the Forest Service is guided by a number of broad goals articulated in the Organic Act (1897), the Multiple Use-Sustained Yield Act (1960), the Resource Planning Act (1974), and the National Forest Management Act (1976), among others. Especially important for wood energy is the "multiple use" principle, a long-standing guide to land and timber resource management that is followed by the Forest Service. The goal of multiple use management is to assure the balanced use of forest resources by many interests and to prevent over-use by one or a few economically powerful sectors such as logging and forest products companies. The renewable uses for which the national forests are to be managed are grazing, outdoor recreation, timber, watershed, and wildlife and fish. Note that energy is not one of the statutory uses; to the extent that forests are used for energy it is the result of timber operations that involve residue collection and, to a lesser extent, private harvesting of cordwood that may be permitted as part of stand thinning and debris clearing,

The Forest Service interprets the Multiple Use Act as mandating what may be called "dominant use" zoning. That is, while multiple use applies to an entire forest, particular management areas may emphasize one or another of the uses. In practice this means that for each area, such as a Ranger District, the manager identifies dominant uses and limits others to the extent that they are compatible with the dominant ones. For example, if a particular zone is especially valuable as a wild turkey habitat, constraints will be placed on other uses so that they do not interfere with wild turkey nesting and management. Clearly, this approach to land management has important implications for wood harvesting on Federal lands.

A second key Forest Service policy is that of seeking to assure a "sustained yield" of renewable resources from national forests and rangelands, Sustained yield has been interpreted as "even flow" or "nondeclining yield, " meaning that the allowable timber harvest on national forests is limited to a yield no higher than can be sustained in perpetuity.

Sustained yield management has been the subject of considerable controversy, largely because on the western national forests that contain large areas of even-aged, old-growth timber, such management often means delaying timber harvests for a long period and, thus, continued low net growth. This can result in greater wood decay and may sacrifice potential growth on land with mature trees. Merchantable timber on private lands has become scarcer as these lands have been "mined" by the forest products industry, leading to growing industry pressure on national forest resources. Many environmentalists support the long-term sustained yield policy as a means of limiting this logging and retaining the esthetic and ecological values of old-growth forests. *

The controversy over sustained yield policies is compounded by poor information regarding forest inventories and uncertainty regarding the possible consequences of different timber yield alternatives. Insofar as current policies influence the supply of wood products, especially sawtimber — and it is likely that they do in a minor way—they also affect wood energy,

An additional area of interest is Forest Service policies and practices for timber harvesting. **currently, for example, logging residues are burned or left to decompose— as much as 1.7 Quads,** in energy terms, are disposed of this way each year— rather than collected and used for energy. A decision to harvest some of these for energy would much improve the energy supply equation in the regions involved.

State and private forest management policies are also of central importance for wood

* See " Environmental Effects" under 'Wood" in ch 4

Photo credit USDA —Soil Conservation Service

Much of the forestland in the Eastern United States is privately owned in small lots

energy, particularly in the East where most forestland is owned in small lots by State governments or private individuals or companies. As noted earlier, it is from this area and ownership class that a large proportion of new wood energy resources must come if wood is to make a significantly greater contribution to the Nation's energy supply. The Cooperative Forestry Assistance Act of 1978 is the latest policy directive that addresses the issue of Federal assistance to, and guidance of, State and private forestry. It provides broad authority to the Forest Service to administer research, extension, and assistance programs, and some of these have been initiated. However, the Federal Government has chosen to downplay these activities in the overall allocation of funds, assuming that State and local agencies and the market can best allocate forest resources and determine the level of management on State and private lands. *

Finally, forest management is affected by policies designed to protect the public health and welfare and the environment. In general, environmental controls implemented by the Forest Service have been initiated by courts that strictly interpreted the mandates of national forest legislation. For example, the Organic Act of 1897 provides that "no national forest shall be administered, except to improve and protect the forest within the boundaries"

* State forestry policies vary widely in character and effectiveness While there are some exceptions, most State programs place a heavy emphasis on forest fire prevention and are able to do only minimal stand management on private land Some States, including Indiana and New York, heavily restrict cutting of wood for any purpose on State lands These limit access to State forests by those seeking to harvest even residues for energy purposes

or for purposes of watershed management. The courts have construed the basic policy behind this language to be regard for the future welfare, [3] and, accordingly, have prohibited practices that would decrease forest growth or water supplies.

In response to these judicial mandates for environmental protection, Forest Service management practices have changed significantly in the last 10 to **20** years. These changes have been accelerated by legislative directives such as the National Environmental Policy Act of 1969 (NE PA, described in detail in the section on "Alcohol Fuels"). Environmental impact statements (EISs) required by NE PA will play an increasingly important role in forest management as demand for wood increases.

At the State and local level, environmental controls on forestry vary widely. Some States have statutes modeled after NE PA that can be used to control the effects of logging on State lands. Other States have varying degrees of forest protection built into the legislation for administering State forests. In many other States, however, the primary impetus to proper forest management on State and private land is section **208** of the Clean Water Act. However, as discussed under "Alcohol Fuels, " section 208 only applies to nonpoint source water pollution and not to land quality or other issues, and its implementation has been delayed due to political, administrative, and other problems.

Energy Policy

DOE has the primary responsibility for research, development, and demonstration in the field of bioconversion, and its Biomass Energy Systems (B ES) Program has launched a number of small projects aimed at wood energy development. Current activities include support for the design of safe and efficient wood heaters, research on silvicultural energy plantations (tree farms), and a *very* modest demonstration of one kind of wood gasifier. The administration of bioenergy development, however, has been deficient in a number of respects. The BES Program has been understaffed and underfunded, and coordination with other agencies, especially in USDA, has been poor, delayed, or nonexistent. Not surprisingly, there also has been a rapid turnover in management.

Recently the biomass program has been restructured and granted some additional technical staff — the BE S Program now numbers five professionals and may increase to eight in the near future — and a wood resource manager has been appointed in the Industrial Applications Program (of the Solar Applications Office) and charged with promoting the rapid commercialization of systems using direct wood combustion. In the future, DOE intends to delegate many wood-related responsibilities to the regional Solar Energy Centers, while retaining overall program guidance in Washington. To improve coordination of biomass and wood energy activities, USDA and DOE currently are working on a memorandum of understanding to clarify the roles and responsibilities of the respective agencies involved.

Although these activities attest to the awakening interest in wood in DOE, it is clear from funding decisions that program activities concerning wood retain a very low priority in the overall Federal energy effort. As indicated earlier, this reflects, on the one hand, the administration's bias in favor of large-scale, centralized applications, especially those that hold the prospect of producing synthetic liquid fuels, and, on the other hand, the belief that wood energy is "ready" and requires little additional support in comparison to many of the other possible candidates for support.

[3] U S v *Shannon*, 151 F 863 (C (' Mont 1907)

Policy Options

There are a number of ways by which the Government might encourage and regulate use of wood energy in the United States (table 19). Indeed, a combination of policy support and high energy prices probably will be required if the contribution of wood energy is to grow

Table 19.—Policy Options: Wood Energy

Action	Objective
• Higher priority for wood energy in Government, especially DOE and USDA	• Increase attention, funding, and interagency cooperation
• R&D: Timber-harvesting technology and demonstration	• Wood fuel-supply system improvement
• R&D: Close-coupled, intermediate-Btu gasifier	• Low-cost retrofit for use of wood (and crop residues) in commercial and industrial sector outside forest products industry
• R&D: Development of oxygen-blown gasifiers designed to maximize yields of gas suitable for methanol synthesis	• Improve methanol synthesis
• R&D: Development of tree hybrids designed to give high yields	• Improve yields
• R&D: Basic research into thermochemistry of biomass	• Develop new, and improve old, fuel options for wood and other biomass
• R&D: Long-term effects on forest soils of short rotation-high biomass removal management	• Protect long-term forest productivity and forest ecosystems
• Programs and incentives to encourage or require good forest management, including assistance in selecting trees for harvest and in the timing of harvests	• Sustain and increase the resource base; make residue available for fuel; prevent environmental damage
• Resource inventories and monitoring	• Establish basis for decision regarding conversion to wood; monitor impact of increased use of wood for energy
• Government steps to make available supplies of wood, especially residues from national forests, and concentration yards	• Increase use of wood; increase reliability of supply
• Direct and indirect support for private wood harvesting activities and establishment of concentrate ion yards	• Establish wood supply system
• Information disseminate ion	• Encourage considerate ion of wood as an option
• Publication of test data on equipment	• Increase understanding and confidence in decisions
• Rapid decision on regulation and emission standards	• Decrease uncertain y
• Extend guarantees against retroactive requirements mandating new expenditures	• Decrease uncertain y
• Encourage utility cooperation in cogeneration	• Use of "excess" residues in forest products industry
• Measures to cushion against very high capital cost of wood-combustion equipment; e.g., loan guarantees, accelerated depreciation	• Rapid adoption of wood-burning equipment
• Special provisions for fuel switching in case of industries now using oil or gas	• Increase fuel-stream flexibility; decrease uncertain y
• Technical assistance systems for prospective users	• Assist in decisions about resources and technologies
• Performance standards for wood stoves and fireplace inserts and other small-scale combustion systems	• Protect user health and safety and control air pollution

SOURCE. Off Ice of Technology Assessment

beyond the 4- to 5.5-Quad/yr level that might otherwise be achieved. In the pages that follow, some of the options available for promoting wood energy growth beyond this level are reviewed.

New Priorities in Administration and Research

As previously pointed out, wood energy has a very low priority in the Government agencies whose policies will affect its growth. If the use of wood energy is to expand beyond the minimum levels OTA has identified, the Federal Government, in particular DOE and USDA–– especially the Forest Service, the Soil Conservation Service (SC S), and the Science and Education Administration — as well as the States must give it much stronger administrative and budgetary support. In addition, there should be less emphasis on large-scale, isolated systems such as tree farms, and more on smaller, integrated arrangements in which energy is not the sole product. This is true of most bioenergy systems––biogas production can be part of a dairy operation, ethanol distillery byproducts can be fed to animals. Wood is no exception. **Broadly speaking, these new priorities in research and administration are a precondition to the successful implementation of most of the specific initiatives listed below.**

Although one of the attractive characteristics of wood energy is that combustion technologies of various kinds are already in use and widely understood, a number of areas remain in which R&D can make an important contribution. Five areas, in particular, still require this kind of support: 1) wood-harvesting technology and demonstration, **2)** wood gasification technology and demonstration, 3) basic research on the thermochemistry of biomass, 4) development of fast-growing, high-yield plant hybrids as fuel sources, and 5) research on the conversion of wood and lignocellulosic materials to ethanol. Specialized timber harvesting for wood energy is new to most energy users, and experimentation with different harvesting strategies and with machines that can harvest timber efficiently and safely in different kinds of terrain and at greater distances from roads, is needed. Also, harvesting programs to demonstrate the costs and benefits of different patterns of wood collection would provide useful information, especially to those contemplating large-scale conversion alternatives.

Perhaps the most important single technical contribution to the expansion of wood energy use would be the development of reliable close-coupled, airblown, intermediate-Btu gasifiers. Described at greater length in volume I I of this report, this technology is critical because it can be used to produce process heat for industry (an option for which direct combustion is not suited), and would al low many current users of oil and gas to convert to wood at about two-thirds the cost of a new wood boiler, while retaining the flexibility to switch back to oil or gas if necessary. This might make wood energy attractive to a broad range of investors whose businesses are located close to wood resources but who are reluctant to commit themselves at high cost to an uncertain source of supply. Although working gasifiers have been built in the past, they need further development to meet the needs of potential users for commercial purposes.

Research on the thermochemistry of wood, also treated in volume II of the report, is needed for possible technical improvement across the whole range of biomass combustion and gasification technologies, as well as fuel and chemical synthesis.

The Resource Base: Establishing a Secure Fuel Supply While Protecting the Forests

One of the principal obstacles to wood energy outside the forest products industry is the absence of an established wood fuel supply and delivery infrastructure. The adoption of new energy technology is often contingent on the investor's sense of confidence regarding long-term reliability of supply at predictable costs. Such confidence is unwarranted in most parts of the United States today.

The Government might take a number of steps to improve the supply outlook. To begin with, **improved inventories of wood resources are needed in most areas. As the demand for biomass grows, it becomes increasingly important to be able to assess total wood inventory and wood growth with** more precision than is possible today. The Forest Service Survey should be redesigned to provide a census of forest inventory and forest growth by species and qualities on a whole-stem biomass basis not obscured by arbitrary assumptions concerning forest use standards and thresholds of commerciality. In addition, it would appear advisable for the Government to: 1) improve the census of forest product use to include wood used for industrial, commercial, and residential fuel; 2) improve the specification, classification, and census of wood residues, including silvicultural, harvesting, and manufacturing residues; and, 3) carefully explore the theoretical feasibility of multiple use forest management that includes fuel as one of the management objectives.

In those regions where the Federal and State governments are major owners and managers of forests, the management agencies might further encourage the establishment of a fuel supply industry by actions such as providing program funds to support the establishment of concentration yards. In the case of utilities and large institutional energy consumers, the Government might make available a guaranteed supply of fuelwood from publicly owned forest material, logging slash, and the woody residues of site preparation, fire prevention, and stand improvement measures. National forest

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decisions regarding the supply of wood can be expected to affect the overall wood market, and policies must be designed with this in mind. **In particular, it is important that the Forest Service assess its current and future timber sales procedures to determine possible impacts of pricing policies on the market for wood energy and on incentives for forest management in the private sector.**

Public forests, because of their size and the ability of management to make discrete inventories and plans, offer excellent opportunities in all regions of the United States to design and implement fuelwood use and forest growth pilot projects that can be evaluated for wider private sector adoption. Finally, there are many incentives that might be adopted to support commercial wood supply systems in the private nonindustrial forestlands. Direct and indirect help in financing timber harvesting (or the purchase of mechanized harvesting equipment), or incentives for forest-thinning activities with the provision that the wood residues be used for energy and the harvest plan be approved by qualified experts, are but two examples. Also worth considering are **educational programs to improve** logger efficiency in conducting integrated harvest operations. Experience in New England has shown that one of the most significant factors in determining the economic viability of harvesting low-quality material with mechanized equipment is the skill of the logging foreman in planning and executing the cut. One way to approach this is the staging of demonstration harvests to provide loggers with an opportunity to see well-executed operations and to show landowners the variety of possible management strategies for their forests.

The options described above would help to establish a reliable wood fuel supply infrastructure. In doing so, however, it is critically important that the protection and improvement of the forest resource be assured. Increased demand for wood energy **might** lead to more intensive and effective forest management that actually would increase the quality and quantity of timber resources. Unfortunately, it is by no means clear that such management will occur automatically, or in a uniform manner, everywhere in the country. A key uncertainty here is the unpredictable behavior of the 4.5 million private, nonindustrial woodlot owners who control 58 percent of the forestland and whose resources will be vital to wood energy supplies. Most of these individuals lack the expertise to make environmentally sound forest management decisions, and it is unclear how they will respond to increasing incentives to manage their lands for wood fuel.

Moreover, economic incentives do not always favor sound forest management. Although the absence of such management may damage forest productivity, landowners must have extremely long planning horizons in order to consider this damage when short-term economic pressures often favor cutting on vulnerable lands or with environmentally damaging techniques.

Other factors that will affect proper forest management include weak regulatory incentives, the often short leadtimes for selecting a logging site and harvesting techniques, the large number of relatively small sites that will make careful implementation, monitoring, and enforcement difficult, and the nature of the potential environmental damage, which does not lend itself to relatively simple technological controls or process changes.

There are a number of avenues available for environmental control in forest management. These include both preventive measures that are implemented before any impacts can occur and mitigative controls that alter the ecosystem response to impacts. *

On national forest lands, the existing policies described above might be expanded to encompass intensive resource management for energy. **The primary legislative change that might be considered is including fuel as one of the statutory forest uses under the Multiple Use Act.** This would remove any potential obstacles to including wood energy supplies in other forest management directives and regulations, including those that implement NE PA. However, the degree to which Forest Service practices conform to existing directives is unclear. Additionally, even though sound management tech-

*See "Resource Base" in vol II

niques may be included in an E I S filed under NE PA, there is no assurance that the specified techniques will be followed.

Forest management practices on State and private lands are more difficult to control at the Federal level. Where these activities are part of a comprehensive Federal program (e. g., incentives for wood energy use) management plans could be made a precondition of participation, and an E IS could be required for the entire program. However, just as management decisions on national forests often are made on a site-specific basis in accordance with general guidelines, techniques for controlling environmental impacts on non-Federal forestland also need to be tailored to a specific site.

In addition, federally mandated controls would be most effective if they were implemented throughout the forestry system rather than only on lands supplying wood for energy. That is, incentives that are tied only to fuelwood would be difficult to enforce without continuous supervision of logging because it would be nearly impossible to prove what wood came from which land once it had been cut. I n addition, if the environmental sensitivity of the land is the only variable (and not the kind or quality of timber), forest landowners would just shift their wood fuel activities to less sensitive lands.

At the State and local level, environmental controls could be implemented through logging permit schemes tied to forest management plans. Such schemes might include federally assisted education and demonstration programs. Again, these controls would be easier to implement and enforce if they apply to all forestland.

Finally, as discussed above, vigorous State and local implementation of section 208 of the Clean Water Act could be a powerful tool in controlling nonpoint source pollution from logging, but due to a variety of factors it is unlikely that this will occur.

Energy Conversion: Managing Uncertainty

Assuming that policies designed to protect and enlarge the resource base and to encourage the harvesting, transport, and marketing of fuelwood are adopted, a number of obstacles remain that prevent potential users from converting to wood energy. In many cases, removal of these requires only minor adjustment in policy or program emphasis. One such obstacle, for example, is the lack of public information concerning technologies and their applications. Another is continuing uncertainty about future Government regulations related to health, safety, air quality, and similar issues. **A continued expansion of Government information dissemination activities, along with the preparation and distribution of accurate and understandable environmental monitoring and equipment test data, plus rapid setting of regulatory standards would be helpful in dispelling some of this uncertainty. In the residential heating sector, for example, there** is a need for accurate information regarding the safety, efficiency, and proper installation and operation of wood stoves and fireplace inserts, and for clear guidance regarding emission standards. Although wood stoves are already economical in many parts of the country, the provision of an investment tax credit for this equipment, as well as for wood furnaces, would speed the expansion of wood use in home heating.

For those forest products firms with excess energy resources (i. e., with more residues than needed for onsite power), cogeneration to produce electricity as well as steam may be an economically attractive alternative. Unfortunately, cogeneration often is impeded by utility pricing policies in which backup energy is sold at very high prices, while energy from sources such as cogenerators is purchased at very low prices. Although this problem is addressed in the National Energy Act of 1978, it will take a long time to change rate structures and more regulatory support for cogeneration is needed.

In the commercial/industrial sectors, the high capital cost of wood combustion equipment is a barrier that can be addressed by the provision of tax credits–some already have been authorized, but are not widely used-– loan guarantees, and accelerated depreciation allowances. Wood-fired systems generally require three to four times the capital of comparable oil-fired systems. It would appear that small- and medium-sized businesses, especially, would be able to benefit greatly from such incentives.

Still another problem for businesses considering adding large-scale wood-fueled gasifiers to an oil- or gas-fired boiler is the possibility that, as a result of fuel-switching regulations of the National Energy Act, switching back might be prohibited. If this is the case, turning to wood could decrease fuel stream flexibility and increase uncertainty.

Most prospective wood energy users outside the forest products industry also would benefit from a carefully designed program of technical assistance. Such a program would provide basic information and help those interested work their way through the many complicated steps involved in a decision to convert to wood. This might include assistance with a review of the technology, an assessment of resource inventories, an investigation of applicable Federal and State subsidies and incentives, and perhaps even help with the preparation of engineering plans. Forgivable loans to small- and medium-sized businesses as well as to small utilities for conversion studies also would be of assistance. These loans might be repaid from investment funds if a decision is made to go ahead, and be forgiven if the project should prove unfeasible.

Finally, wood combustion can be an important source of local air pollution. The regulatory structure of the Clean Air Act in regard to stationary sources is described in "Alcohol Fuels. " However, most wood-fired equipment will be too small to be affected by Clean Air Act requirements and legislative or regulatory action to reduce emissions may be required as more homes and businesses turn to wood fuel. The easiest option to implement would be New Source Performance Standards for small wood combustion equipment. However, this option overlooks the substantial number of combustion facilities already in place. **In addition, regardless of how emission limits are implemented,** they will be difficult to monitor and enforce due to the great number of dispersed sources.

What impact would these policies have if adopted? The answer is unclear because the uncertainty about key aspects of the wood energy system simply is too great. OTA is confident about the estimate that 4 to 5.5 Quads/yr of energy from wood will be used annually by 2000, but this represents mainly a projection of current trends. If the forest products firms continue to grow and move toward energy self-sufficiency, as much as 4.5 Quads/yr are likely to be derived from wood in that sector. OTA also is confident that the resource base, with proper management, is large enough to sustain energy production in the 6- to 10-Quad/yr range by 2000 or sooner. But **important uncertainties remain, and it is critical that these be acknowledged and incorporated in policy decisions affecting wood.**

Only one technical question appears to be crucial at this point: whether a reliable gasifier can be developed and marketed in the near future. Other technical innovations may help speed the use of wood for energy, but do not appear as important in capturing an entirely new set of users for this resource. The reason is that gasifiers can be used for process heat and give fuel-switching flexibility that is essential in the absence of certainty regarding future wood supplies. In addition, gasification would require less initial investment than direct combustion. Clearly, therefore, this represents a bottleneck that should be addressed as quickly as possible if a greater use of wood energy is desired. The nontechnical uncertainties are more difficult because they have to do mainly with the behavior of diverse groups of producers and consumers and with the operation of complex, multi sector markets.

Perhaps the most important uncertainty concerns the crosspoint between wood consumption and forest depletion. Growth in dependence on wood for energy will mean drawing heavily on the *283* million acres of forests now in the hands of many small- and medium-sized woodlot owners, but very little is known about their management objectives, about how they might respond to incentives to manage their land, harvest wood, and so forth. Currently large proportions of wood used for fuel in residences are cut with little or no professional guidance. Although it may seem economically sensible from a long-term perspective for these owners to manage their resources carefully, it is entirely possible that growth in demand for wood fuel and a desire to maximize short-term profits will lead to regional or local deforestation as well as an overall decline in the quality of national forest resources. For this reason, and because an increase in the resource base should, if at all possible, parallel the growth of wood energy use, policies to enlarge Government support for forest management activities would appear prudent despite the uncertainties listed here. Programs with this objective can always be phased out if private initiatives appear adequate, whereas a lack of adequate forest management would decrease the energy potential obtained from wood and could cause significant environmental damage.

If the forests are more intensively managed, the overall character of these lands will change. Extensive management would alter the physical appearance of woodlands and transform the mix of wildlife supportable by forest ecosystems. To a degree, it is possible to grasp these changes by observing the character of woodlands in parts of Europe where intensive forest management has been practiced for many years.

Finally, there remains a broad range of market uncertainty that stems from the possibility of changes in the prices of petroleum and natural gas and from continuing competition with nonenergy uses of wood and land. It is quite possible, for example, that as larger amounts of wood are cut, the nonenergy uses for incremental wood supplies may grow more attractive economically, resulting in far less conversion to wood energy than might otherwise be expected. Because feedstock costs are such an important part of biomass energy system costs, the continuing possibility that wood prices may rise will tend to dampen enthusiasm for this energy source outside the forest products industry.

To summarize, all these uncertainties make it difficult to predict with any precision or confidence either how much energy will be produced from wood with the adoption of even vigorous promotional policies or the full consequences of the success of such policies for the environment and nonenergy wood markets, This conclusion, in turn, suggests several important principles that should be considered in the formulation of wood energy policies. First, **legislators should acknowledge the uncertainty about the effectiveness of policy initiatives at the outset by making their commitments tentative and by including in legislation, where appropriate, requirements for subsequent assessment of results.** Sunset provisions, price and quantity thresholds for subsidies and incentives, statutory requirements for review of existing policies, and similar provisions might contribute to this goal. For example, policy makers might require a formal review of the wood energy system, the condition of the forest resource, and the need for continued incentives for conversion to wood when 5 Quads/yr of wood energy are being consumed. Second, the United States should simultaneously monitor with great care the responses to promotional policies and other regulations in order to detect problems and unanticipated impacts. **Continuous monitoring of the condition of the forest resources, the kinds of technologies being deployed, and the environmental and social impacts of wood energy use, is essential.**

As this report has tried to emphasize, the possible problems and costs associated with increasing reliance on forest resources are not as well understood as the benefits. In general, these appear to be manageable but are of the kind that are often neglected until it is too late, The broad tendency in the United States, when the goal is perceived to be that of "commercializing" an economic activity, has often been to piece together a rough package of loosely related incentives and then to assume that the problem has been solved, Wood energy, like all biomass energy systems, requires not a solution but a long-term commitment to the management and guidance of interdependent systems of economic activity. This, in turn demands careful orchestration of incentives, controls, and regulations, along with constant monitoring of the consequences of policy choices.

Alcohol Fuels

Introduction

Biomass has become the object of widespread public and legislative interest because it is the only source of liquid fuels from solar energy produced with available technology. As noted in chapter 4, the largest potential source of alcohol fuels is methanol from wood, grass and legume herbage, and crop residues. If managed properly, these feedstocks can be obtained with a minimum of environmental damage or disruption of existing markets. Ethanol from grain and sugar crops represents a much smaller potential source of liquid fuels. However, ethanol is likely to remain important for at least the next decade as a means of diversifying domestic energy sources and as a transitional fuel until other synfuels become commercial.

A number of technical and policy constraints could limit the commercial production and use of alcohol fuels, and policy support will be needed if these fuels are to make a significant contribution to domestic energy supplies. In the short term, the limiting factors include the long leadtimes for constructing new distilleries and for converting idle capacity, the need to demonstrate conversion technologies using cellulose feedstocks, and the lack of a reliable feedstock supply infrastructure. In the long term, alcohol fuels production could be limited by competition with other synfuels for investment capital and by competition with feed and food. Other issues surrounding ethanol from grain and sugar crops include its net energy balance as well as its potential for environmental damage and for significantly altering the focus of agricultural regulation.

Policy makers might also promote onfarm and other small-scale operations that would contribute to liquid fuel self-sufficiency in agriculture and other sectors. Onfarm distillation may be inhibited in the short term by its cost (especially relative to the subsidies for gasohol sold at the pump), the lack of relatively automatic inexpensive distilling equipment, and farmers' lack of technical knowledge. in addition, onfarm use would mean sacrificing the value of ethanol as an octane booster in gasoline. Once farmer acceptance has been achieved, however, the cost or labor may become secondary to the value of some degree of fuel self-sufficiency.

The policy context for alcohol fuels is very broad, encompassing forestry, agricultural, revenue, energy, and environmental policies. This section analyzes policy considerations related to the production of grain and sugar crops for ethanol and to the conversion and use of all alcohol fuels. Policy related to supplies of wood and grasses and residues is discussed in other sections of this chapter. Because ethanol from grain and sugar crops has attracted such widespread attention, and because it has potentially severe environmental, institutional, and economic consequences, its policy implications are discussed in greater detail than is the case for the other fuel cycles.

Resource Base

Several hundred million gal/yr of ethanol could be produced from sugar and starch crops and food wastes without expanding crop acreage or withdrawing grains from traditional markets. Production beyond this level, however, would require cultivating additional acreage or diverting supplies from traditional domestic and international markets. Unless feedstock supplies are managed carefully, grain-based ethanol might disrupt the complex and highly regulated agricultural economy and could result in environmental degradation. To some extent, these problems can be avoided in the market or under current agricultural and environmental policies. In some instances, however, new policies will be necessary.

Current Agricultural Policy

Since the 1700's, American farmers have been dissatisfied with the prices of agricultural commodities that result from free competitive market conditions. After World War 1, farm prices and income were low, and farmers began to turn to the Federal Government for price supports and controls on surpluses. During the 1920's, Congress twice passed legislation designed to subsidize grain exports, but President Coolidge vetoed it both times because he believed foreign nations would take retaliatory steps. [4]

In 1929, under President Hoover, the Federal Farm Board was established to administer a program of "orderly marketing" based on storing surplus grain that was depressing grain prices. Although the grain was stored, the program failed, partly because grain supplies remained uncontrolled and partly because the anticipated increase in demand did not materialize due to the depression. [5] In 1933, the Federal Farm Board was replaced by the New Deal production control, price support, and storage programs. This basic regulatory structure, with the addition of export subsidies, continues today in order to balance the supply and demand of agricultural commodities, maintain farm income, and ensure reasonable prices for consumers.

The present form of these programs was established under the Food and Agriculture Act of 1977 (Public Law 95-1 13), one of the most comprehensive pieces of farm legislation ever passed by Congress. Under this Act USDA estimates the acreage required to meet domestic, export, and inventory needs for a crop year. This "national program acreage" is then divided by the estimated national acreage harvested for each basic commodity (corn, cotton, peanuts, rice, tobacco, and wheat) in order to arrive at an allocation factor that is used to determine individual farm program acreage. Since early in 1980, the national program acreage allocation has included projected demand for alcohol fuel feedstocks. Farmers who agree to limit their production to the allotted acreage are eligible for a variety of economic programs including price supports, loans, and other payments. The production control and income support programs are described below in order to establish the policy context within which ethanol feedstock production must be integrated.

Production Controls

If ethanol production is to be increased by bringing additional acreage under intensive cultivation, the acreage most likely to be used first is the land under production controls. The USDA programs designed to control production by enforcing the individual farm acreage allotments include set-aside lands, diverted cropland, and the cropland adjustment program.

The set-aside approach was initiated under the Agricultural Act of 1970 (Public Law 91-524), which required farmers to remove a percentage of their acreage from production and devote it to approved conservation uses in order to be eligible for other farm support programs, **including loans and other payments. Farm operators must meet the set-aside requirements for all crops ("cross compliance"). Thus, if farmers grow both wheat and feed grains, they must participate** in both set-aside programs to receive benefits from either. Farm operators who agree to reduce their acreage by 10 to 20 percent are guaranteed a slightly higher price for their crops than farmers who do not participate in USDA programs. In 1978 there were 13.3 million acres in the set-aside program, but the amount of set-aside acreage varies annually.

Farm operators also may divert other lands to approved conservation uses in return for additional payments under several USDA programs. In years when the demand for a basic commodity (such as wheat or feed grains) is projected to be relatively low, or when reserves are high, farmers may voluntarily divert acreage to conservation uses in return for diversion payments. Approximately 5 million acres were under cropland diversion in 1978; again, the acreage varies annually.

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4 S Barber, et al , *The Potential 01 Producing Energy From Agriculture*, contractor report to OTA, May 1979

5 Marion Clawson, *Policy Directions for U S Agriculture* (Baltimore, Md The Johns Hopkins Press, 1968)

As mentioned above, agricultural policy requires set-aside and diverted lands to be converted to "approved conservation uses. " In practice, there is a wide range of such uses; some would conflict with ethanol feedstock production while others specifically provide for it. In general, set-aside and diverted acreage must be devoted to crops or practices (such as grasses and legumes, small grains, trees or shrubs, terraces and sod waterways, and water storage) that will protect the land from wind and water erosion. Both set-aside acreage and diverted lands also may be devoted to wildlife food plots or habitat or to public recreation in accordance with standards developed by USDA in consultation with other agencies. Government assistance often is available to help defray the costs of these activities.

Moreover, under the Emergency Agricultural Act of 1978 (Public Law 95-279), USDA may permit all or any part of the set-aside or diverted acreage to be used to produce any commodity (other than the commodities for which acreage is being set-aside or diverted) for alcohol fuel feedstocks. This energy use of diverted and set-aside lands is permitted under the Act if USDA determines that the production is desirable in order to provide an adequate supply of liquid fuels and is not likely to interfere with the other goals of farm programs. Participating farmers would continue to receive set-aside payments for these lands. During years in which there is no set-aside or acreage diversion requirement, the Act authorizes USDA to formu late and administer a program for the production of commodities for liquid fuels. Under such a program, producers of wheat, feed grains, upland cotton, and rice would receive incentive payments to devote a portion of their acreage to energy crops. The amount of these payments would be determined by the degree of participation necessary to ensure an adequate supply of commodities for liquid fuels. However, this program has not been implemented by USDA.

The third production control is the cropland adjustment program. It was authorized by the Food and Agriculture Act of 1965 to reduce the costs of farm programs; to assist farmers in converting their land to nonagricultural uses to promote the development and conservation of soil, water, forest, wildlife, and recreation resources; and to establish, protect, and conserve open spaces and natural beauty. Under the cropland adjustment program, farm operators entered into 5- to 10-year contracts to maintain conservation practices on land taken out of production. In issuing these contracts, USDA gave priority to practices most likely to result in permanent conversion of the land to nonagricultural uses. In 1976, 1.2 million acres remained under cropland adjustment program contracts.

Income Support Programs*

Many proponents of gasohol argue that it would increase commodity prices and thus farm income, and therefore would be a boon for farmers. In order to assess this argument, it is necessary to understand USDA programs related to basic commodity prices (corn, cotton, peanuts, rice, tobacco, and wheat). The agricultural programs designed to protect farm income and consumer interests are price supports, direct income and deficiency payments, loans, and disaster payments.

A target price is used as the basis for providing farmers with direct income payments that vary inversely with the market price. Target prices are determined annually from USDA estimates of production costs (excluding land) and of returns to management. When the average market price received by farmers during the first 5 months of the marketing year is less than the target price, eligible farmers receive deficiency payments based either on the difference between the two prices or the difference between the target price and the support price, which is determined by the loan rate at which farmers can borrow on their crop production. In practice, the loan rate becomes a price floor below which the market price is unlikely to fall, because the Government loan effectively eliminates financial pressure on the farmer to sell at any price.

To obtain a USDA nonrecourse loan, the farm operator pledges a specified amount of

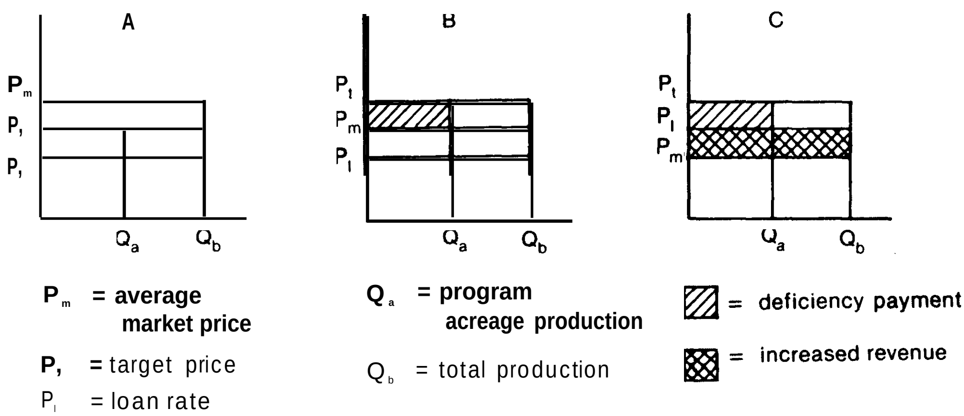
*Much of the discussion in this section is from S Barber, et al , Op cit his crop as collateral. The amount of the loan is equal to the loan rate (or support price) times the quantity of crop pledged. At the end of the loan period (9 to 12 months) the farmer may either repay the loan with interest or forfeit the stored crop. Farmers may extend a nonrecourse loan and receive a prepaid storage payment by signing a 3-year contract to enter the farmer-held reserve program. Under this program, the farmer agrees to hold the crop for the contract period or until the market price reaches the release level (140 percent of the loan rate for wheat and 125 percent of the loan rate for corn). The farmer only pays interest during the first year of the contract at 7 percent. Farmers can release the grain earlier by paying a penalty.

Finally, payments are available when natural disasters either prevent normal planting operations for basic commodities or result in a harvest of less than 60 percent of normal production. The disaster payment rate is 50 percent of the target price for the deficit of production below 60 percent of normal.

Operation of the current farm price and income program under three circumstances is illustrated in figure **37.** In part A, the market price is above both the target price and the loan rate. In this situation, farmers would sell their crops in the market, no loans would be requested, and no deficiency payments would be made. In part B, the market price is below the target price but above the loan rate. Under these circumstances, producers would not elect to take the nonrecourse loan but would receive a deficiency payment equal to the difference between the target price and the market price times the production from program acreage. In part C, the market price is below both the target price and the loan rate. In this situation, farmers probably would take advantage of the nonrecourse loan program, which would increase their crop revenue, and they would receive an additional deficiency payment on their program acreage equal to the difference between the target price and the loan rate times the program acreage.

The current farm programs have two main effects. First, the deficiency payments represent an income transfer from the general public to farmers; they have little effect on market prices. Second, the loan program operates as a price support that tends to increase prices to consumers up to the level of the loan rates and transfers income from consumers to farmers. Thus, the current program splits the incidence of income transfer between consumer payments (if the market price is below the loan

Figure 37.—Operation of the Current Farm Program



SOURCE S Barber, et al *The Potential of Producing Energy from Agriculture* contractor report to OTA May 1979 rate) and general tax revenues (for deficiency payments).

Reserves and Exports

Agricultural policy also provides for storage and export of commodities— both potential sources of alcohol fuel feedstocks. Strategic reserves are maintained as part of the general agricultural programs. The sources of reserves include farmer-held reserves and production in excess of farm marketing quotas for basic commodities. As discussed above, farmer-held reserves are stored under contract and released for sale on the market at a specified time. Under the market quota programs for basic commodities, when production exceeds the farm allotment the farmer stores the excess and uses it the next year to offset the farm allotment for that year, or the Commodity Credit Corporation (CCC) may acquire the excess as part of its strategic reserve. [n general, the reserves are used in disaster relief and welfare assistance or as a hedge against future supply deficits.

Agricultural policy also encourages the expansion of international trade to use the abundant U.S. agricultural productivity to aid the balance of payments. **In 1978, for example, agriculture had a favorable trade balance of $13 billion. Moreover, concessionary commodity exports are subsidized by the Federal Government to provide assistance to developing countries.**

Research, Education, and Extension

In addition to the regulatory programs discussed above, USDA also sponsors research, education, and extension service programs that could affect the production of energy commodities.

The Agricultural Research Service supports basic and applied research in a number of areas including plant sciences, entomology, soil and water conservation, and agricultural engineering. The Cooperative State Research Service (CSRS) administers congressionally mandated research in the State Agricultural Experiment Stations. Several of the research programs sponsored by these agencies could affect bioenergy, including research in crop productivity, and processing, storage, and distribution efficiency. CSRS also administers special grants to develop solar technologies that can be used in modern farm operations.

The Agricultural Extension Service and SCS inform farmers of the results of agricultural research. The Extension Service, through the land grant colleges, gives instruction in agriculture and related subjects and encourages use of the information by people not attending the colleges through demonstrations, publications, and direct farm visits. **In addition, the Extension Service conducts** a model farms program that includes demonstrations of the effective use of solar energy in agricultural operations. SCS works with county Soil and Water Conservation Districts (SWCDs), watershed groups, and Federal and State agencies with related responsibilities to bring about physical adjustments in land use that will conserve soil and water resources and protect long-term agricultural productivity.

Finally, the Economics, Statistics, and Cooperatives Service performs studies to support cooperative groups that market farm products, purchase production supplies, etc. Technical assistance is available to farmers on organizing new cooperatives, improving cooperative performance and efficiency, and related business services.

Agricultural Policy Options

As already indicated, if the United States decides to aggressively promote ethanol from grain and sugar crops as a means of increasing domestic energy supplies, distillery demand for feedstocks must be integrated into the agricultural economy without subverting the goals of the existing policies described above (table 20). There are three main sources of distillery feedstock supplies (see ch. 4): diverting commodities from export or other markets to distilleries, bringing currently idle and potential cropland into production, and changing the mix of crops currently grown and reformulating animal feed. Each of these supplies can be provided either by modifying agricultural policies or by maintaining current policy

Table 20.—Policy Options: Alcohol Fuels

Action	Objective
• Include alcohol fuel feedstock demand in USDA national program acreage allocation	• Expand feedstock supplies; integrate feedstock supply into agricultural production system
• Divert limited quantities of feedstocks from export, feed, and other markets	• Expand feedstock supplies; protect commodity prices
• Direct or indirect support for domestic sugar crops used as alcohol fuel feed stocks	• Expand regional feedstock supplies; support domestic sugar producers
• Direct or indirect support for new cropland planted in alcohol fuel feedstocks	• Expand feedstock supplies; increase farm income
• Strengthen support for onfarm and cooperative storage	• Maintain the ability to moderate short-term supply deficits for all grain consumers
• Monitor grain ethanol production and grain prices and re-evaluate incentives as distillery capacity increases	• Determine correlation between grain ethanol and inflation in food prices; protect consumer prices
• Provide production tax credits for all alcohol fuels	• Equalize tax treatment between ethanol and methanol and between private and commercial production; stimulate alcohol fuel use
• Implement section 208 of the Clean Water Act	• Control agricultural non point source pollution; protect long-term agricultural productivity
• Expand farm information, education, and support programs on soil conservation	• Reduce soil erosion; protect long-term agricultural productivity
• Require approved conservation plans for all cultivated lands	• Reduce soil erosion; protect long-term agricultural productivity
• Program support for alcohol fuels used as octane-boosting additives in gasoline	• Increase displacement of premium fuels
• Simplify BATF regulations for alcohol fuel producers	• Reduce cost of alcohol fuels; encourage production
• Use gasoline tax revenues to support new alcohol fuels production capacity	• Encourage gasoline conservation; increase alcohol fuels supplies
• Direct and indirect support for onfarm and cooperative alcohol fuel production	• Increase agricultural and rural liquid fuel self-sufficiency
• Support distilleries that convert from grain to cellulosic feed stocks	• Reduce potential for food-fuel competition
• Limit number of BATF permits for grain ethanol production	• Reduce potential for food-fuel competition
• Extend auto warranties to include methanol-gasoline blends and straight alcohol fuels	• Reduce consumer risks; encourage alcohol fuel use
• Provide long-term gasoline supply guarantees to alcohol fuel-gasoline blenders	• Increase alcohol fuel use
• Provide long-term supply guarantees for auto fleets	• Increase alcohol fuel use; provide controlled situation for studying fuel effects on autos and emissions
• Require grain ethanol distilleries to use coal, biomass, solar, or other non premium boiler fuels	• Maximize premium fuel displacement
• Study liquid fuels system vis-a-vis methanol	• Determine most economic strategies for using methanol to displace oil
• R&D; Develop high-yield crops that do well on land poorly suited to food crops	• Increase feedstock supplies; reduce potential for food-fuel competition
• R&D: cellulose-to-ethanol	• Expand alcohol fuel supplies; reduce potential for food-fuel competition
• R&D: Develop inexpensive, safe, highly automated small-scale stills, including the capability to produce dry ethanol and dry distillers' grain, and to use a wide range of feedstocks	• Decrease the cost and increase the use of alcohol fuels on farm; increase agricultural and rural liquid fuel self-sufficiency
• R&D: demonstrate herbage-to-methanol processes	• Expand alcohol fuels supplies; reduce potential for food-fuel competition

SOURCE Off Ice of Technology Assessment

and using end-use subsidies such as the Federal excise tax exemption to modify market forces in agriculture. Both options are discussed below. A subsequent section outlines market and regulatory options for controlling the environmental impacts that could result from the production of grain ethanol. The reader should keep in mind that **maintaining long-term stability and productivity in agriculture will require an integrated approach that combines agricultural, energy, and environmental policy initiatives.**

If current production of grain and sugar crops for feed were diverted to distilleries, it would yield substantial quantities of ethanol (up to 30 billion gal/yr, more than half of it from corn). Although it is highly unlikely that this much grain ethanol would be produced at the expense of traditional agricultural products, OTA's analysis indicates that as much as 1 billion to 2 billion gal/yr could be produced without significantly inflating food prices.

Part of this 1 billion to 2 billion gal/yr would come from the diversion of commodities from export markets. This could be done either by USDA or through other political diversions such as the recent Soviet grain embargo, or could result from distillers outbidding exporters. The former would make it easier to control the amount of grain diverted. The latter would be limited by how much distillers can afford to pay for feedstocks in order to remain in operation. Given the profitability of producing fuel ethanol with current subsidies, the latter market limit may be high, and before it is reached, the price of grain feedstuffs in export markets could increase—or grain exports decrease — substantially.

Reducing commodity exports or increasing their price in order to augment U.S. energy supplies could result in adverse responses from importing countries. Furthermore, the resulting reduction in oil imports would not necessarily represent a net gain in the balance of trade if commodity exports also are reduced. That is, there is a relative economic advantage in exporting $2.50/bu corn and importing oil until the price of oil reaches $40 to $45/bbl.

An alternative source of feedstocks for grain ethanol would result from farmers substituting one crop for another and reformulating animal feed. Again, crop switching could be accomplished within the framework of the existing national program acreage allocation or could occur in response to higher prices for distillery feedstocks. The primary constraints on crop switching are limits on the degree to which animal feed can be reformulated and still retain its nutritive value, and the amount of cropland that is suitable for switching to corn or other ethanol feedstock cultivation.

Finally, it has been suggested that sugar crops could be used for fuel ethanol feedstocks. Although total domestic sugar production would yield only about 800 mill ion gal/yr of ethanol at a significantly higher cost than ethanol from corn, the United States is the world's largest raw sugar importer and the domestic industry currently is depressed due to rising land, labor, and other expenses. The Department of Labor estimates that 4,500 sugar workers have been laid off in the past 3 years, [6] while the General Accounting Office reports that substantial defaults on Government loans to domestic sugar producers are occurring as a result of low-cost sugar imports. [7] The domestic price of sugar is higher than the world price due to import tariffs and other price supports designed to protect domestic producers. [8]

Either imported or domestic raw sugar could be diverted to ethanol production. One option for using imported sugar would be to allow ethanol producers to purchase raw sugar on the world market (i.e., without import tariffs). However, this probably would allow the world market price to rise to match the U.S. price and would increase the price of other products containing sugar. Also, there would be a net increase in the U.S. balance-of-trade deficit.

Alternatively, domestic sugar sold for ethanol production could be subsidized, allowing the growers to recover their costs but providing distillers a guaranteed cheap feedstock. Due to the physical limits on sugar crop production in the United States and to the probable cost of the ethanol, this option is not likely to produce substantial quantities of liquid fuel. It might, however, attract interest in sugar-producing areas as a means of increasing regional alcohol fuel production and further diversifying domestic liquid fuels supplies.

The third major source of distillery feedstocks is cultivation of potential and currently idle cropland. As discussed above, approximately 18.3 million acres were under production controls in 1978 (but the amount varies from year to year). In addition, a 1977 SCS survey of private lands classified 40 million

[6] *Employment and Earnings* (Washington, D C Department of Labor, Bureau of Labor Statistics), monthly

[7] *Questionable Payments and Loan Defaults in Sugar Programs* (Washington, D C General Accounting Office, Mar 16, 1979)

[8] *Reduction in the U.S Import fee on Sugar* (Washington, D C General Accounting Office, July 17, 1979)

acres as having a high potential for being converted to cropland and another 95 million acres as having medium potential.[9]

Any program designed to increase agricultural production for ethanol feedstocks must consider several factors. First, the available uncultivated lands are subject to problems usually not associated with normal cropland, such as high erosive potential, existing land uses, limited size, and drainage, seepage, and flooding, that will increase annual variability in yields and the potential for environmental damage. **Because of the increased probability of reduced yields or crop failures, incentives for ethanol could include a storage reserve equivalent to a 6-month or greater supply of feedstocks to provide a buffer against short-term supply deficits. This** reserve could be implemented through either agricultural programs or distillery subsidies. Finally, if the demand for food and the conversion of cropland to other uses continues to increase, the quantity of land potentially available for energy crop *production* will decrease. Therefore, programs designed to promote grain ethanol should either be reversible or be able to accommodate a change in ethanol feedstocks (e. g., to cellulosic feedstocks), and policymakers should consider ways to preserve agricultural land uses.

Given these considerations, two principal options for increasing agricultural production to supply ethanol feedstocks are discussed: 1) expansion of current agriculture programs to include energy crops, and 2) elimination of existing production controls. For these options, the potential impacts on commodity production and prices and on Government expenditures have been projected through computer modeling and the results are presented to facilitate comparison between these options and

[9] *1977 National Erosion Inventory* (Washington, D C U S Department of Agriculture, Soil Conservation Service)

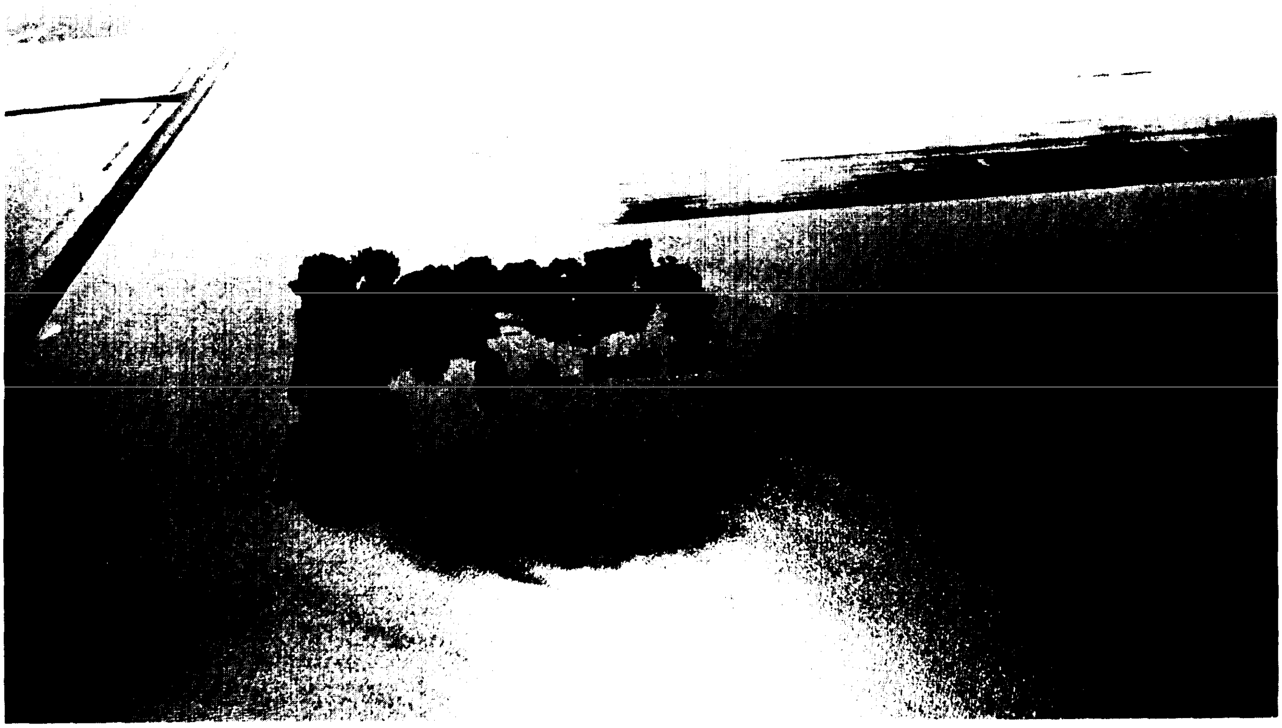


Photo credit. USDA, Cal Olson

Problems such as flooding potential increase the annual variability of crop yields current agricultural trends.'" The reader should keep in mind that these modeling results are **not** predictions, but projections of hypothetical situations based on assumed values for particular variables (see app. B for description of model). The real future values of those variables may be very different and other factors not built into the models could produce radical changes. Note also that the model shows only the hypothetical effects of increased **corn** production; other ethanol crops could have different impacts.

The first option incorporates the exogenous demand for grain for ethanol production within the context of the current commodity programs. The deficiency payment, nonrecourse loan, and domestic grain reserve programs continue to operate as described above, but set-aside acreage may be used to produce grain for ethanol. Ethanol feedstock crops would be purchased by CCC and sold to distilleries as needed. In this option, the higher market prices created by distillery demand (stimulated through either conversion process or end-use subsidies) would be the primary incentive for using set-aside and other idle lands for ethanol crops.

The second option would eliminate production control and deficiency payment programs, but increase the loan rates to nearly the level of target prices. This would result in a production incentive and level of farm income protection roughly equivalent to those provided by current agricultural programs. The increased loan rates also would provide the means to increase CCC inventories of corn for sale to distillers.

The modeling results for these options are shown in table 21 to compare two means of implementing policies designed to stimulate increased production of corn for use as an ethanol feedstock as well to compare various levels of corn production. In the long run, there are few operational differences between the two options because, by 1985, the first evolves to closely approximate the second. That is, over time in the first option the set-aside acreage diminishes. Hence, the loan rate becomes the primary means of ensuring the stability of farm income under both options. In effect, the increased demand for corn obviates the need for pure income support (deficiency payments), and the price support provides price stability.

As shown in table 21, either of these options results in substantial impacts on the agricultural system at ethanol production levels of 4 billion gal/yr. Season average corn prices increase 30 percent while the annual instability in corn prices nearly doubles. In addition, strategic reserves are reduced by 55 percent. Together, these effects undermine two of the goals of agricultural policy: to maintain stability in commodity prices in order to protect farm income and consumer prices, and to maintain strategic reserves in order to moderate short-term supply deficits.

Furthermore, several features of these options may prove to be unacceptable even at the l-billion- to 2-billion-gal/yr level of ethanol production. The first are the economic impacts related to commodity prices and Government program expenditures. Even at the 2-billion-gal level, the exogenous demand results in increased corn prices that probably would increase the price of food to consumers. Under the first option, Government expenditures for CCC operations, acreage diversion payments, and farmer-held reserve payments also increase. As discussed in the review of income support programs, consumers would bear most of these costs. The composition of the expenditures also changes significantly because the deficiency payments are substantially above those projected for the existing agricultural programs; these payments reflect the cost and risk in cultivating new lands and represent an income transfer from the general public through tax revenues. They have little effect on market prices. As the supply commitment level increases, these costs diminish because of higher corn prices, but are more than offset by increasing net purchase costs of CCC. Under the second option, deficiency and diversion payments are eliminated, but CCC purchase costs again increase steadily with the level of supply commitment, and again, must

'['Ronald L Meek hof, et al , U S. *Agricultural Policy and Gasohol Simulation of Some Policy Alternatives,* June 1979

Table 21.—Potential Impacts of Increased Corn Production for Gasohol

	Current agri-cultural trends	First option			Second option			Percent difference between options		
		1 x 10^9 gal/yr	2 x 10^9 gal/yr	4 x 10^9 gal/yr	1 x 10^9 gal/yr	2 x 10^9 gal/yr	4 x 10^9 gal/yr	1 x 10^9 gal/yr	2 x 10^9 gal/yr	4 x 10^9 gal/yr
Corn prices ($/bu).	$2.53	$2.53	$2.67	$3.21	$2.56	$2.70	$3.32	– 1.2	– 1.1	– 3.4
Soybean prices ($/bu)	$7.00	$6.95	$6.90	$7,34	$6.66	$6.52	$6.38	4.4	5.7	1.4
Corn production (10^6 bu)	7,250	7,467	7,590	7,730	7,569	7,588	7,580	– 1.4	—	2.0
Soybean production (10^6 bu)	2,188	2,125	2,088	NA	2,192	2,170	NA	– 3.1	– 3.9	–
Corn exports (10^6 bu) .	2,056	2,055	1,996	1,850	2,115	1,957	1,783	– 2.9	2.0	3.7
Soybean exports (10^6 bu)	932	936	953	945	975	1,005	1,047	– 4.1	– 5.3	– 10.2
Corn reserves (10^6 bu)	1,960	1,561	1,242	NA	2.146	1,554	NA	–31.6	– 22.3	–
Value of corn production and deficiency payments (10^9 $).	$18.6	$19.7	$20.9	NA	$19.3	$20.4	NA	2.1	2.4	—
Value of soybean production (10' $).	$15.0	14.5	14.1	NA	14.4	13.9	NA	0.7	1.4	—
Government expenditures (10' $)	$1,626	1,915	1,834	NA	1,635	1,586	NA	15.8	14.5	—

NA = not available

[a]Positive difference indicates first option is greater relative to second option, negative difference indicates second option is greater relative to 's'option

SOURCE Ronald L Meekhof et al *U S Agricultural Policy and Gasohol Simulation of Some Policy Alternatives*, June 1979

either be subsidized (i. e., paid by taxpayers) or borne by consumers.

Second, there is the shift that could occur in soybean production at or beyond 1 billion to 2 billion gal/yr of ethanol. On the supply side, some farmers would shift their acreage from soybeans to corn in response to the increased price of corn, while on the demand side, the substitution of distillers' grain for soybean meal reduces the demand for soybeans. (Note that the distillers' grain also may be substituted for feed grains — such as corn — that have been diverted to ethanol production; in this case the demand for soybean meal would not be reduced so much.) At the same time, under the second option, soybean prices decrease significantly and consequently the export demand increases. Soybean meal producers have substantial capital investments they would want protected from the distillers' grain competition, yet the meal could not be exported in large quantities due to competition with foreign production.

Finally, despite the higher payments for farmer-held reserves under the first option, corn in storage is reduced by approximately 20 percent at 1 billion gal/yr and 37 percent at 2 billion. Decreased reserves mean that the ability to moderate supply fluctuations due to variations in yields would be reduced, and the likelihood that distillery feedstocks would be diverted to feed markets in bad crop years would increase.

Relatively minor market adjustments or changes in implementation of current agricultural policies could, to an extent, resolve some of these issues. For example, increased Government expenditures would be moderated if CCC did not function as the middleman between producers and distillers. Instead, distillers could purchase their own cropland or negotiate long-term supply contracts with farmers as a hedge against feedstock supply interruptions. Both these alternatives, however, tend to favor consolidated ownership of large blocks of cropland, to the detriment of small farmers. Moreover, **it is likely that storage and reserve policies will have to be changed anyway in order to maintain the ability to moderate short-term supply deficits for all grain consumers.**

Despite the potential problems with ethanol production at the l-billion- to 2-billion-gal/yr level, the difference in their magnitude relative to *4* billion gal/yr is important. That is, these results indicate that lower levels of production can be achieved for a very low resource cost. Basically, idle agricultural land can be used at little cost and the current subsidies that keep land idle can be transferred to a subsidy for converting grain to ethanol. Thus, it probably is not necessary to modify agricultural policy as in the second option. Rather, current agricultural policies in conjunction with the market forces created by end-use subsidies such as the gasohol excise tax exemptions (see "Conversion and End Use,") can be used to increase distilleries' share of grain supplies. At a minimum, this will reduce the need for farm income supports and it could change the focus of agricultural subsidies to maintaining reserves as a hedge against food price inflation in years with low crop yields, and to controlling agriculture's environmental problems and the conversion of cropland to nonagricultural uses.

Assuming the gradual phasing out of present farm commodity price supports as distillery demand drives prices up above the levels needed to maintain farm income, the central policy issues will become the size of the gasohol tax exemptions, how long they should remain in effect, and whether they should be replaced by other incentives or subsidies. These issues are discussed in detail under "Conversion and End Use."

In the long run, if the demand for food and the conversion of cropland to other uses continue to increase, the land available for energy crops will dwindle, and, in the absence of significant changes in consumer behavior, market intervention may be necessary to prevent inflation in commodity prices. Alternatively, distilleries could be required to shift to cellulose feedstocks. Policy issues related to feedstock conversion also are discussed under "Conversion and End Use. "

Environmental Controls

Agriculture often degrades land quality and pollutes surface and ground waters; the two problems are closely linked. For example, erosion reduces land productivity and is the major cause of sedimentation in surface waters. Similarly, fertilizers and pesticides build up in the soil and alter its ecology and then enter aquatic ecosystems through agricultural runoff. As discussed above, USDA production controls require the use of "approved conservation practices" on idle agricultural land in order to control wind and water erosion as well as insects, weeds, and other pests. These practices are designed and implemented on set-aside lands by SCS through local SWCDs, and are subsidized by Federal and State cost-sharing funds. In addition, SCS and the Extension Service provide technical assistance to farmers who request aid in developing a soil conservation plan for their entire farm, but implementation of the plan is voluntary.

The surface water sedimentation that results from erosion and the water pollution that can result from "runoff containing pesticides, fertilizers, and other chemicals are regulated under the Clean Water Act of 1977 (formerly the Federal Water Pollution Control Act of 1972), which requires States to develop plans for the control of water pollution from nonpoint sources. This approach, based on areawide waste treatment plans, was inaugurated in the 1972 Act and reaffirmed and strengthened under the 1977 Act.

In general, under section 208 of the Clean Water Act, the Environmental Protection Agency (EPA) establishes guidelines for the identification of areas with substantial water quality control problems. Local agencies, with State and Federal assistance, then develop areawide waste treatment management plans for the problem areas. The local agency also must implement a continuing areawide waste treatment management planning process that includes identification of agricultural sources of water pollution and procedures and methods (including land use requirements) to control nonpoint source pollution to the extent possible. Section 208 is implemented through best management practices (BMPs), which are determined to be the most effective and practicable (including technological, economic, and institutional considerations) means of preventing or reducing nonpoint source pollution to a level compatible with water quality goals.

A variety of problems, including the political sensitivity surrounding any Federal involvement in land use planning, a lack of direction in EPA guidelines for determining the degree and type of nonpoint source pollution to control, and short deadlines for developing novel and controversial land use management techniques, prevented effective implementation of section *208* following its passage in 1972. * Consequently, more immediate and better understood water pollution problems with strict statutory control deadlines, such as sewage treatment and industrial process controls, received funding priority over section 208, even though 208 was intended to provide integrated planning and management for all pollution sources.

In the intervening years, knowledge about nonpoint sources and their control has improved vastly, and the 1977 amendments reflect this knowledge in the revisions to section *208.* These amendments include a USDA-administered program to enter into 5- to 10-year contracts with rural land operators to install and maintain BMPs under plans approved by a soil conservation district and consistent with the areawide plan. In return, the land operator receives technical assistance and up to 50-percent cost sharing. This program marks a radical departure from the traditional approach to nonpoint source control in that the plan is implemented by a Federal, rather than a State or local agency, while the cost-sharing contract represents a direct Federal subsidy for land management practices that will reduce nonpoint source pollution.

In the future, EPA implementation of section 208 will tend to focus more on regulatory, statewide nonpoint source controls. The 1977 criteria for evaluating nonpoint source programs reinforce the trend toward regulatory control by allowing permits, licenses, and contracts (as well as voluntary management techniques) to be required when justified by the intensity, scope, and type of nonpoint source pollution as well as by landownership patterns and other physical factors. Nonregulatory controls will be allowed only when they can achieve water quality standards. In addition, EPA is developing a 4- to 6-year plan that will emphasize statewide nonpoint source control; in 1978, EPA and USDA began a joint program to demonstrate the effectiveness of statewide BMP coordination in seven model States.

Nevertheless, given farmers' resistance to regulatory controls, the low priority assigned to agriculture's environmental problems by State and Federal agencies, and other constraints on nonpoint source control (see discussion in ch. *4),* it is unclear whether future implementation of section *208* will be any more effective than it has been in the past. Thus, **if set-aside and other diverted cropland or potential croplands are used to produce grain for ethanol, the water pollution effects could be substantial. In general, these lands have a higher erosive potential than land presently under production and therefore** are more likely to contribute to sedimentation of surface waters. In addition, set-aside and other lands may not be as productive, requiring increased use of fertilizers and pesticides[11] that contribute to chemical water pollution. Finally, these lands may be tied up in competing land uses.

Because of the potential for environmental damage and because it usually is not economical in the short term for individual farmers to protect against such damage, the Government may want to consider introducing additional incentives for environmental controls. These incentives could be implemented within the current policy context or new environmental control policies could be developed. These options include both voluntary and mandatory controls.[12]

The policies discussed below share several common considerations. First, any policy that applies only to energy crops will be difficult to implement because farmers could shift those crops to their least sensitive lands. Thus, **if envi-**

• See also "Environmental Impacts" in the "Introduction" to Ch. 4

[11] For policies related to the use of pesticides, see *Pest* Management *Strategies* in Crop *Protection* (Washington, D C Office of Technology Assessment, October 1979), OTA-F-98

[12] 'Much of the following discussion on nonpoint source control options is from D L Uchtmann and W D Seitz, "Options for Controlling Non-Point Source Water Pollution A legal Perspective," *Natural Resources Journal* 19587, July 1979

ronmental control policies are to have more than a minimal effect, they should be introduced throughout the agricultural system.

Second, the farming community is more likely to accept policies if traditional agricultural agencies implement them than if new agencies are created or existing nonagricultural agencies are involved. The traditional agricultural agencies may, however, have to shift to an advocacy role to which they are unaccustomed. Moreover, using traditional agencies would involve the least implementation cost.

Third, the farming community views policies that allow flexibility in selecting the means of control as more rational and more equitable than policies that impose uniform practices or prohibitions. Of course, when farmers consider controls to be commercial or profitable, they are more likely to adopt them voluntarily. When controls represent a net loss in farm income, or when the only perceived benefits are environmental, mandatory programs or prohibitions may be necessary.

Fourth, the environmental effects of agriculture are extremely difficult to monitor. Consequently policies that result in changed farming practices or that impose limits on the use of chemicals will be easier to implement and enforce than those that penalize farmers for polluting.

Finally, any controls that limit the availability of farmland (e. g., green belts along streambanks) also will affect the supply of feedstocks for ethanol production, and ultimately will contribute to inflation to the extent that the limits on production are not offset by environmental benefits.

Voluntary programs that could be used to control the environmental impacts of intensive agriculture include educational programs and economic incentives such as low-interest loans, and cost sharing and tax policies.

The current SCS, local SWCD, and Agricultural Extension Service education programs rely primarily on public meetings and demonstration projects. These programs could be expanded to use other communication methods, such as print and broadcast media, mass mailings, and more frequent direct farm visits. The initial goal of such an expansion would be simply to increase farmer recognition of environmental issues; surveys reveal that few farmers are aware that agricultural practices have significant environmental impacts,

In general, agricultural education programs have a long tradition of Federal and State support and would not be difficult to implement. The primary consideration here is whether education programs alone would be sufficient to encourage farmers to adopt conservation practices that may mean less intensive farming (and in some cases forgone income) or capital outlays for equipment. Therefore, this option probably would be more effective when combined with other voluntary economic incentives, such as loans, cost sharing or tax credits, or with mandatory programs.

Low-interest loans could be offered for farm investment in equipment or practices that would reduce the environmental impacts of intensive agriculture. The relative advantage of these loans would be determined by the prevailing market interest rate. However, during recessions or other periods of "stagflation," such legislatively mandated loans could contradict executive branch policies designed to limit credit. Additionally, during recessions or in poor crop years defaults could be a problem unless the loans were coupled with deficiency payments. Finally, the amount available under this option would be limited to legislative appropriations.

Current cost-sharing programs to encourage soil conservation on set-aside and other production control lands could be expanded to cover any agricultural environmental controls. Qualifying expenditures might include measures such as the construction of terraces or the implementation of alternative pest management strategies, with the Government providing up to 50 percent of the farmers' costs. If the farm operator fails to maintain the measures for which the subsidy was granted, the subsidy would be revoked and/or a monetary penalty imposed. As with low-interest loans, cost-sharing programs ultimately are limited by the legislative appropriation.

Tax incentives such as credits and exemptions also could be offered for environmental controls. Current tax law already allows a deduction for certain soil and water conservation costs that otherwise would be nondeductible capital expenditures. However, a deduction alone probably would not be sufficient to achieve more than isolated controls, and a tax credit equal to a set percentage of the cost of any environmental controls could be instituted. In effect, such a credit would be a cost-sharing policy implemented through the tax system, and not limited by legislative appropriations. The credit could be limited to a percentage of the actual outlays for equipment and practices or could also include any lost income that might result from less intensive management, but the latter would be more difficult **to calculate and verify.**

At the State level, tax incentives also might include exemptions from excise and sales taxes for any equipment needed to implement non-point source controls, as well as special property tax provisions for lands on which environmental controls are maintained.

Mandatory environmental controls for cropland under intensive cultivation include approved conservation plans and economic penalties. It should be emphasized at the outset that, while mandatory nonpoint source controls ultimately may be necessary, it will be extremely difficult to get farmers to accept them. In addition, mandatory controls must be phased in with great care in order to avoid damage to farm productivity and income.

As discussed above, SCS and SWCDs provide technical assistance to those farmers who request aid in developing a soil conservation plan for their farms. In addition, these agencies approve mandatory conservation uses for set-aside and other production control lands. These mandatory uses could, to some extent, be carried over to other croplands, or new mandatory conservation plans could be developed. Such plans could be implemented through the general agricultural programs or could be included in a mandatory contract system under the 1977 amendments to section 208 of the Clean Water Act. Under either system, the approved conservation plan would include a full range of environmental controls based on numerical standards such as soil-loss tolerance limits.

Approved conservation plans also must take into account the competing uses of the land to be developed. For example, some diverted croplands have been "permanently" converted to nonagricultural uses such as wildlife habitat and recreation, windbreaks or shelterbelts, permanent cover and timber, or water impoundments. In many cases, these uses should not be disturbed.

Environmental control plans should be developed at the farm level to accommodate regional differences and to provide farmers enough flexibility to choose from the full range of available controls. Guidelines could be provided at the Federal or State level for various combinations of terrains, weather and climate, soil types, crops, and other variables.

Mandatory economic incentives include taxes or charges for the absence of environmental controls. For example, erosion or effluent charges might be based on the absence of soil-conserving farming methods, on soil-loss tolerance limits, or on allowable levels of sediments and chemical pollutants in the run-off from agricultural land. As discussed above, the effluents are difficult to measure; changes in farming practices would be easier to enforce. **Individual farmers** would determine whether it was more cost effective on their farm to pay a charge or tax, and if it were not, which controls they would implement.

A system of charges or taxes based on regulatory effluent limitations also could be set up on a market basis, allowing those farmers whose effluents are below the limits to market the difference to farmers who are unable to meet the limits economically. This scheme would primarily be advantageous at high production levels when all available land is needed for energy crop production but a straight charge system would inhibit the cultivation of particularly sensitive lands. The primary problem with a market scheme is that it only addresses the water quality controls. Where erosion degrades land quality, marketing the rights to do so would seriously threaten productivity. Other problems with a market scheme are the difficulty in measuring effluents and the tendency for sensitive lands to be grouped together, thus subjecting the adjacent ecosystems to disproportionate environmental impacts.

As with the options to increase corn production, modeling results are available for the impacts of some environmental control options'[3] and are presented in table 22. Again, it must be cautioned that these are hypothetical projections based on assumptions about the values of particular variables. They are not predictions.

These model results are important in the short term because they suggest that if environmental controls are imposed on increased corn production for use as ethanol feedstocks, the price of that corn and consequently the price of the ethanol will be higher than generally assumed in the gasohol literature. However, the costs indicated by the model do not include the reduction in social costs from a cleaner, more productive environment. The cumulative economic impact of policies intended to stimulate energy crop production coupled with those to control environmental impacts has yet to be calculated, nor has the impact of mandatory erosion control policies on the net availability of ethanol cropland been quantified.

The model results also suggest that, in the long term, erosion control policies will result in dramatic improvements in the maintenance of soil productivity. But, they indicate that it is not economic for individual farmers to adopt erosion control practices unless they have extremely long planning horizons and assume a very low discount rate on future income.

Finally, the model results have significant implications for equity. For example, sensitive croplands are not evenly distributed geographically. Thus in some areas increased production would be impossible, while in areas with a very low erosive potential farm income could increase substantially. Moreover, policies such as regulatory controls and taxes are more effective than subsidies in improving the degree to which individuals pay for benefits received or are compensated for social costs incurred. Finally, some of the policies tend to reduce the income differences within the population while others tend to widen the gap.

''W D Seitz, et al , *Alternative Policies for Controlling Nonpoint Sources of Water Pollution* (Washington, D C Environmental Protect Ion Agency, April 1978), EPA-600/5-78-005

"See Ibid , for a detailed discussion of the equity implications of nonpoint source controls

Table 22.—Potential Effects of Alternative Erosion Control Policies

	Percent change						Millions of dollars			
Policy	Soil loss	Corn production	Soybean production	Corn prices	Soybean prices	Nitrogen load	Producers' surplus[a]	Consumers' surplus[b]	Government Cost[c]	Net social Cost[d]
2-ton/acre-yr soil loss limit	– 70	- 6	– 15	15	20	- 5	$ 15	-$1,205	–	-$1,190
5 ton/acre-yr soil loss limit	–45	– 2	- 3	4	5	—	231	– 433	–	-202
$0.50/ton/yr soil loss tax	-30	–	—	—	1	—	– 458	160	$212	-85
$4/ton/yr soil loss tax	-67	—	—	–1	6	—	–1,506	344	772	– 390
$5/acre subsidy for terracing	—	—	—	—	—	—	0.11	028	-56	– 5
$40/acre subsidy for terracing	-27	—	—	—	—	—	942	- 9	– 1,233	-300
100 lb/acre nitrogen application limit	– 2	– 2	—	4	—	-24	20	– 320	–	-300
100 lb/acre nitrogen application limit combined with 5 ton/acre-yr soil loss limit	–45	- 3	- 3	6	3	– 24	247	-772	–	-525
100 lb/acre nitrogen application limit combined with 2 ton/acre-yr soil loss limit	-74	– 9	-16	17	19	-30	228	– 1,605	—	– 1,377
50 lb/acre nitrogen application limit	-1	-13	– 9	25	11	– 48	2,037	-3,325	–	– 1,288
50 lb/acre nitrogen application limit combined with 5 ton/acre-yr soil loss limit	– 45	-14	– 12	28	14	– 49	2,180	-3,677	–	-1,497
50 lb/acre nitrogen application limit combined with 2 ton/acre-yr soil loss limit	– 74	-20	-23	39	26	– 58	1.674	– 4,163	—	-2,489

[a]Producers' surplus is equivalent to the land rents from production and terracing.
[b]Consumers' surplus is the difference between what consumers are willing to pay and the market Price
[c]Subsidies paid or taxes received Does *not* include cost Of administration.
[d]Sum of the changes in producers' surplus, consumers, surplus, and Government costs. Does *not* include environmental benefits

SOURCE W D Seitz, et al , *Alternative Policies for Controlling Nonpoint Sources 01 Water Pollution* (Washington D C , Environmental Protectlon Agency, April 1978), EPA-600/5-78.005

Conversion and End Use

If alcohol fuels are to make a significant contribution to U.S. energy supplies, incentives may be needed (depending on the price of oil) for the construction of large- and small-scale conversion facilities as wet I as for the use of these fuels in automobile and other engines. Current and proposed policies already provide incentives to increase conversion capacity and alcohol fuel use. Other policies, however, pose constraints to alcohol fuels and should be revised if the Government decides to promote such fuels aggressively. The current policy context for alcohol fuels, as well as policy options to stimulate production and use, are discussed below.

In general, policies intended to stimulate investment in conversion facilities or to encourage the use of alcohol fuels will be the same for ethanol and methanol. That is, the conversion technologies and end uses for these fuels are similar, and for most issues one policy would be sufficient. However, issues applicable only to one of these fuels should be given special attention. For example, ethanol distilleries might be required to use alternative fuels (e. g., coal, biomass, solar) in order to maximize premium fuel displacement, but there is no comparable problem with methanol facilities. Similarly, methanol is more likely to damage rubbers and plastics in automobiles and to increase evaporative emissions; factory warranties—some of which already include ethanol use— could be expanded to cover methanol blends.

As with the options related to the resource base, the policies discussed below share several common considerations. First, both alcohol fuels will displace more premium fuel if used as an octane booster. Higher subsidies to alcohols used as octane-boosting additives would encourage this use. Second, both fuels could affect the drivability of automobiles and could damage some auto parts. Auto warranties ***might*** encompass such problems. Third, variables such as distillery size or ownership can be used by policy makers to influence the degree of sectoral or regional energy self-sufficiency to be achieved. A size "ceiling" or limiting funding to individual or cooperative ownership would emphasize onfarm and other rural operations, while a size "floor" would encourage the construction of commercial-scale distilleries. Finally, long-range energy planning by policy makers should incorporate the need to remove subsidies for conversion facilities and gasohol use as the economics improve or for ethanol if competition with traditional food crops for agricultural land becomes a problem (see below). Such planning also should consider the implications of a possible future shift in feedstock composition as well as those of developing domestic reliance on a liquid fuel whose availability ultimately may be limited.

Tax Policies and Other Subsidies

Ethanol: Policies to Encourage Production

Current U.S. revenue policy regulates the manner in which alcohol is produced and distributed, and taxes both alcohol and liquid fuels.

The Federal Government has taxed the production of alcoholic beverages since 1791; nearly $5.5 billion was collected in 1976. The laws and regulations designed to protect this source of revenue include restrictions on operating conditions, licenses and permits, bond and reporting requirements, and distribution controls. In general, the requirements for an operating permit and license include construction specifications, such as secure premises and sealed distilling systems, and operating conditions, such as constant supervision by the Bureau of Alcohol, Tobacco and Firearms (BAT F), designed to prevent unauthorized diversion of the distilled spirits. In addition, the distillery operator must post a distilled spirits bond to ensure payment of penalties or fines, and must maintain complete and accurate records including details of all distilled materials received, the quantity of alcohol produced and denatured, and final disposition of the denatured spirits. Daily reports of distillery activities are filed with the responsible BATF operator while monthly operational reports are submitted to the Regional Administrator.

All of the above requirements add significantly to the cost of alcohol production, and could discourage investment in distillery capacity. Recognizing this problem, the Energy Tax Act of 1978 (part of the National Energy Act) requires the Treasury Department to recommend legislation that will simplify the regulation of fuel alcohol producers while maintaining the integrity of the beverage alcohol tax system. In addition, the President has directed the executive branch to simplify and reduce Federal reporting requirements for fuel alcohol producers. The primary targets in this process should be the security requirements that increase distillery construction costs, permit and other procedures for the manufacture and use of small-scale stills, and the frequency and level of detail in BATF recordkeeping and reporting provisions. On the other hand, additional production reports could be required by energy agencies to monitor gasohol supplies and use and to facilitate long-range energy planning.

In addition to the regulations on denatured spirits, taxes are levied on gasoline and on special liquid motor fuels at the Federal, State, and local levels. Gasoline is subject to a Federal tax on its sale by any producer. However, the Energy Tax Act of 1978 exempts gasohol from the Federal motor fuel excise tax between January 1, 1979, and October 1, 1984; President Carter supports a DOE recommendation that this exemption be extended beyond 1984. A number of States also have exempted gasohol from State gasoline taxes or have placed an additional tax on gasoline to subsidize construction of fuel alcohol distilleries. As can be seen in table 23, the combined Federal and State tax exemptions represent a substantial ($16.80 to $56.70/bbl of ethanol) subsidy for gasohol.

DOE also has revised the crude oil entitlements program to include ethanol produced from biomass. This provides an incentive equal to about $0.05/gal of ethanol used in gasohol. However, this program expires on September 30, 1981, and the incentive is substantial only for those who begin ethanol production soon.

Table 23.—State Tax Incentives for Gasohol

State	Exemption (in dollars per gallon)	Total subsidy (Federal plus State, in dollars per barrel of ethanol)
Arkansas	$0.095	$56.70
Iowa	0.085	52.50
Indiana	0.08	50.40
Louisiana	0.08	50.40
Montana	0.07	46.20
Oklahoma	0.065	44.10
Colorado	0.05	37.80
Kansas	0.05	37.80
Nebraska	0.05	37.80
New Hampshire	0.05	37.80
North Dakota	0.04	33.60
South Carolina	0.04[a]	33.60
Wyoming	0.04	33.60
South Dakota	0.03	29.40
Connecticut	0.01	21.00
Maryland	0.01	21.00
No State tax exemption		16.80

aReduced to$002 in 1982

SOURCE Off Ice of Technology Assessment

Revenue policy also provides for a IO-percent additional investment tax credit for facilities that convert feedstocks (including coal and biomass) into "synthetic liquid fuels. " The Internal Revenue Service (IRS) currently is developing regulations to implement this credit, which was included in the Energy Tax Act of 1978. DOE is assisting IRS with technical definitions and interpretations that should ensure that facilities to produce alcohol fuels will qualify for the credit.

Nontax subsidies and other economic incentives available to the emerging gasohol industry include loan guarantees, grants, and low-interest loans as well as marketing regulations. Loan guarantees are available for alcohol production facilities under two programs. Four Government-guaranteed loans of up to $15 million were granted under the Agricultural . Act of 1977 to facilities that convert agricultural products to alcohol. In addition, in May 1979, President Carter announced a series of major initiatives intended to assist small towns and rural areas in approaching energy self-sufficiency, including $11 million in grants, low-interest loans, and loan guarantees for the construction of 100 small-scale plants to produce fuel alcohol. This program is administered by the Economic Development Administration and the Community Services Administration, with DOE providing technical guidelines. Funds became available in fiscal year 1980.

In addition, DOE gasoline-marketing regulations have been revised to allow refiners— as well as resellers and retailers — to sell gasohol as a separate grade of gasoline and to directly pass on the cost of the alcohol. Under previous rules, refiners had to sell gasohol as unleaded regular gasoline and absorb the alcohol fuel cost by averaging their gasohol-refining costs with the costs of all refined products.

New tax incentives for commercial distilleries might include investment or energy production tax credits, accelerated depreciation, and special deductions for the interest paid on construction loans. A special tax on gasoline also could be imposed and the resulting revenue earmarked for distillery construction, including direct subsidies such as low-interest loans and guaranteed prices for feedstocks and for gasoline for blending. Authorization for some of these options exists but would need to be expanded in scope for maximum effect; others would require new legislation. At the State level, distilling equipment and feedstocks could be exempt from any excise and sales taxes. Special property tax classifications for fuel alcohol distilleries also could be developed. In addition, State gasoline tax exemptions could be expanded or special gasoline taxes imposed.

In addition to commercial distribution of alcohol fuels, their production and use on farms and by cooperatives also is likely to be important in diversifying energy supplies. The resource base is closer to rural areas and gasohol use there would involve the least transportation and distribution costs. In addition, energy use in agriculture is structured around critical time "envelopes" (e.g., planting, harvesting) that reduce short-term flexibility or conservation potential and make supply reliability crucial. Even minor energy shortages at critical periods could reduce agricultural production significantly.[15] Onfarm distillation would alleviate this vulnerability. Moreover, onfarm stills are promoted among farmers as a means of reducing grain surpluses and thereby increasing grain prices and, thus, farm income.[16]

Incentives for small-scale stills might include tax deductions or credits for feedstocks and equipment, special income tax provisions for cooperative distillery ownership, or direct subsidies such as cost-sharing and interest-free loan programs. Those that are already available are shown in table 24. All the incentives for onfarm distillation should include information programs and technical assistance; these might be implemented through the Extension Service and the Economics, Statistics, and Cooperatives Service.

Policy makers should consider several factors in promoting onfarm and cooperative use of ethanol. First, using ethanol in diesel engines (e. g., in farm machinery) would negate its value as an octane booster. In addition, only 35 percent of the fuel used in retrofitted diesel engines can be displaced by ethanol; more extensive modifications would be needed to displace a larger proportion of the diesel fuel. On the other hand, only 2 percent of the corn crop from a typical farm would provide 35 percent of the farm's diesel fuel requirements. Onfarm use also is constrained by its cost relative to the subsidized price of gasohol sold at the pump and by the lack of relatively automatic inexpensive distilling equipment, both of which operate against farmers' acceptance of onfarm distillation. The former could be offset by production tax credits for alcohol fuels not sold commercially.

Moreover, ethanol production cooperatives might have their own special benefits and costs. Co-ops would allow a relatively large number of small farmers to benefit from scale economies and could enhance the sense of rural community. However, inequalities among members in large coops may lead to an inequitable internal distribution of benefits. In addition, large co-ops would tend to serve a wider market and may evolve to closely resemble corporate-owned distilleries, thus poten-

[15] Frederick H Buttel, et al , "Energy and Small Farms A Review of Existing Literature and Suggestions Concerning Future Research," report prepared for the Project on a Research Agenda for Small Farms, National Rural Center, Washington, D C , 1979

[16] Iowa Corn Production Board, "Corn Alcohol Farm Fuel ! Things You Need to Know, " 1979

Table 24.—Sources of Public Financing for Small-Scale Ethanol Production

Organization	Program	Applicant eligibility	Type of assistance	Eligible activities	Purpose of project	Limits of project
U S Department of Agriculture/Science & Education Admin	Alcohols & Industrial Hydrocarbons (see 1419 of Food and Agricultural Act of 1977, Public Law 95-1 13)	Colleges and; universities having a demonstrable capacity in food and agricultural research	Grants of 2 to 3 years duration for research	Research on the evaluation, handling, treatment, and conversion of biomass resources for manufacture of ethyl alcohol	To develop improved processes for production of alcohol from biomass	$100,000 per grant of 2 to 3 years duration
U S Department of Agriculture/Science & Education Admin	Energy Research (see 1414 of Food and Agricultural Act of 1977, Public Law 95-1 13)	Colleges and universities having demonstrable capacity in food and agricultural research	Grants of 2 to 3 years duration for research	Research on fermentation and related processes for production of alcohol, other than ethanol, and hydrocarbons	To develop improved methods of production and blending. marketing, and utilization of products	$100,000 per grant of 2 to 3 years duration
U S. Department of Agriculture/Office of Energy	No restrictions	General advice	General advice on USDA program avail. ability	Biomass production for alcohol fuels; conversion and use of alcohol	Serves as information clearinghouse and provides for coordinated USDA programs	None
U S Department of Agriculture/Farmers Home Admin	Business & Industrial (B&I)	Cooperatives, private Investors in town of less than 50,000	Loan guarantees	Fixed costs, operating capital	Creation of jobs, economic growth in communities under 50,000 population	$25,000.000 per Project maximum Priority on small and intermediate scale of $1,000,000 or less
U S Department of Agriculture/Farmers Home Admin	Operating and Farm Ownership Loans	Farmers, farmer cooperatives	Direct loans at cost of borrowing, loan guarantees	Fixed assets, working capital	Improvement of farm income	$200,000 direct loan, $300,000 loan guarantee
U S Department of Agriculture/Farmers Home Admin	Community Facilities	Private nonprofit public entitles	Loans at 5%	Construct Ion loans, working capital	Improvement of the levels of public services and economic growth	Same as B&I ($25,000,000 project maximum) priority on small and intermediate scale of $1,000,000 or less
Housing and Urban Development (HUD)	Urban Development Act Ion Grant	Distressed cities and urban counties	Grant to city to be used for public improvements or loans to developer	Fixed assets related expenses	Stimulate employ. ment and tax base in distressed cities	None
Small Business Administration	Small Business Energy Loan Act, Public Law 95-313	Small business, including farmers and cooperatives for solar and energy conservation technologies	Loans and loan guarantees	Working capital, research and supplies, plant construction, materials, development, manufacturing equipment for alcohol fuels purposes	Promote small businesses in alcohol production-related activities	Direct loans of less than $350,000, loan guarantees of less than $500,000, no more than 30% for R&D, no more than 35% for working capital
Department of Commerce/Economic Development Administration	Public Works and Development Facilities	States. local governments, Indian tribes, non.profit organizations	Grants for 50 to 80% of a total project cost depending on need	Construction and equipment of alcohol fuel plants, priorities on small. scale plants (less than 1 million gal/yr)	To stabilize or stimulate local economy, agricultural area em. phasis	Generally $300.000 per project Must be EDA Designated redevelopment Area
Department of Commerce/Economic Development Administration	Business Development Assistance	Business enterprises including cooperatives	Direct loans up to 65%; loan guarantees up to 90%	Fixed asset and/or working capital for production plants or auxiliary facilities to such plants	Help job situation, Increase crop markets, Increase supply of transportation fuel	Generally for $500,000 minimum size Plants must be in eligible areas This program nor really would not be appropriate for individual farmers
Community Services Administration	Currently funded by CSA Rural and Small Farm Energy Grantees	Grant (limited)—technical assistance	Construction and operation of demonstration plants serving energy needs of rural low-income residents, provision of technical assistance to other communities in small alcohol production	To develop and disseminate efficient technologies for small-scale fuel alcohol production	Grants go only to 5 currently funded CSA projects Phase II technical assistance available to other eligible organizations	

Table 24.—Sources of Public Financing for Small-Scale Ethanol Production—continued

Organization	Program	Applicant eligibility	Type of assistance	Eligible activities	Purpose of prefect	Limits of project
Department of Energy	Biomass Energy Systems Program	Individuals, farmers, businesses institutions (no restrictions)	Technical assist ance competitive awards	Conversion of biomass to alcohol fuels	R&D for onfarm systerns advanced energy crops collection and harvesting improvements, and advanced conversion technologies	None
Department of Energy	Small Scale Technology Program	Individuals and small Institutions	Grants	Small-scale renewable energy sources	Develop Innovative small-scale renewable energy technologies	$50,000 per project over 2 years
Department of Energy	Alternative Fuels Utilization Program	Individuals, farmers, businesses Institutions (no restrictions)	Competitive awards	R&D—also testing of alternative fuels	Develop and test alternative fuels including alcohols in diesel and Internal combustion engines	None
Department of Energy	Urban Waste Pro grams	Individuals, businesses, institutions, communities (no restrictions)	Competitive awards—loan guaran tees are under consideration	Conversion of urban and municipal waste products to energy	Conduct R&D and demonstrative techniques converting municipal waste to gases and liquids energy	None
Department of Energy	Office of Consumer Affairs	No restrictions	Technical, economic, and regulatory advice	Small-scale onfarm alcohol production systems	Disseminate state-of-the-art information — train the public in small alcohol fuels facilities	None

SOURCE:Department of Energy *Fuel From Farms,* February 1980

tially negating many of the benefits to the farming community. On the other hand, even small co-ops may not have the financial means to take advantage of economies of scale, and they may be subject to the problems of the members' unwillingness to participate actively.[17]

Ethanol: Policies to Limit Production

All the subsidies and incentives discussed above make it extremely profitable to produce ethanol for use as an octane-boosting additive in gasoline. In the short term, these subsidies may be justified because they make investments in new ethanol capacity more attractive and thus increase the rate at which new capacity becomes available. Arguments can be made for ethanol distillation as one of the synfuel technologies that can be used immediately as a hedge against the rising price of imported oil and against the effects of another oil import interruption.

As noted above, these conversion and end-use subsidies for grain ethanol are likely to become more important than agricultural programs in determining distillers' share of commodity markets. If this in fact occurs, the form, magnitude, and duration of the subsidies become critical issues.

First, the form of the subsidy will determine its effect on the indirect cost of ethanol production. For example, State gasohol excise and sales tax exemptions could reduce available highway funds, while a special tax on gasoline could provide revenue to subsidize the expansion of distillery capacity, spread the cost among gasoline users, and encourage conservation. On the other hand, such a special tax would provide a more direct link between ethanol production and food price increases.

Second, when the available subsidies are added up they can be quite large. The $0.04 Federal excise tax exemption alone adds at least $1/bu to the purchasing power of gasohol users relative to food consumers or livestock feeders. State tax exemptions often add at least an additional dollar to fuel users' relative purchasing power. Furthermore, many of the ethanol conversion and end-use subsidies that have been proposed or are in place have no expiration date. Yet, the need for subsidies could be obviated by increased distillery capacity re-

[17] Michael Schaaf, *Cooperatives* (Washington, D.C.: Exploratory Project for Economic Alternatives, 1977

solving economic questions about grain ethanol production, by increases in the price of oil, or by increases in the price of or demand for food requiring that distilleries switch feedstocks.

Consequently, DOE and USDA should monitor the economic and other effects of grain ethanol production carefully and reevaluate the need for incentives as planned capacity approaches 2 billion gal/yr, and then set new production limits for further reevaluation, if appropriate. Policy incentives for ethanol also could be made self-limiting with sunset provisions, price or quantity thresholds, or similar requirements.

If adverse economic effects do occur, and policies are not self-limiting, three principal options could be used to arrest the growth of grain ethanol production. First, policy makers could remove grain ethanol subsidies. If the price of oil is so high that ethanol production continues to grow without subsidies, taxes on fuel ethanol use could be instituted. Of the three options, a tax system would represent the least market interference.

Second, policy makers might require distilleries to switch from grain to cellulosic feedstocks. Because commercial cellulose-to-ethanol processes are not yet well defined, it is uncertain exactly what process changes would be necessary. But, based on current knowledge, conversion to cellulosic feedstocks could cost nearly as much as the initial investment in the grain-based distillery. Moreover, administering mandatory conversions would be more expensive than a tax system, and the taxes might achieve the same goal through market forces.

Third, policy makers could limit permits for new grain-based distilleries. Although this option implies a high degree of market interference, it would allow subsidies and other incentives for grain ethanol production to remain in place up to a specified capacity (e. g., 2 billion gal/yr) while retaining control over the industry's growth. Moreover, some gasohol proponents maintain that cellulose-to-ethanol conversion processes will be developed successfully before grain-based ethanol causes major food price increases. If this development in fact occurs, limits on grain ethanol distillery permits would not limit the overall growth of alcohol fuels. Again, however, most of these objectives could be accomplished through a tax system and its effects on the market.

Methanol

Many of the above policies for ethanol also apply to methanol. The major difference between the two fuels is that methanol could be produced in much larger quantities, either from biomass or coal, at relatively low costs. Also, there are unresolved technical questions about the use of methanol-gasoline blends. Therefore, policies should be designed to encourage the use of methanol both as a standalone fuel and in blends. The more attractive options include using methanol in gas turbines for peakload generation (currently fueled with light distillate oil), in appropriately modified automobiles in captive fleets (11.7 percent of the automobiles and light-duty trucks in 1976[18]), and in diesel engines modified for dual-fuel use. The first two options increase gasoline supplies while the third increases the availability of diesel fuel.

Subsidies can reduce the cost of the methanol used for fuel, while tax credits or grants could be made available for converting existing equipment to methanol or applied to the added cost of new equipment capable of using methanol. The diesel engine option is particularly attractive because: 1) diesel fuel usage may increase sharply in the 1980's due to an increased number of diesel passenger cars, 2) the methanol will reduce visible particulate emissions, 3) the diesel engines can continue to operate normally if methanol supplies are unavailable, and 4) a methanol distribution system eventually would enable noncaptive fleet automobiles to use pure methanol. With incentives for using methanol in blends and as a standalone fuel, the market could choose the more appropriate options. The introduction of gasoline pumps with the capacity to blend different amounts and kinds of alcohol, and even to dispense pure alcohol, also would help introduce these fuels.

[18] *Transportation Energy conservation Handbook* (2d ed, Oak Ridge National Laboratory, October 1977), ORNL-5493

Energy Policies

in addition to subsidization, gasohol production and use could be encouraged through both supply and market guarantees. DOE already has the authority to provide supply guarantees to gasohol manufacturers by ordering oil companies to provide them with gasoline for blending into gasohol. For maximum effect, DOE could mandate long-term supply contracts between oil companies and distillers of all sizes. **In addition, DOE could be author**ized to allocate fuel ethanol to areas experiencing gasoline shortages.

The principal market guarantee options are fleet use, mandated levels of use, and purchase guarantees. Fleet use would be applicable mainly to Government-owned vehicles, such as motor pools, police, and other public service cars, or to large private operations such as rental car agencies, taxicabs, and delivery trucks, and could involve mandated long-term contracts for gasohol supplies. Fleet use would have the advantage of providing somewhat control led circumstances for evaluating gasohol performance and emissions. Mandated levels of use (i. e., requiring that all automotive fuel sold be at least X percent alcohol) should be limited to areas with abundant feedstocks. Negotiated purchase guarantees would virtually eliminate any marketing uncertainties for the fuel producer.

Finally, Federal and State Governments should consider rewriting their regulations (where necessary) to give equal weight to ethanol and methanol, and to provide for blends that contain less than 10 percent alcohol fuels. In addition, R&D funding is needed to determine the best ways of introducing methanol into domestic liquid fuel supplies from fuel production and distribution to the various end uses. The results of such a study would enable policies to be directed toward promoting methanol fuel use.

Environmental Policy

For the most part, the regulatory structures to control the environmental impacts of commercial gasohol production and use are in place. These include the environmental reporting requirements established under NE PA, the Clean Water Act regulations on point source discharges, and the Clean Air Act requirements for stationary sources. In addition, the use of ethanol as an automobile fuel is affected by Clean Air Act provisions related to mobile source emissions.

NEPA is designed to ensure that Federal agency decision making considers environmental amenities and values along with the traditional economic and technical factors. As part of the NE PA process, all Federal agencies must include a detailed E IS in every Federal action (such as issuing a permit) that significantly affects the quality of the human environment. If an agency determines that an action will not have a significant impact on the environment, they must publish a negative declaration to that effect. Because fuel alcohol distilleries must obtain a BATF operating permit, they are subject to the NE PA requirements. BATF requires the permit applicant to file supporting environmental information upon which the EIS determination is based. In most cases, an EIS will not be required, and NE PA will not affect the construction of fuel alcohol plants.

The Clean Water Act establishes national water quality goals that are structured around the quality necessary for a variety of uses including public water supplies, the protection and propagation of fish and wildlife, and recreational, agricultural, industrial, and other **purposes. Each State is required to develop and implement, subject to the approval of EPA, a comprehensive water quality management plan designed to achieve the national goals through water quality standards for the designated uses of the receiving waters and through effluent limitations that restrict quantities, rates, and concentrations of chemical, physical, biological, and other constituents that are discharged from point sources. Effluent** limitation guidelines for various categories of point sources are determined by EPA.

Water quality standards and effluent limitations are implemented through State certification programs and through the National Pollutant Discharge Elimination System (NPDES). An applicant for a Federal permit to conduct any activity that may result in a discharge must have State certification that the discharge will not violate any water quality requirements. NPDES is designed to ensure the orderly and timely achievement of the national water quality goals without sacrificing economic or energy goals. Under NPDES, States (or, where State programs have not been approved, EPA) issue permits for discharges on the condition that they will meet all applicable water quality requirements, including State effluent limitations based on the national effluent guidelines.

As discussed in chapter 4, the effluent from fuel alcohol distilleries is very high in biological and chemical oxygen demand and would contribute to water quality problems if not treated or recovered for use as animal feed. In order to obtain a BATF permit for the distillery, the operator must supply BATF with information on the facility's potential environmental impacts. Based on this information, BATF determines whether State certification is necessary. In addition, in most States the operator must obtain an NPDES permit for the distillery. However, effluent guidelines for fuel alcohol plants have not yet been established. Therefore, any restrictions on discharges from these plants must be based on State water quality standards and the best engineering judgment of the permit writer. Within the next year, EPA will prepare an environmental technical report that will serve as the basis for establishing effluent guidelines.

Fuel alcohol plants also could be subject to Clean Air Act regulations on stationary sources. The Clean Air Act is structured around National Ambient Air Quality Standards (NAAQS) that are implemented through a variety of regulatory programs designed to limit emissions of airborne pollutants. The programs most likely to affect fuel alcohol plants include NSPS for industrial boilers and permit requirements designed to prevent the significant deterioration of air quality (PSD) in clean air areas. Although NSPS have not yet been established for industrial combustion sources, many distillery boilers will be large enough to trigger the current PSD permit requirements. However, until NSPS have been formulated it is not possible to determine to what extent the Clean Air Act will affect fuel alcohol distilleries. Larger distilleries also will be subject to the stringent requirements for siting in nonattainment areas. But, most facilities will be located in rural areas and the latter should not pose a major constraint to construction.

Provisions of the Clean Air Act related to mobile source emissions include numerical standards for emissions of pollutants from new motor vehicles or engines as well as the regulation of fuels and fuel additives. Standards have been established for emissions of carbon monoxide, hydrocarbons, and nitrogen oxides from light-duty vehicles and engines. Although gasohol could result in violations of these standards, the adverse effects are not likely to be great, and the violations could be avoided by restricting gasohol use in problem areas or by requiring minor carburetor adjustments. Should a significant adverse impact be found, vehicles using gasohol could be exempted by EPA for purposes of R&D or national security.

The Clean Air Act also requires EPA to regulate automotive fuels and fuel additives through a registration scheme. The manufacturer must petition EPA for registration of the fuel or additive and provide EPA with supporting information including the commercial identifying name, range of concentration or chemical composition, and purpose-in-use. If EPA determines that the fuel or additive will contribute to air pollution that may endanger the public health or welfare or will impair the performance of automotive emission control systems, they can regulate or prohibit its manufacture, distribution, or sale. In 1977, a group of marketers petitioned EPA to register gasohol, and the EPA Administrator determined that there was insufficient evidence to deny the petition. A similar petition for a 2.75-percent blend of methanol with unleaded gasoline was approved early in 1980, but a petition for a blend of up to 15 percent anhydrous crude methanol (75 percent methanol, 5 percent ethanol, 7.5 percent n-propona1, and 12.5 percent i-butanol) recently was denied on the basis of anticipated evaporative emission, phase separation, materials incompatibility, and drivability problems.

Hence, if it became necessary, distillery boiler emissions could be regulated under the Clean Air Act provisions related to stationary sources, distillery effluents can be controlled under the Clean Water Act, and automotive emissions from using ethanol as a fuel additive could be regulated under the mobile source provisions of the Clean Air Act. A possible exception would be if NSPS included a size floor that exempted boilers in alcohol fuel plants.

None of the above regulatory authorities has been exercised as yet because the scientific data necessary to justify regulation are incomplete or ambiguous. Although EPA is researching the environmental effects of alcohol fuels, the fact that legislative interest in promoting gasohol is at its height while the resulting short- and long-term implications of doing so are not yet fully understood reflects a continuing regulatory problem. That is, the Federal Government tends to direct its attention and funding toward existing recognized problem areas and, thus, can give very little attention to long-range planning or to researching emerging and potential future problems.

Crop Residues and Grass and Legume Herbage

Introduction

Although the energy potential of grass and legume herbage and crop residues is not as widely known as that of wood or gasohol, it is considerable. Forage grasses and legumes, such as big bluestem, orchard grass, broom grass, tall fescue, alfalfa, hay, clover, and reed canary grass, could contribute up to 5 Quads/yr of renewable energy by 2000, depending on the availability of cropland, while the crop residues that currently are left in the field after harvesting could contribute more than 1 Quad/yr to domestic energy supplies in 2000. Grasses and residues can be combusted alone or cocombusted with coal or other biomass feedstocks in small boilers or used as the feedstock for gasifiers. Because more oil is displaced by these materials through gasification, this may be the more valuable use. In the long term, however, both grasses and residues— as well as other cellulosic materials — may become more valuable as ethanol or methanol feedstocks.

If the energy potential from grasses and residues is to be realized, both incentives for supply and demand and funding for R&D might be necessary. It is possible that increased oil prices alone will be a sufficient incentive to stimulate demand, which in turn will raise prices and elicit a supply of grasses and residues for energy. Policy initiatives such as education programs and subsidies would accelerate the introduction of these energy sources. This section reviews current policies affecting the production and use of grasses and residues for energy and presents some policy options that could stimulate their use or manage any resulting adverse impacts.

Current Policy

There is little current policy related to grasses and residues. Demand for these materials has never been great enough to necessitate regulating their supply or their manner of use. However, a number of considerations related to their role in overall agricultural, energy, and environmental policy have been raised.

Relative to the resource base, forage crops play a minor role in agricultural policy (as described in the gasohol policy section) to the extent that they can be grown on set-aside lands. In some cases, grasses constitute "approved conservation uses" for set-aside and other production control lands because their sod helps to control erosion. On the other hand, land can only be designated as set-aside if it produced a crop other than hay or pasture within the previous 3 years, unless it was used for forage crops in all 3 years as part of a normal crop rotation pattern.

The policies that could affect the conversion of grasses and residues into energy include those that discourage or restrict new uses of oil or natural gas as well as those that regulate air pollutant emissions from stationary combustion sources.

The Fuel Use Act of 1978, part of the National Energy Act, prohibits (with certain exceptions) the use of oil or natural gas as a primary energy source in new fuel-burning installations and the use of natural gas in existing facilities after 1990. But, these prohibitions do not apply to most cogeneration facilities or to units that have a fuel heat input rate of less than 100 million Btu/hour. Where combustion or gasification facilities would be used for cogeneration or would be relatively small, they will not come under the Fuel Use Act prohibitions and the primary incentive to use grasses and residues as a primary fuel in these facilities would be the cost of oil and gas. Where grasses or residues are cocombusted with coal, however, the facilities could be quite large.

Similarly, the Clean Air Act provisions related to stationary source emissions (as reviewed in the gasohol policy section) primarily are applicable to larger sources and, for the most part, would not affect biomass combustion or gasification. If technological controls or process changes were required, they could increase the cost of conversion. In addition, it could be difficult to site conversion facilities in nonattainment areas, but because these are usually urban areas and the most cost-effective use of grasses and residues is in rural areas, these will have only a limited effect.

Policy Options

Policy incentives for grasses and residues would accelerate their introduction into domestic energy markets and help reduce the long-term investment uncertainties. The important policy options are those that would ensure the development of and investment in conversion technologies, as well as those that would provide a reliable supply of feedstocks without causing adverse environmental impacts.

Resource Base

While gasohol must compete in traditional markets for starch and sugar feedstocks, there are no established markets for crop residues and about 75 percent of current forage crop production is used onfarm. Thus, links between farmers and conversion facilities need to be established. It is likely that the development of conversion technologies such as gasifiers will be a sufficient stimulus to the establishment of a supply infrastructure. At some point, however, **the Government may choose to intervene in the market to ensure that, in the long term, using cropland to produce grass and legume herbage for energy does not conflict with food needs, or to ensure that residue harvesting does not result in increased erosion or reduced soil productivity.**

The two sources of forage crops for energy are increased productivity and production on set-aside and potential croplands. Demands for these crops, stimulated through conversion process subsidies, could be sufficient to increase productivity. If additional incentives are needed, they could include income support programs similar to target prices or deficiency payments, or tax credits or deductions for the costs incurred in more frequent harvesting. For the use of set-aside lands, however, forage grass production would have to be integrated into the existing agricultural policy structure. This could merely take the form of allowing forage grasses to be grown for energy purposes on production control lands aside from their value as an approved conservation use, or forage grasses **could be included** in the general agricultural production control and income support system.

The options that involve income support payments (such as deficiency payments), or that use CCC as the middleman between farmers and conversion facilities, would increase Government program expenditures, but would tend to make the supply **more reliable in that CCC** could monitor production and maintain reserves as a hedge against short-term supply deficits. Alternatively, conversion facilities could establish long-term contracts with local forage producers or could purchase their own crop land.

If demand for food continues to increase, little cropland may be available by 2000 for grass and legume herbage production. Thus, **special attention should be given to R&D support for plant hybrids with high dry matter yields when grown on land that is poorly suited to food crops. So** long as these hybrids do not have significantly higher yields on better quality land, there will be no economic incentive to displace food crop land with them.

Most existing agricultural production represents a potential source of crop residues for energy. They can be harvested after the crop, but this method delays fall ground preparation, and, if fall rains come early, can prevent it altogether and thus delay spring planting. Alternatively, custom operators could work **under contract for farmers.** As **with forage** grasses, an exogenous demand may be sufficient to encourage residue harvesting. If additional incentives are needed they could include cost sharing, attractive financing, or tax subsidies for the harvesting equipment. Again, residues could be bought and resold by CCC or through long-term contracts directly with farmers. Compensation programs should be developed for onfarm storage of crop residue stacks.

Although grass and legume herbage cultivation has a much lower erosive potential than grains and other row crops, achieving high dry matter yields of lignocellulose crops may increase the potential for chemical water pollution from fertilizers. The options for controlling this include education programs, effluent charges, and fertilizer application limits implemented through approved conservation plans or section 208 permits; these are discussed in detail in the gasohol policy section. However, any controls on nitrogen fertilizer use will limit productivity of crops other than nitrogen-fixing plants.

The primary issue surrounding crop residue removal is ensuring that farmers do not harvest too much of the residues and thereby lose erosion protection. Education programs sponsored by the Extension Service probably would be necessary, but not sufficient, because research suggests that it is not within the economic interests of many farmers to protect against soil erosion unless they have extremely long planning horizons and assume a very low discount rate on future income. Therefore, **subsidies for residue harvesting also might be linked to environmental controls** such as mandatory approved conservation plans, or taxes on residue harvest beyond levels determined to protect soils. Again, these options are discussed in detail in the gasohol policy section.

Conversion

If the energy potential of grasses and residues is to be realized in the near to mid-term, Government incentives for the development of and investment in conversion facilities will be necessary. For example, RD&D support is needed to develop gasifiers that can use grasses and residues, to develop inexpensive compaction or pelletization methods to reduce fuel transportation costs and improve handling characteristics, to demonstrate the use of grasses as a methanol feedstock, and to improve lignocellulose-to-ethanol processes. In addition, a full range of tax incentives (such as investment tax credits, accelerated depreciation, or special energy production credits) as well as subsidies such as low-interest loans, cost sharing, or guaranteed feedstock prices should be considered to spur investment. The general implications of these options are discussed in detail in the previous sections. The primary noneconomic incentive to be considered is a guaranteed supply of forage grasses or crop residues for conversion facility feedstocks, implemented either through CCC or direct long-term contracts.

Finally, where cocombustion of grasses and residues results in net adverse air quality impacts, alternative control strategies for these should be developed under the Clean Air Act.

Anaerobic Digestion of Animal Wastes

A review of the analysis in chapter *4* indicates that anaerobic digestion of manure from small confined animal operations could produce approximately 0.27 Quad/yr of biogas–-a mixture of 60 percent methane and 40 percent CO,. Although 0.27 Quad/yr is not a large contribution to total U.S. energy demand, it could make many livestock operations energy self-sufficient.

However, several issues must be resolved before anaerobic digesters could be widely used. First, **the basic technological designs should be improved and the biological reactions better understood so that advanced automatic digesters will perform reliably with widely varying feedstocks.** Means of financing digesters that reduce farmers' investment costs also might be implemented. Gas and electric utility rates and practices must be revised in order to provide backup power at a reasonable cost and to purchase excess electricity (or, where applicable, gas) at a fair return. Finally, farmers must be convinced to change their present waste management practices to include anaerobic digestion systems. Fortunately, the necessary changes are consistent with emerging trends in confined animal operations.

Farmers can obtain financial assistance from several Federal agencies to defray digester costs, including DOE and USDA. In genera], this assistance consists of grants, loans, and loan guarantees. Farm investment tax credits also can be used for digesters, but often farmers already will have applied the credits to other equipment.

Manure-handling practices are federally regulated under Clean Water Act provisions related to both point and nonpoint sources. The general framework of the Act is described in the gasohol policy section. EPA has established effluent limitation guidelines for the point source category of "feedlots." This category includes most forms of livestock operations such as open and housed lots or barns with relatively large numbers of animals (e. g., 1,000 head of cattle, 700 dairy cows, 2,500 swine, 55,000 turkeys). I n general, these regulations establish a zero discharge limit for new and existing feedlots unless the discharge is to a sewage treatment plant.

Livestock operations of al l sizes can be regulated under the Clean Water Act's section 208 provisions for nonpoint sources. However, as discussed under alcohol fuels policy, section 208 is only now being implemented and it is not clear what BMPs to control manure-related runoff will be. **Including anaerobic digestion as a BMP probably would accelerate introduction of the technology.**

In addition to the provisions of the Clean Water Act, manure-handling practices also are regulated under State laws. State requirements vary widely; they may include permits, minimum runoff storage capacity, maximum land application limits, and odor and dust regulations. Some States also offer income on investment tax credits or other financial incentives (e. g., grants, loans) for anaerobic digestion systems, as part of either State environmental or energy policy. For larger systems with high initial investment costs, **innovative financing schemes such as leverage leasing may accelerate digester use.**

In general, the Federal and State regulations related to manure-handling practices have the potential to encourage anaerobic digestion because they provide a strong incentive to change such practices; surveys reveal that a demonstrated need for such change is a major obstacle to farmer acceptance of anaerobic digestion. [19] Financing for both the implementation of Federal and State regulations and for new manure-handling systems would help to increase farmer acceptance.

Utility policies may also pose an obstacle to digester use. Existing rate structures both for providing backup power and for purchasing surplus power discriminate against small indi-

[19] R H Cole, et al , "A Survey of Worcester County, Massachusetts, Dairy Farms With Respect to Their Potential for Methane Generation, *Science Technology Review*, September 1976 27-45

vidual energy sources such as digesters. Some of these utility policy issues will be resolved by implementation of the Public Utilities Regulatory Policies Act of 1978, part of the National Energy Act. Others may require additional legislation. Policy options related to these issues are discussed in detail in OTA's forthcoming study of dispersed electric generation and are not discussed further here.

Probably the most important policy options for anaerobic digestion are RD&D support **for the demonstration of a wide range of inexpensive and reliable digester systems and the implementation of attractive financing schemes.** Once farmers have been shown that reliable, automatic, and relatively inexpensive digesters are available, and that these systems will solve environmental problems stemming from current manure disposal practices, the primary obstacle to anaerobic digestion — farmer acceptance—will have been removed. From that point, existing incentives such as DOE and USDA loans and grants, as well as available tax credits and deductions, should be sufficient, especially if they help farmers overcome the high initial investment cost for digesters. Finally, it should be recalled that Federal subsidies for conventional energy sources are substantial. These subsidies make both the internal and external costs of individual energy systems such as digesters seem relatively greater than they are.

Conclusion: Biomass and National Energy Policy

The United States today confronts several broad policy issues with respect to bioenergy development: 1) whether to adopt policies to promote the growth of bioenergy beyond those levels that will be reached through the operation of market forces in conjunction with incentives and subsidies that already have been approved; 2) whether to change the character or size of existing incentives and subsidies that affect bioenergy; and 3) whether to adopt new policies to manage the impact on soils, forests, the environment, and society that will accompany the growth of these new sources of energy.

A key conclusion of this report is that there is a great deal of biomass in the United States that can be converted to useful energy— much more than most people realize— and it can be brought into production quite rapidly if necessary. OTA estimates that as much as 5 to 6 Quads/yr of bioenergy will be used by 2000 if prices remain stable (in real terms) at 1980 levels, or increase moderately, and if Government promotional activities remain more or less as they are today. This means that the contribution of energy from biomass **will more than triple in less than 20 years even if little or nothing new is done. OTA's confidence** in this estimate is based on the fact that it projects a continuation of current trends and the expected growth would take place primarily in the forest products industry and in home heating applications where technologies are already well known and in use.

Growth of bioenergy beyond this level, however, is likely only if prices increase significantly or if America adopts policies to promote a much more rapid expansion. Those who support such a course of action do so chiefly on the grounds that bioenergy would help displace imported oil and would hasten the transition to reliance on renewable resources. Assuming a major national commitment to this goal, OTA estimates that the resource base will sustain the production of as much as 12 to 17 Quads/yr of energy.

The objective in this chapter has been to point out those considerations that should be taken into account in making choices about the speed and character of bioenergy development and to describe and analyze specific actions that might be taken by the Federal Government to further promote and guide that development. The pages that follow summarize the key policy alternatives that have been identified.

As noted, Congress already has passed a number of measures to support the development of new resources of energy of all kinds, and many of these have improved the prospects for investment in bioenergy. The most important of these provide for the phased deregulation of crude oil and natural gas prices. **Because of the wide range of feedstocks and conversion technologies involved, however, many bioenergy systems can benefit from policies more carefully tailored to the needs of the producers and users of this form of energy.** Although some legislation with this objective has been passed, a number of additional options should be considered.

In the case of wood, a principal concern is the management and care of the resource base —the Nation's forest lands. One of the reasons that wood energy is attractive is the possibility that increased demand for it will lead to more intensive forest management, and thereby to an increase in the quantity and quality of available timber. Unfortunately, however, it is not certain that this will occur, or that the many kinds of environmental damage that may result from wood harvesting, transport, and conversion, can be avoided. Therefore, **an increase in the use of wood energy should be accompanied by new and expanded programs and incentives to encourage–and perhaps even require–good forest management practices, including much more extensive assistance to, and cooperation with, State forestry agencies.**

The need for supportive Government programs is especially great outside the forest products industry where inexperience with wood energy may delay its adoption even when it is cost effective. Programs to provide information and technical assistance in con-

version are needed for these users, as are improved inventories of national and local forest biomass resources and loan guarantees and tax credits to help **overcome the higher capital cost of wood combustion systems. Incentives to support the establishment of commercial wood supply systems in the private, nonindustrial forests also would encourage** wood energy use. Where possible, the Federal and State governments might promote wood use by establishing concentration yards and making available a guaranteed supply of Government-owned logging slash and the residues of site preparation, fire prevention, and stand **improvement activities.**

The precise impact of policies designed to promote the use of wood for energy is difficult to estimate. As is the case with many unconventional energy sources, the most important determinant remains the price of conventional fuels. Nonetheless, as wood energy use competes with demand from forest products industries, the continuing problem of supply unreliability and regional price fluctuations may act as a significant additional deterrent to conversion.

The policy issues raised by gasohol are more complicated. The range of available feedstocks extends from wood itself to grass and legume herbage, crop residues, feed crops, and food-processing wastes; these in turn are governed by a variety of legislative, regulatory, and administrative policies and jurisdictions that affect both production and use. Should the United States choose to promote the rapid expansion of the use of gasohol made with ethanol from grain and sugar crops, policy support will be needed to: 1) ensure that feedstocks are available without causing unwanted inflation in the food and feed markets; *2)* increase investment in distillation, distribution, and blending; and 3) manage the resulting impacts on the environment and society as a whole.

A major Federal subsidy, in the form of exemption from excise taxation, already has been granted to gasohol blended from either ethanol or methanol provided that it includes at least 10 percent alcohol produced from biomass sources. Sixteen States have added subsidies that range from 1 cent (Connecticut) to 9.5 cents (Arkansas) per gallon of gasohol. When combined with available investment tax credits and crude oil entitlements, these have made ethanol economically competitive when used as an octane booster, and gasohol made with grain ethanol is now on sale in many parts of the country. Finally, as part of the response to the Soviet invasion of Afghanistan, President Carter has set as a national goal the production of 500 million gal/yr of ethanol by the end of 1981, and has indicated his support for legislative proposals to expand subsidies and extend their duration.

The prospect of an expansion of gasohol production raises a number of important policy issues. Perhaps the most important of these is the problem of assuring the availability of ethanol feedstocks while moderating the impact of this new demand on the price of food and feed. Indeed, managing the consequences of the emerging interdependence between agriculture and energy is likely to remain a key challenge to policy makers responsible for programs in both areas for many years.

The general sources of ethanol feedstocks are expanded production on lands not presently under cultivation, production on lands freed by crop substitution, and commodities diverted from export markets. However, direct competition for feedstocks between ethanol producers and feed, sugar, and export buyers would increase the price and decrease the supply of commodities in all markets.

Encouraging the cultivation of idle lands, including lands now in production control programs as well as potential cropland of many kinds, also introduces problems. These lands often are not cultivated because they are inaccessible, highly erosive, or experience problems with drainage, seepage, or flooding. The cost of special incentives needed to bring them into cultivation, if paid by the public, would constitute an additional but less visible subsidy to alcohol production.

Whatever approach is chosen, careful management of agricultural programs will be necessary in order to minimize the potential undesirable economic and environmental consequences of using grain and sugar crops for ethanol. Up to 1 billion to 2 billion gal/yr, these consequences may be minor. Once ethanol production approaches this amount however, the effects of programs designed to increase grain ethanol production should be reevaluated. If, following such an evaluation, it appears that significant food-fuel competition has begun to occur, a number of changes in existing policy may be desirable to prevent large increases in the price of food and feed. Even before this limit is reached, however, significant new policies may be necessary to minimize the potential environmental effects of ethanol feedstock cultivation.

Despite these potential problems, ethanol from grains is likely to remain important for several years as a means of diversifying U.S. liquid fuel supplies and of encouraging energy self-sufficiency in agriculture. However, if the United States chooses to move quickly to the development of gasohol as a significant source of liquid fuel, while avoiding increases in food prices, careful consideration should be given at the outset to an early shift to methanol (and possibly ethanol) from wood and lignocellulosic feedstocks. Also important here is the development and demonstration of means of converting grass and other herbage to methanol and the further development of lignocellulose-to-ethanol processes. *

Policies and programs to promote the production and use of gasohol raise a number of other policy issues that deserve attention. These include, among others:

- **The nature of the alcohol subsidy. — I**n general, good policy instruments signal to the consumer the full cost of the product being used. Current gasohol subsidies, especially if they are continued for long periods into the future, contravene this concept and instead force the general public to subsidize the consumption of automotive fuel. The signal to the consumer— that gasohol is cheaper than it really is — is false, and will lead to greater consumption of the resource, which may run counter to overall national energy goals. Another way of accomplishing the same objective is by mandating alcohol blending at gasoline terminals and allowing a pass-through to the gasoline consumer of the full cost of the blend.
- **The duration of the alcohol subsidy.–-To** promote further investment in distillery capacity, it may be desirable to extend the excise tax exemption granted to gasohol beyond its current expiration date of October 1, 1984. However, many policymakers argue strongly in favor of strict limitations on the tenure of any energy subsidy, and these arguments must be weighed alongside those supporting continued investment in gasohol production. Note that a continuation of inflation can be expected to reduce the value of the subsidy over time.
- **The treatment of imported alcohol.–-Cur**rent legislation allows the blenders of imported alcohol to qualify for the subsidy. Large-scale imports of alcohol would have the consequence of creating a substitute foreign dependence, but this probably would be minor in terms of overall fuel use and would almost surely represent a diversification of energy import sources (e. g., from OPEC members to countries such as Brazil) and would lessen the impact of gasohol use on domestic food markets.
- **The blending of varied amounts of alcohol. —** The octane-boosting properties of alcohol can still be utilized when it is blended with gasoline at percentages lower than 10 percent and the resulting fuel may cause fewer problems in automobiles using it. Accordingly, there is little reason to maintain the current requirement that a full 10-percent blend be produced to qualify for the subsidy.
- **The subsidization of onfarm production and use of alcohol. —** Because current subsidies accrue only to alcohol blended with gasoline for use as a commercial motor fuel, onfarm use of alcohol receives no support. One way to remedy this is by replacing the excise tax credit with a direct tax

*Should the technology be developed for economical conversion of lignocellulosic feedstocks to ethanol, it might replace methanol; but only the methanol conversion process for these feedstocks is ready for immediate deployment credit to the producer. Although there are a number of reasons why farm energy autonomy is attractive, these should be weighed against the increased fuel savings that would be achieved by the country as a whole if alcohol is used as an octane booster in the national gasoline supply stream rather than in pure form as a standalone fuel.

- **The adjustment of the automobile fleet to accommodate alcohol blends.– Experiments indicate that at blends as low as 10 percent alcohol some cars will experience difficulties. There may also be problems of corrosion of parts** in **cars as well as** in blending and transport facilities (these are somewhat greater with methanol than with ethanol), and the Government may want to consider means of assuring that automobiles are adapted to avoid these problems in the future. Early disillusionment with gasohol as a result of problems of this kind — problems that may only appear after the expiration of new-car warranties — may prevent the rapid acceptance of this fuel blend.
- **The passage of regulations to ensure maximum displacement of imported fuel and the most favorable net energy balance. — Of particular importance, in this respect, is requiring** the use of solar energy, coal, or biomass fuels in new distilleries built to produce alcohol for gasohol and requiring that the alcohol be blended with a lower octane gasoline than that which the gasohol displaces.
- **The introduction of methanol to the liquid fuel system.—** For a number of reasons, methanol produced from wood, grasses, residues, and other plant feedstocks appears to be an attractive option. Therefore, a careful study should be made of the best ways of introducing methanol to the liquid fuel system of the country, from the fuel production and distribution system to the various end uses.

In the design of national policies to promote and manage the development of bioenergy a number of broad considerations are worth highlighting. The first is that the actual effectiveness and impact of policies, whether promotional or regulatory, are extremely difficult to anticipate. Because of this it is of the utmost importance that this uncertainty be acknowledged at the outset by making any commitments tentative and including in legislation, where appropriate, detailed provisions concerning subsequent monitoring and assessment of results. It is also important to avoid the pitfall of granting large or permanent subsidies that will distort the allocation of economic resources in the future. Such measures as "sunset" provisions, price and quantity thresholds for subsidies and incentives, and statutory requirements for review of existing policies are means that may be employed to accomplish these goals. A **graduated** phase-out of incentives for alcohol production, for example, might begin when imported oil costs $35/bbl (1980 dollars) or in 5 years, whichever came first. Formal review of wood energy systems and the condition of the forests and soils might be required when USDA determines that 5 Quads of wood and other lignocellulosic feedstocks are being consumed annually. Regulatory measures designed to protect the environment serve best if they are spelled out clearly at the outset of a new kind of economic activity, and not imposed on investors after they have committed themselves. This is especially important in the case of bioenergy because the environmental impacts of harvesting and use are so complex and potentially far-reaching. Finally, particular attention to the degree of premium fuel displacement achieved in production and consumption is needed if the development of bioenergy is to reduce the dependence on imported oil.