

***CRITERIA FOR SELECTING REASONABLE
NON-BURNING ALTERNATIVES***

AND

***A SUMMARY OF ACCOUNTABILITY
MECHANISMS FOR AGRICULTURAL BURNING
IN THE WESTERN UNITED STATES***

Task 2 and Task 3 Draft Report

Prepared for:

**The Fire Emissions Joint Forum of the
Western Regional Air Partnership**

November 14, 2001

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TASK 2 AND TASK 3 DRAFT REPORT

Prepared for:

The Fire Emissions Joint Forum of the
Western Regional Air Partnership

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ACRONYMS

AK	Alaska
AZ	Arizona
CA	California
CARB	California Air Resources Board
CO	Colorado
ERG	Eastern Research Group, Inc.
ETC	Enviro-Tech Communications
FEJF	Fire Emissions Joint Forum
GCVTC	Grand Canyon Visibility Transport Commission
GIS	geographical information system
HI	Hawaii
ID	Idaho
MT	Montana
ND	North Dakota
NM	New Mexico
NV	Nevada
OR	Oregon
PM ₁₀	particulate matter less than 10 microns in aerodynamic diameter
SD	South Dakota
UC	University of California
UT	Utah
WA	Washington
WESTAR	Western States Air Resources Council
WGA	Western Governors' Association
WRAP	Western Regional Air Partnership
WY	Wyoming

INTRODUCTION

Air emissions from burning agricultural residue, primarily consisting of fine particles, can be a significant source of air pollution on a short-term and intermittent basis. These emissions can directly impact visibility in Class I areas located near burns, or those Class I areas located far away through regional transport. The Western Regional Air Partnership (WRAP) and its Fire Emissions Joint Forum (FEJF) are sponsoring a project to conduct a thorough assessment of the non-burning alternatives to infield burning of agricultural residues, including their impacts on the environment, economy, health and safety, society, politics, and on the business and productivity of the agricultural industry.

In the context of this study, “agricultural burning” is defined as the burning of organic crop residue consisting of field crops, wood, and leaves. Also, the burning of ditch banks adjacent to, or associated with, crop production are included in this evaluation of alternatives to agricultural burning. The geographical scope of the project includes the 15 Western states of Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, North Dakota, New Mexico, Nevada, Oregon, South Dakota, Utah, Washington, and Wyoming. State, as well as tribal, jurisdictional issues will be addressed. The overall project objectives include the following:

1. Identification of crops grown and the extent to which residue is disposed of through burning for the 15 Western states;
2. Display of the crop and residue/burning data in a database using a geographical information system (GIS);
3. Identification of potential alternatives to agricultural burning and characterization of their agronomic, environmental, health and safety, social, economic, and political impacts;
4. Development of criteria for selecting reasonable non-burning alternatives, cost-abatement curves (i.e., cost of alternative by crop) and examples of how to apply the criteria and cost-abatement curves to evaluate alternatives;
5. Identification of existing and potential accountability mechanisms for tracking if, and which, non-burning alternatives are used by local, state, tribal, or federal entities;

6. Identification of existing and potential barriers to the use of alternatives, including non-statutory barriers (e.g., public acceptance, cultural practices, etc.), and recommendations on how these can be overcome;
7. Development of a plan for implementing a non-burning program based on the analysis, findings, and recommendations developed under this project.

The purpose of this report is to document the approach used and results of the work conducted to address Objectives 4, 5, and 6. The work to address Objectives 4, 5, and 6 was performed under Tasks 2 and 3 of Western Governors' Association (WGA) Contract 30203-31 by Eastern Research Group, Inc. (ERG) and Enviro-Tech Communications (ETC). The focus of Task 2 is on developing criteria for selecting reasonable non-burning alternatives. The focus of Task 3 is on accountability mechanisms being implemented within the 15 Western states. The focus of Task 4 (for which work is still underway) is on the non-statutory administrative barriers that can exist when attempting to implement a program for facilitating non-burning management alternatives on agricultural lands.

Report Organization

This Task 2/3 report is organized in such a manner as to be a follow-on to the "Task 1 Draft Report - Revised" submitted by ERG and ETC to the FEJF on July 17, 2001 (ERG, 2001). As such, the Task 1 report contains Sections 1.0 through 5.0, and this Task 2/3 report contains Sections 6.0 through 8.0. The draft final report to be prepared under this project will comprise all sections previously prepared (1.0 through 8.0) as well as new sections (9.0 through 11.0) addressing tasks 4 and 5 and references.

6.0 CRITERIA FOR SELECTING NON-BURNING ALTERNATIVES

To develop reasonable criteria for adoption of non-burning alternatives, it is important to understand the impacts non-burning alternatives will have on farms, the environment, and the regional economy. This section presents two case studies that assess impacts of non-burning alternatives. These case studies illustrate the use of criteria to determine the feasibility of adoption of the non-burning alternatives.

Open-field burning has been the traditional method to dispose of rice straw and control disease. Alternatives to burning present different sets of challenges to rice producers and their communities. A case study of rice straw alternatives demonstrates the methods of assessment that lead to criteria for adoption. Burning has also been a traditional treatment for grass seed fields. A second case study considers impacts of reduced burning on grass seed producers.

The methodology used to evaluate the impacts of non-burning alternatives for these case studies was described in Sections 5.0 and 6.0 of the Task 1 report (ERG, 2001). The three tier data collection effort first described in the Task 1 report, and then continually implemented for this Task 2/3 effort, provided data for all tasks conducted under this project. The data that have been collected are described in detail in Section 7.0 of this report. A survey of stakeholders affected by and knowledgeable of agricultural burning and alternatives and other types of information sources was part of the data collection effort.

6.1 Rice Straw Case Study

More than 400,000 acres are devoted to rice cultivation in California. When rice fields are harvested, a standing crop of rice straw remains. The least costly means to dispose of the straw is to burn the open field. Burning creates smoke in nearby communities, irritating respiratory ailments and interfering with driving and air travel. Efforts have been underway since the 1970's to reduce the extent of rice straw burning and ensure that it occurs only when meteorological conditions are favorable. Since 1992 rice burning in the Sacramento Valley has been curtailed from 90 percent of planted acreage to less than 30 percent. Beginning in 2001, the

annual goal is to burn the lesser of 25 percent of planted acres or 125,000 acres exclusively for disease control purposes.

The legislated goal of less acreage burned has driven an effort to develop alternatives to burning. Rice straw is a biomass resource that can be used in many different processes and products. Among the uses being developed are ethanol production, particleboard, paper, composite materials, and straw bale construction. Agricultural and construction industries use rice straw as a mulching material and bale barrier to reduce sediment runoff from bare soil and promote new growth. California has sought to promote alternative uses through grants and other vehicles to initiate markets for rice straw. These efforts continue to show promise though they have not yet come to fruition (CIWB, 1998).

6.1.1 Agronomic Impacts

After rice is harvested, rice straw is burned to prevent overwintering of disease organisms and prepare the field for planting. There are, basically, two alternatives to burning rice straw. One is to incorporate it into the soil in the field. The other is to remove it and utilize it in some other fashion.

Continuous soil incorporation by chopping and disking or rolling the residue into the soil promotes stem rot infection and changes soil tilth. In the long run, these changes lead to decreased yields and more difficult working conditions as the fields become slower to dry out (REI, 1997). Methane generated by decomposition of rice straw under wet conditions may poison later crops. Yield decline represents the largest financial risk to growers from soil incorporation (CARB, 1993). Chopping and disking takes considerably more labor and machine time than burning but probably does not require the farm to purchase new equipment. Disease build-up may be compensated for by greater application of pesticides but consequences to soil structure cannot be easily mitigated. A combination of soil incorporation and occasional therapeutic burns may be a viable alternative to annual burning. Winter flooding can also mitigate many of the disadvantages of soil incorporation and improve nutrient cycling and yields. However, it requires greater use of water and fuel which contribute to higher costs (CARB, 1993).

Removing rice straw from the field avoids some of the agronomic issues of soil incorporation but creates a large volume of material that must be used or disposed. Other than burning or composting in windrows, removal techniques require baling straw for transport. Purchasing a baler or hiring custom baling services is a significant cost of any removal alternative. Baling standards for many alternative uses are quite stringent which adds to the costs of removal (REI, 1997). Techniques requiring additional passes of machinery over the field raises the risks of soil compaction and possible delays from wet field conditions. These may be addressed with more expensive technological options, such as tracks or flotation wheels on balers (REI, 1997).

Soil incorporation will continue to require burning or winter flooding of some rice land each year to maintain yields. Removal of rice straw for other uses may be a viable alternative if the producer can offset the added costs of removal with profits from sale of the product.

6.1.2 Environmental Impacts

The goal of promoting non-burning alternatives for agricultural activities is to reduce the environmental impact of burning on visibility and air quality. Alternatives, however, have environmental consequences of their own. Soil incorporation of rice straw reduces smoke and carbon dioxide emissions but increases methane production as the organic matter decomposes in the wet soil. Methane is a powerful greenhouse gas with 20 times the heat trapping potential of carbon dioxide. Methane emissions increase 3 to 12 times when rice straw is added to the soil rather than burned (REI, 1997). Clearly, there is a local/global trade-off in environmental impacts from soil incorporation.

Other alternative uses of rice straw offer different trade-offs. Burning rice straw for power generation, for example, reduces the production of particulates and methane because the burning conditions can be tightly controlled. However, disposal of the silica rich ash may be difficult to dispose. Non-burning alternatives require greater use of tractors and other equipment to chop and disk, or bale and remove, the rice straw. This added activity increases diesel and dust emissions. While the diesel emissions have a considerably smaller volume than the straw burning smoke, particulate emissions from diesel-fueled engines are listed by the California Air

Resources Board (CARB) as a toxic air contaminant (CARB, 2001a). Relative risks from each source need to be considered as alternatives are assessed.

Alternative uses of rice straw that result in aerobic decomposition have fewer balancing emissions issues than soil incorporation. These include uses such as animal bedding, erosion control, and weed suppression. Rice straw is particularly well-suited as a mulch because it is slow to decay and carries few weed seeds (REI, 1997). Uses that preserve the straw for an extended period or displace the use of other more valuable resources sequester excess carbon and so alleviate global warming without significant negative trade-offs. These include straw bale construction, building materials, and paper-making.

Wildlife adapts to the agricultural practices in their environment. California rice fields have been significant resources for migratory waterfowl (CARB, 2001a). If a non-burning alternative resulted in a change in the flooding regime, historical patterns of waterfowl migration could be affected. Ultimately, waterfowl populations could be reduced. Increased rice production in Arkansas and Texas is considered an important contributor to the over-population of mid-continent white geese and the subsequent destruction of their arctic breeding habitat (FWS, 1999). Such over-population issues have not arisen on the West Coast but indicate the interconnectedness of agriculture and wildlife.

Uses that consume large volumes of straw are also preferable environmentally. While composite materials made from rice straw are an exciting possibility (REI, 1997). Such production, however, will consume only a small portion of the total rice straw harvest even when technological and financial hurdles are overcome. Proven uses which require large volumes of straw may be more successful in developing straw markets in the near term.

6.1.3 Health and Safety Impacts

Farm safety impacts do not appear to be a strong criterion for differentiating among rice straw burning alternatives. None of the alternatives appear to be unusually hazardous compared to other agricultural work.

6.1.4 Energy Impacts

Recent experience with the deregulation of the California power supply system has highlighted the vulnerability of the region to energy shortfalls and the need to find new sources of electricity. Rice straw can provide a renewable source of biomass for power generation. However, it presents several challenges for electricity generation as described below:

- It has a low heat content. It requires a large volume of straw to generate as much energy as a cubic foot of natural gas. Collection is, therefore, costly. Large volume also creates handling problems in getting fuel into furnaces efficiently.
- Straw supplies are seasonal. Large amounts of straw need to be removed from fields in the Fall and may not be available during the remainder of the year. As a consequence, large volumes of fuel will typically need to be stored for considerable periods to keep a power plant operating continuously.
- Rice straw must be dried and chopped to be an efficient fuel. If energy must be expended to process the low energy fuel, more energy may be required to transport and process the fuel than it provides.
- Rice straw has an ash content of 14 to 20 percent, compared to wood that typically has an ash content of from less than 2 percent to 4 to 8 percent (typically used in power generators). Therefore, it leaves more ash to be disposed in landfills or similar facilities.

Even with these management issues, persistently high wholesale electricity prices may make a rice straw burning power plant a viable option for some locations. The California Air Resources Board has evaluated the prospect for new biomass power plants (CARB, 1993). Straw burning district heating systems are common in Denmark where subsidies have been offered to curtail open-field burning (REI, 1997).

6.1.5 Economic Impacts

The economic impact of adopting non-burning alternatives is an important consideration. One criterion for selecting the preferable options is cost effectiveness (i.e. the cost per acre per pound of particulate emissions reduced). The costs of adopting a non-burning agricultural alternative are measured by the difference in the cost of agricultural operations between a traditional burning operation, about \$3 per acre, and alternative non-burning

approaches, about \$31 to \$47 per acre (CARB, 2001a). The viability of any alternative also depends on the firm's ability to remain profitable given the new labor, capital, and land requirements of the new technology.

Cost-Effectiveness - Enterprise Level Assessment

Engineers estimate that each ton of rice straw burned emits 6.3 to 9 pounds of PM₁₀ (CARB, 2000). A typical acres of rice yields approximately 3 tons of rice straw residue after harvest. Thus, each acre burned emits approximately 19 to 27 pounds of PM₁₀ each year. Limiting burning to weather conditions that reduce the probability that smoke will reach cities can reduce the impact of smoke emissions on society. However, since the air quality goal is overall reduction in particulate emissions, cost effectiveness is determined in terms of reduced pounds of emissions rather than reduced human exposures.

Crop production budgets for current agricultural practices show all of the necessary tasks to raise the crop and their costs per acre by expenditure category for a well-run operation. Budgets do not represent the average but generally show an idealized production operation using the best practices suggested by the state cooperative extension service. The University of California (UC) Cooperative Extension Service (Williams, 2001) has produced a rice crop budget that contemplates a farm using a mix of burning and non-burning alternative practices.

An expanded budget that estimates the costs of four alternative straw management strategies was developed by the California Air Resources Board (CARB, 2001a). Rice growers actually use a variety of practices depending on field characteristics, past performance, and the prices of water and fuel. The CARB options range in cost from \$31 to \$47 per acre with the two most popular practices (Chop/Stubble Disc/Winter Flood and Chop/Chisel/Stubble Disc/Winter Flood) averaging about \$43 per acre. The UC rice budget also indicates that the least costly non-burning alternatives are to chop and disc (\$37 per acre) or chop, flood, and roll (\$32 per acre). However, neither of these methods can maintain yields without resorting to occasional burning. The UC rice budget suggests that 15 percent of rice land may need to be burned in a given year. Thus, the costs to abate burning rise by \$1.19 per pound abated [$(\$32-3)/27$] until 85 percent of acreage is managed by the chop, flood and roll method. To avoid releasing the last 15 percent of

PM₁₀ emissions, a more sustainable winter flooding regime must be adopted at an increased cost of \$1.63 per pound abated [$(\$47-3)/27$]. The cost of complete abatement reaches approximately \$35.09 per acre. Figure 6-1 illustrates the relationship between cost of reduced burning and potential reductions in PM₁₀ emissions on a per acre basis for rice straw.

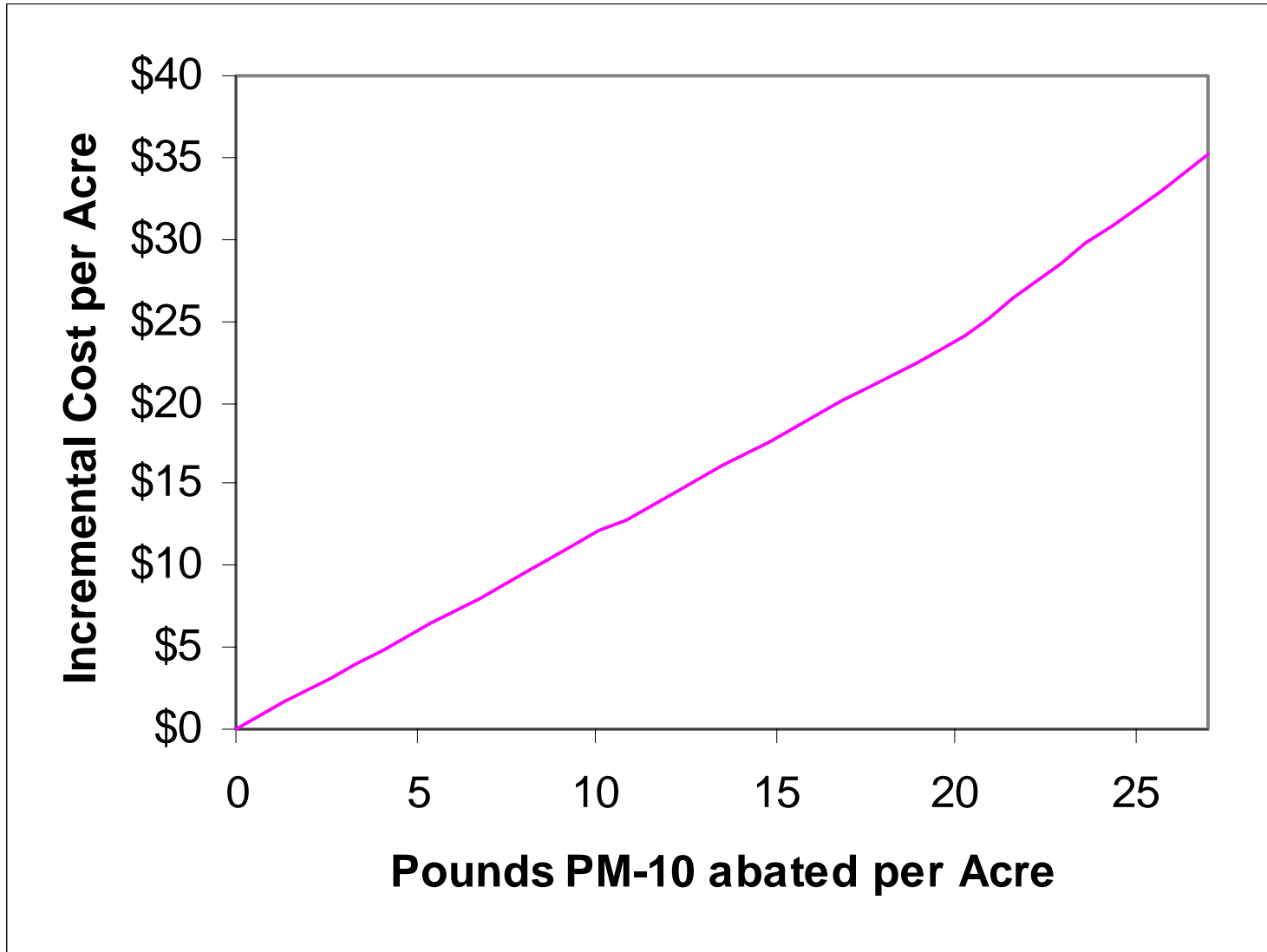
The UC rice budgets do not estimate the costs of baling rice straw, storing, and transporting it to alternative uses. These activities are more costly as they involve investment in a baler or hiring custom baling as well as more fuel and labor time in transit. The California Air Resources Board estimates field removal costs of \$75 per acre based on field clearing costs of \$60 per acre plus transportation costs of \$15 per acre (CARB, 2001a). However, if a market for rice straw evolves, baled straw could earn a compensating income. While use as compost or mulch, animal feed, or erosion control are the most likely alternative uses to consume large quantities of straw, there are many possible substitutes which will keep the price of straw for these uses relatively low. Hence, the costs of baling and hauling rice straw may not be recouped at competitive prices.

Affordability - Farm Level

Growers will not adopt a new technology or practice unless it makes economic sense for their firm as a whole. Rice acreage on farms that grow rice tends to be greater than the specific crop acreage of other commodity farms (Chambers and Childs, 2000). Rice farming is also more capital intensive than any commodity crop, other than cotton. This suggests a greater reliance on a single crop and the possibly a higher degree of borrowing by rice farmers than other producers. (Debt load information specific to California rice farming is not available.)

The UC rice enterprise budget shows producers' operating, overhead, and capital recovery costs are \$188 greater than their revenue given current federal rice program payments and a price of \$8.00 per hundredweight. Even a well-managed farm is operating at a long run loss. A more closely watched measure of profitability is revenues minus operating costs. Many growers will continue to operate at a paper loss as long as their cash flow is adequate to cover variable costs and the essential fixed costs, e.g., debt service. The UC rice budget indicates a net return above operating costs of \$150 per acre. Additional costs to achieve complete abatement of PM₁₀ of \$35 per acre represents 21 percent of the farm's net return. The U.S. Environmental

Figure 6-1. Rice Straw - Cost of Implementing Non-Burning Alternatives



Protection Agency (EPA), as an example, typically considers changes in net income of 3 to 5 percent as indicators of moderate stress (USEPA, 2000). It is unlikely that farms can support such a high level of abatement costs in the long term without earning some return from rice straw sales. Thus, criteria should favor, credible alternatives that encourage markets for rice straw

Indirect Impacts - Regional Level

Changes in farm operations can have impacts in the regional economy. Collecting and transporting crop residue may require extra labor which may generate more income for farm workers. New equipment that might be needed or faster depreciation of old equipment may increase sales at agricultural implement dealers. Such effects generate ripple effects throughout the regional economy. The California Air Resources Board used a computable general equilibrium (CGE) model to trace the impact on prices and quantities of adopting different policy options for rice straw burning (CARB, 1993). Their baseline information indicated that agriculture provides about 10 percent of the Sacramento Valley's value added and employment. Rice production and processing accounts for about 13 percent of the region's agricultural value added and 7 percent of its agricultural employment. So, about one percent of the region's employment and value-added come from the rice sector. The conclusion is that small changes in the output of this sector would have very small effects in the regional economy as a whole (CARB, 1993).

6.1.6 Social and Equity Issues

A survey of stakeholders (described in detail in Section 7.0) failed to reveal any special considerations about social or equity issues among rice straw non-burning alternatives. National trends over the last 10 years indicate that the number of large rice farms, measured both in terms of acreage and sales, has been growing faster than other field crop operations (Chambers and Childs, 2000). Very small farms, less than 100 acres, have also been disappearing rapidly. Large farms have greater yields per acre and so can absorb the added costs of non-burning alternatives more easily than small farms. Providing small producers access to straw markets and greater burning flexibility can mitigate the differential impact of adopting non-burning alternatives.

6.1.7 Political Issues

Promotion of non-burning alternatives by government, even on a voluntary basis, has the potential to antagonize agricultural interest groups. The California Rice Commission routinely advocates growers' concerns in the state. Environmental and recreation interests are also well organized. Surveyed stakeholders did not cite any specific groups with strong positions on agricultural burning but noted general concerns about implementation of the rice straw burning phase down in the Sacramento Valley.

6.1.8 Summary of Impacts

Table 6-1 summarizes the discussion above by indicating the severity of each potential impact for each alternative to burning rice straw on a scale from zero to three. Blank indicates "not relevant" or "no information." The factors in Table 6-1 are phrased in the negative so that a high number in the table always indicates a stronger degree of negative consequences for that alternative. An alternative with many 3's in its column is probably not a viable option. A total or average of these scores indicates an overall weight of problematic impacts. However, it would also imply an equal weighting among the impacts listed, which is unlikely among different interest groups.

The cut and haul residue to a waste facility or permitted burn facility alternatives contain several 3's because they incur the additional costs of baling and hauling without any hope of compensation for the grower. These alternatives are economically and politically untenable. The conversion of land to a non-agricultural use in detail received many 3's because conversion to a developed use is likely to require greater water and energy use as well as generating other forms of air emissions.

6.2 Grass Seed Case Study

Grass for seed is widely grown in Washington, Oregon, and Idaho. Legislation that allows burning only under favorable weather conditions has reduced the number of smoky days experienced in Spokane and other cities (WDOE, 1998a). While burning is a convenient disposal method for rice straw, it is an ecological necessity for grasses that evolved in fire-prone environments. Cessation of all open field burning results in production losses of 23 to 31 percent even with the best mechanical residue management practices (WDOE, 1998a). Thus,

Table 6-1. Rice Straw - Impacts of Non-Burning Alternatives^a

Potential Impacts	Leave Residues in Place			Cut or Collect Residues and Haul										Scientific Improvements			Alternative Land Use			
	Mulch Residue	Soil Incorporation: Wet or Dry	Soil Incorporation: Fallow Field	Waste Facility	Permitted Burn Facility	Power Generation Facility	Ethanol Production Facility	Redistribution Facility	Manufacturing or Use Facility	Fiber Board Facility	Particle Board Facility	Use as Compost or Mulch	Use as Animal Feed	Use For Erosion Control	Less Fuel Residual	Disease / Pest Resistance	Other Tolerances	Plant Crops That Are Not Burned	Land Conversion to Non-Agriculture	Conservation Tillage
Agronomic:																				
Soil compression	1	3	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	0	0	1
Increased water use	1	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3	1
Increased herbicide use	2	2	2	0	0	0	0	0	0	0	0	0	0	0	1	1	1	2	2	2
Increased pesticide use	2	2	2	0	0	0	0	0	0	0	0	0	0	0	1	1	1	2	2	2
Land constraint	1	0	0	2	2	2	2	2	2	2	2	2	2	2	1	0	0	0	0	0
Time or equipment constraint	1	2	2	2	2	2	2	2	2	2	2	2	2	2	1	0	0	0	0	2
Environmental:																				
Countervailing air emissions	0	2	1	2	1	1	1	1	1	2	2	0	1	1	0	0	0	2	3	1
Negative wildlife impacts	1	2	2	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	3	1
Water quality degradation	1	2	1	3	3	2	2	2	2	2	2	0	1	0	1	1	0	2	2	1
Health and Safety:																				
Increased equipment use	1	1	1	2	2	2	2	2	2	2	2	2	1	2						1
Energy Impacts:																				
No contribution to energy production	2	2	2	2	2	0	0	2	2	1	1	2	2	2	2	2	2	2	3	1
Economics:																				
Not cost-effective	2	2	2	3	3	1	1	1	1	1	1	2	2	2				2		
Farm financial stress	2	2	2	3	3	1	1	1	1	1	1	2	2	2				2		
Negative regional impacts	1	1	1	2	2	1	1	1	1	1	1	1	1	1				1	3	
Social and Equity:																				
Raises Tribal issues																			3	0
Raises small business issues	1	2	2	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0
Impacts low resource farms	2	2	2	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1
Political:																				
Agricultural objections	2	2	2	3	3	0	0	0	0	0	0	0	0	0	1	1	0	3	3	3
Environmental objections	2	1	1	3	3	1	1	2	1	1	1	0	0	0	2	3	2	1	3	0
Average Score	1.4	1.8	1.6	1.9	1.9	1.1	1.1	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.2	1.1	0.9	1.6	2.1	1.1

^a Feasibility factors are phrased to indicate a negative outcome. Higher ratings indicate worse consequences for that impact and alternative.

Blank = not relevant

0 = no problem

1 = some problem may exist

2 = definite problem exists

3 = a major issue exists

evaluations of burning cessation in grass seed production often entail assumptions about farms converting to alternative crops, most often wheat.

6.2.1 Agronomic Impacts

After the seed is harvested, the remaining stubble is burned to prevent overwintering of disease organisms and condition the field for future growth. Alternatively, the straw must be cut, baled, and stacked and a crewcut vacuum used to remove the secondary residue. Soil incorporation is not an option as the grass is established as a long-lived stand and is not tilled each year. Repeated passes with equipment increase the risks of soil compaction, root damage, and possible delays from poor field conditions. Unlike rice straw, creating markets for grass straw will not mitigate all of the disadvantages of the non-burning alternative. Yields cannot be maintained by mechanical means so the consequences of farms shifting from grass to other crops must be considered. For example, growth of Meadowfoam has been explored as a rotation crop for annual ryegrass in Oregon's Willamette Valley. Meadowfoam seed produces oil that has had fluctuating market demand in the cosmetics industry.

6.2.2 Environmental Impacts

Non-burning alternatives require greater use of tractors and other equipment to cut, bale, and remove, the straw. This added activity increases diesel and dust emissions. While the diesel emissions have a considerably smaller volume than the straw burning smoke, particulate emissions from diesel-fueled engines are listed by CARB as a toxic air contaminant (CARB, 2001a). The most likely alternative crop, wheat, exposes soil to wind and water erosion for much longer periods than grass production. Substantial volumes of particulates may be raised during wheat operations.

6.2.3 Health and Safety Impacts

Grass is often the crop of choice on relatively sloping sites because of its ability to hold the soil and limited need for cultivation. Non-burning alternatives require more mechanical operations and so increase the risk of tipping accidents injuring workers operating machinery on steep slopes. The Washington regulations permit burning on steep slopes and so avoid this risk (WDOE, 1998b).

6.2.4 Energy Impacts

Straw can provide a renewable source of biomass for power generation. Like rice straw, it has a low heat content, seasonal supplies, and processing requirements. However, the ash content of grass straw is more comparable to other biomass fuels, so it is preferable to rice straw.

6.2.5 Economic Impacts

The economic impact of employing non-burning alternatives on grass stubbles are discussed below.

Cost-Effectiveness - Enterprise Level Assessment

Engineers estimate that each ton of grass straw burned emits 16 to 102 pounds of PM₁₀ (CARB, 2000). A typical acre of grass yields approximately 2 tons of straw acre after harvest. Thus, each acre burned emits 32 to 204 pounds of PM₁₀ each year.

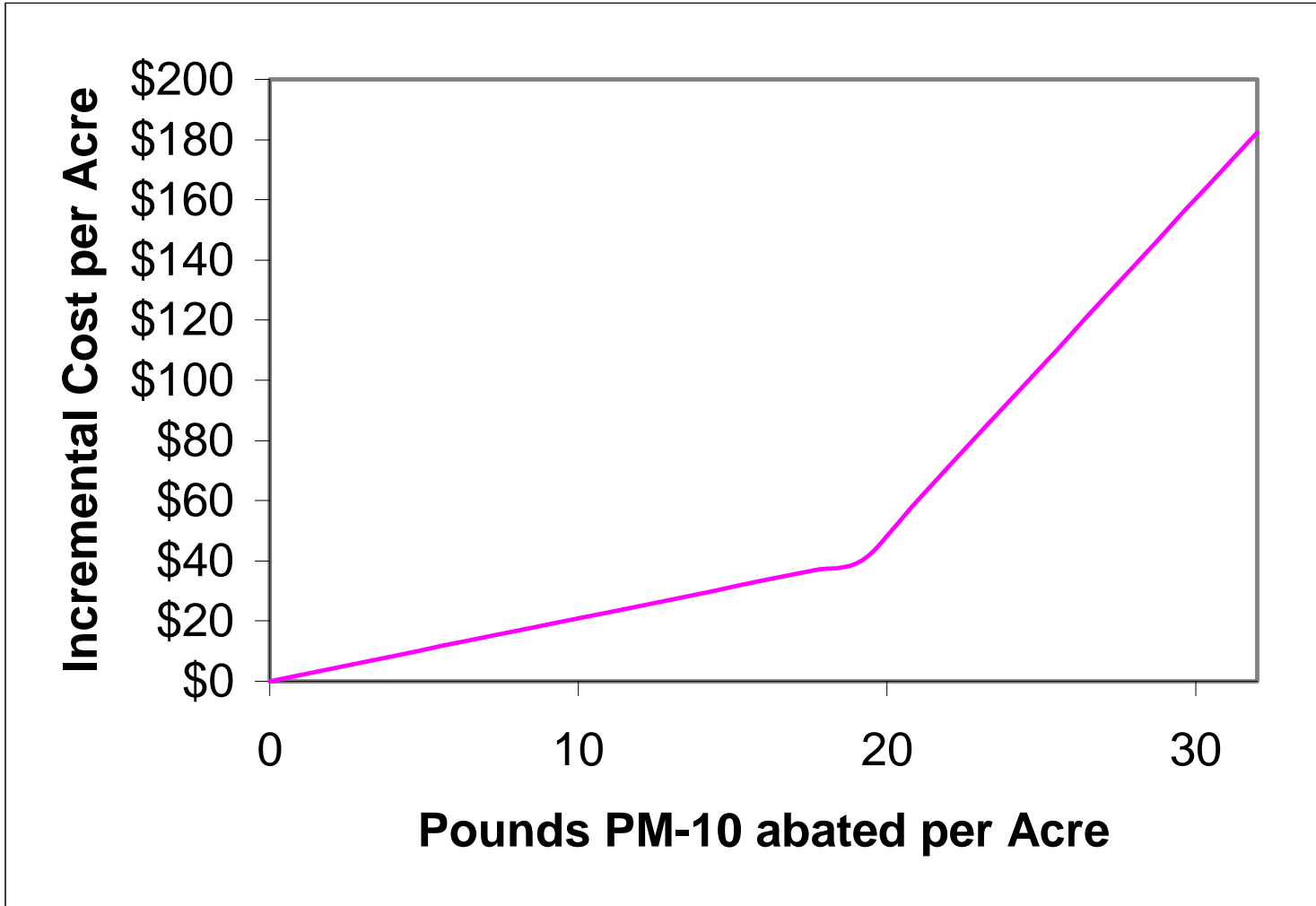
Washington Department of Ecology estimates the cost if mechanical straw management strategies as \$70 per acre (WDOE, 1998a). The costs to the farmer to abate burning rise by \$2.09 per pound abated [$(\$70-3)/32$]. This impact is illustrated by the cost curve shown in Figure 6-2.

If farmers burn after every second crop, rather than every year, burning can be reduced by two-thirds while yields are maintained near traditional levels. Thus, a diminution in yield effect becomes significant if more than two-thirds of the emissions are curtailed. This, in effect, raises the cost of abatement still higher (shown in Figure 6-2 has a sharp rise in cost per acre). As yield reductions are on the order of one-quarter to one-third and total revenue per acre is, roughly, \$350, such losses can double the costs per pound abated.

Affordability - Farm Level

Researchers have developed an enterprise budget for annual ryegrass that shows producers net return per acre with open-field burning is \$73 at a price of \$0.20 per pound (Taylor, Michael, et al, 1990). Additional costs to achieve complete abatement of PM₁₀ of \$70 per acre (not including yield effects) represents 96 percent of the farm's net return. Farms

Figure 6-2. Grass Seed - Costs of Implementing Non-Burning Alternatives



cannot support such a high level of abatement. Thus, criteria should favor alternatives that do not require an end to all grass field burning.

Indirect Impacts - Regional Level

Changes in farm operations can have impacts in the regional economy. Mechanical residue management employs more labor than open-field burning and so smoke abatement increases farm employment slightly (WDOE, 1998a).

6.2.6 Social and Equity Issues

A survey of stakeholders did not reveal any special considerations about social or equity issues among grass seed non-burning alternatives.

6.2.7 Political Issues

Promotion of non-burning alternatives by government, even on a voluntary basis, has the potential to antagonize agricultural interest groups. Survey respondents did not cite any specific groups with strong positions on agricultural burning but noted general concerns about implementation of new burning regulations in Washington.

6.2.8 Summary of Impacts

Table 6-2 summarizes the discussion above by indicating the severity of each impact in relation to each alternative to burning grass straw on a scale from one to three. None of the "Leave Residues in Place" alternatives are viable for grass seed production because of agronomic issues so they are assigned all blanks. The waste and permitted burn facility alternatives cannot be sustained without subsidies because of the high cost to bale and transport straw without creating a saleable product.

6.3 Applicability of Methodology and Case Studies

The case studies described in this section demonstrate the unique conditions that apply to each crop. These conditions indicate the need to assess each crop individually to discover which set of alternatives will best achieve reductions in air emissions.

Table 6-2. Grass Seed - Impacts of Non-Burning Alternatives^a

Potential Impacts	Leave Residues in Place			Cut or Collect Residues and Haul										Scientific Improvements			Alternative Land Use			
	Mulch Residue	Soil Incorporation: Wet or Dry	Soil Incorporation: Fallow Field	Waste Facility	Permitted Burn Facility	Power Generation Facility	Ethanol Production Facility	Redistribution Facility	Manufacturing or Use Facility	Fiber Board Facility	Particle Board Facility	Use as Compost or Mulch	Use as Animal Feed	Use For Erosion Control	Less Fuel Residual	Disease / Pest Resistance	Other Tolerances	Plant Crops That Are Not Burned	Land Conversion to Non-Agriculture	Conservation Tillage
Agronomic:																				
Soil compression				2	2	2	2	2	2	2	2	2	2	2	1	1	1	0	0	1
Increased water use				0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	1
Increased herbicide use				0	0	0	0	0	0	0	0	0	0	0	1	1	1	3	2	2
Increased pesticide use				0	0	0	0	0	0	0	0	0	0	0	1	1	1	2	2	2
Land constraint				2	2	2	2	2	2	2	2	2	2	2	1	0	0	0	0	0
Time or equipment constraint				2	2	2	2	2	2	2	2	2	2	2	1	0	0	0	0	2
Environmental:																				
Countervailing air emissions				2	1	1	1	1	1	2	2	0	1	1	0	0	0	3	3	1
Negative wildlife impacts				0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	3	1
Water quality degradation				3	3	2	2	2	2	2	2	0	1	0	1	1	0	3	2	1
Health and Safety:																				
Increased equipment use				2	2	2	2	2	2	2	2	2	2	2					0	1
Energy Impacts:																				
No contribution to energy production				2	2	0	0	2	2	1	1	2	2	2	2	2	2	2	3	1
Economics:																				
Not cost-effective				3	3	1	1	1	1	1	1	2	2	2				2		
Farm financial stress				3	3	1	1	1	1	1	1	2	2	2				3		
Negative regional impacts				2	2	1	1	1	1	1	1	1	1	1				1	3	
Social and Equity:																				
Raises Tribal issues																			3	
Raises small business issues				3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Impacts low resource farms				3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1
Political:																				
Agricultural objections				3	3	0	0	0	0	0	0	0	0	0	1	1	0	3	3	3
Environmental objections				3	3	1	1	2	1	1	1	0	0	0	2	3	2	2	3	0
Average Score	NA	NA	NA	1.9	1.9	1.1	1.1	1.2	1.2	1.2	1.2	1.1	1.2	1.1	1.2	1.1	0.9	1.9	2.0	1.2

^a Feasibility factors are phrased to indicate a negative outcome. Higher ratings indicate worse consequences for that impact and alternative.

Blank = not relevant

0 = no problem

1 = some problem may exist

2 = definite problem exists

3 = a major issue exists

The methodology used in the identification and assessment of non-burning alternatives for this study can be used to evaluate non-burning alternatives for other crops. A review of this procedure is presented below:

1. Select crop to evaluated;
2. Identify all possible alternatives from research (e.g., literature searches, survey of stake holders, etc.);
3. Evaluate each alternative based on impacts (i.e., agronomic environmental, health and safety, energy, economic, social and equity and political)
4. Rank alternatives using scheme shown in Tables 6-1 and 6-2.

7.0 ACCOUNTABILITY MECHANISMS

This section describes the strategies used to research, identify and characterize accountability mechanisms of greatest importance in supporting the development and use of non-burning alternatives within the 15 Western states. Accountability mechanisms include procedures used for tracking if and to what extent non-burning alternatives are used by local, state, tribal, or federal entities.

Where possible, accountability mechanisms which are currently in place and/or are actively in use at the state, county, and local levels as well as in the tribal community setting are identified. In addition, a discussion of how each accountability mechanism is important in supporting or promoting the development and use of non-burning alternatives to agricultural burning is provided. Accountability mechanisms important to the implementation and use of non-burning alternatives by individual burners is discussed in greater detail in the Implementation Plan portion (Chapter 9.0: To be provided in Final Report) of this research effort.

7.1 Research Strategy and Sources of Information

The identification and characterization of accountability mechanisms of importance in the development, consideration and use of non-burning alternatives to agricultural burning was a complex and involved process. It required a thorough assessment, understanding and interpretation of current agricultural burning practices in the west. It also required a thorough assessment and understanding of the regulatory and programmatic structures in place for addressing agricultural or open burning activities in each state, and where applicable for each county or local air authority. An understanding on the part of the investigators of the variety of practical, technical, political, and economic forces affecting stakeholders involved in or currently conducting agricultural burns was also critical for the successful identification and characterization of accountability mechanisms in this effort.

To collect the depth and variety of information desired and to address the expectedly wide distribution of information sources, the same comprehensive three-tiered

approach to identifying and researching the various potential sources of information discussed in detail in prior chapters of this report (i.e., Task 1 report; ERG, 2001) was employed. This approach included contacting and/or researching the availability of information from three different levels of information sources. It was expected that these sources would provide varying information perspectives and levels of programmatic detail. The majority of the most relevant information pertaining to this task came from the first level of information sources.

7.1.1 Level One Sources

The first level of information sources investigated included state environmental agencies, boards and departments, county and local air pollution control authorities, their respective administrative and statutory rules and regulations, formal published reports and documents, and articles or summary information posted on official state level or county level Webster. For all 15 Western states, the presence or in some cases absence of accountability mechanisms important in the identification, development, consideration and use of non-burning alternatives, was clearly documented by those state and county or local level environmental agencies and air authorities with responsibility for implementing agricultural or open burning programs.

To assist in these efforts, and in general for the collection of data relevant to all other portions and tasks conducted under this project, a process for consistently and reliably identifying, collecting and documenting information obtained from the various sources was implemented. An informal survey tool was designed for in-house use only. Information was obtained from identified contacts at the various state, county, local or tribal environmental authorities who were contacted either by phone or electronic mail (email). Responses to a series of questions designed to identify and characterize accountability mechanisms were used to document information collected for this task. Where appropriate the contact persons have been identified and referenced in this document. References to these contacts and summary comments can be found in the accountability mechanisms summary list in Tables 7-1 and 7-1a.

Table 7-1. Accountability Mechanisms Important to the Use of Non-Burning Alternatives

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	References	Comments
State-Count(ies) or Area	Agricultural Burning is Exempt from all Regulations or Rules	Agricultural Burning is Effectively Exempt from Regulations or Rules	Agricultural Burning is Included in Regulations or Rules	Agricultural Burning has Specific Regulation or Rule	General Open Burning Regulation or Rule	Other Burning Sources More Important	Formal Agricultural Burn Approval Process	Agricultural Burning Permit is Required	Agricultural Burning Permit Fees are Charged	Smoke Management is Required	Agricultural Burn Activity Enforcement Process Exists	Requirement to Estimate Fuels, Acreage, & Emissions: Pre-Burn Permit	Requirement to Confirm Fuels, Acreage, & Emissions: Post Burn Report	Agricultural Burn Activity Data is Reviewed & Included in an Inventory	Requirements to Consider Use of Alternatives	Financial Incentive(s) are Available for Using Alternatives	List of Alternatives is Available from Air agriculturalagency		
AK		√	√		√		√ ^{b,c}	√					√		√			WRAP, 2001a	1, 27
AZ		√	√		√						√	√		√					2, 28
AZ-Pima			√ ^a		√ ^a		√ ^a	√ ^a	√ ^a		√ ^a								3
AZ-Pinal			√ ^a		√ ^a		√ ^a	√ ^a	√ ^a										4
AZ-Yuma			√ ^b		√ ^b		√ ^b	√ ^b	√ ^a		√ ^a	√ ^b							5
AZ-Maricopa		√			√ ^a														6
CA			√		√ ^a			√ ^a	√ ^a	√ ^a	√ ^a			√	√	√		WRAP, 2001a	7, 43
CA-Lake			√ ^a		√ ^a		√ ^a	√ ^a	√ ^a	√ ^a	√ ^a	√ ^a		√ ^a	√ ^a			WRAP, 2001a	44
CA-Sacramento Valley Counties			√ ^a	√ ^a			√ ^a	√ ^a	√ ^a	√ ^a	√ ^a	√ ^a		√ ^a	√ ^a			WRAP, 2001a	45
CA-San Joaquin Valley Counties			√ ^a		√ ^a		√ ^a	√ ^a	√ ^a	√ ^a	√ ^a	√ ^a		√ ^a	√ ^a			WRAP, 2001a	46
CA-South Coast Counties			√ ^a		√ ^a		√ ^a	√ ^a	√ ^a	√ ^a	√ ^a	√ ^a		√ ^a	√ ^a			WRAP, 2001a	8, 47
CO	√					√													9
HI			√		√			√	√		√	√		√					10
ID			√		√						√	√		√	√			WESTAR, 1998	11, 30

Table 7-1. Continued

																		References	Comments
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17		
State-Count(ies) or Area	Agricultural Burning is Exempt from all Regulations or Rules	Agricultural Burning is Effectively Exempt from Regulations or Rules	Agricultural Burning is Included in Regulations or Rules	Agricultural Burning has Specific Regulation or Rule	General Open Burning Regulation or Rule	Other Burning Sources More Important	Formal Agricultural Burn Approval Process	Agricultural Burning Permit is Required	Agricultural Burning Permit Fees are Charged	Smoke Management is Required	Agricultural Burn Activity Enforcement Process Exists	Requirement to Estimate Fuels, Acreage, & Emissions: Pre-Burn Permit	Requirement to Confirm Fuels, Acreage, & Emissions: Post Burn Report	Agricultural Burn Activity Data is Reviewed & Included in an Inventory	Requirements to Consider Use of Alternatives	Financial Incentive(s) are Available for Using Alternatives	List of Alternatives is Available from Air agriculturalency		
MT		√	√		√	√		√	√		√								12, 31
ND		√	√		√		√ ^a				√								13, 32
NM		√	√		√									√					14, 42
NV	√												√					WRAP, 2001a	15, 33
NV-Pershing	√											√						WRAP, 2001a	
OR			√		√			√	√	√	√	√		√	√				16, 34, 35
OR-Jefferson			√ ^a		√ ^a			√ ^b	√ ^a	√ ^a	√ ^a	√ ^a				√ ^a		WRAP, 2001a	36
OR-Umatilla			√ ^a		√ ^a			√ ^a	√ ^a	√ ^a	√ ^a	√ ^a				√ ^a		WRAP, 2001a	36
OR-Union			√ ^a		√ ^a			√ ^a	√ ^a	√ ^a	√ ^a	√ ^a				√ ^a		WRAP, 2001a	36
OR-Willamette			√ ^a		√ ^a			√ ^a	√ ^a	√ ^a	√ ^a	√ ^a				√ ^a		WRAP, 2001a	36
SD	√																		17, 37
UT	√																	WESTAR, 1998	18, 38
WA			√		√			√	√		√		√	√			√	WRAP, 2001a; WESTAR, 1998	19
WA -Benton			√ ^a	√ ^a				√ ^a	√ ^a		√ ^a	√ ^a		√ ^a	√ ^a			WRAP, 2001a	20, 40
WA-Columbia			√ ^a	√ ^a				√ ^a	√ ^a		√ ^a	√ ^a		√ ^a	√ ^a			WRAP, 2001a	21, 40
WA-NW region			√ ^a	√ ^a				√ ^a	√ ^a		√ ^a	√ ^a		√ ^a	√ ^a			WRAP, 2001a	22, 40

Table 7-1a. Comments Key for Table 7-1

No.	Comments
1	Ann Lawton, AK State Dept. Env. Quality, ERG/ETC Informal Survey 2001: No agricultural crops burned. Limited burning conducted to date is for land clearing; may be more in future. Limited to Fall and Spring because of climate, tourism and fire danger. Burning occurs in Delta Junction area only. Rest of AK no agricultural burning at all. Permits are required for burns greater than 40 acres in size only. Most of the smoke issues occur with non-permitted burns.
2	Varma Sunil, AZ State Dept. of Env. Quality, ERG/ETC Informal Survey 2001: Typically agricultural burning is not addressed in statewide open burning smoke management program. Most burning occurs in Yuma county. 8,000 ac/yr limit via State Implementation Plan. Non-agricultural open burning is allowed in Yuma and Maricopa Counties.
3	Bill Maxwell, Pima County Dept Env. Quality, ERG/ETC Informal Survey 2001: Most burning is tumble weeds, year round via open burn permit. Based on Burn/No-Burn days program. No smoke management plan is required and emissions are not tracked.
4	Donald Gabrielson, Pinal County Dept Env. Quality, ERG/ETC Informal Survey 2001: Principal agricultural burning is for irrigation ditch bank clearing. Occurs in Spring. Most other permitted burning is for residential use burn barrels. Some rural agricultural burning. If OK'd for agricultural, annual permit to burn anything up to 320 contiguous acres.
5	Varma Sunil, AZ State Dept of Env. Quality and Kurt Foster, Yuma County Fire Dept, ERG/ETC Informal Survey 2001: Most burning is limited by the State Implementation Plan up to 8,000 ac/yr. It typically includes citrus and other orchard fuels burning for orchard retirement and removal. Often use a curtain air destructor.
6	Rick Hado, Maricopa County, ERG/ETC Informal Survey 2001: No burning for agricultural residues occurs in county. Majority of burning is for ditch banks, tumble weeds, fence line clearing and land clearing. Do often use high temperature burners for ditch banks and best management practices.
7	WRAP, 2001a: Agricultural burning is allowed under state law. It is typically permitted at the county air authority level. Many crops are burned, especially rice, wheat and other grains. Orchard prunings are also burned by permit. The newly adopted statewide Title 17 Smoke Management Guidelines for Agricultural and Prescribed burning in CA provides authority, direction and guidance to the local air authorities (air quality management and/or control districts) for the regulation and management of burning. Smoke management plans are required of each local air authority. There is considerable variability in the implementation of local rules and regs and little systematic statewide review of programs or emissions estimates.
8	WRAP, 2001a: Almost any crop can be burned any time of the year.
9	Coleen Campbell, CO State Dept. of Public Health and Phyllis Woodford, CO State Dept. of Public Health, ERG/ETC Informal Survey 2001: In general no agricultural crops burned. Burn only range land and irrigation ditches. agricultural residues are exempt from regs but do encourage good burning practices. Some spring wheat, corn and sunflower burning may occur in Western County Grand Junction area. OK'd to burn via courtesy Burn/No-Burn calls.
10	Lisa Young, HI State Dept. of Health and Janet Ashman, HI agricultural Research Center; ERG/ETC Informal Survey 2001: Two year crops, roughly half of the acres planted in any year would be burned the following year for both sugar cane and pineapples. Estimate 40,000 to 50,000 acres of sugarcane are in production. Roughly 30,000 acres sugar cane is burned in any given year. We do not know what acreage is burned for pineapples. Sugarcane industry is having economic difficulties due to competition with sugarbeet production in other states. Sugarcane burning will likely decrease the future.
11	Diane Riley, ID State Dept Environmental Quality, ERG/ETC Survey 2001; Dan Redline, Courdelane Regional Office, ERG/ETC Informal Survey 2001; Kurt Thornberg, ID Dept of agricultural, ERG/ETC Informal Survey 2001, Robert Wilkosz, ID Dept Env. Quality, WESTAR (1998): Data not available for most of the state. Some data on grass and cereal grains is available for the Kootenai and Benewah counties. Voluntary smoke management plans are used in Kootenai and Benewah counties. Grass seed and cereal crops are burned in the Fall (August-Sept). Alfalfa, mint and other perennial forage crops are burned in both the spring and fall. Ditch banks are burned in the spring. Individual burner make the burn/no-burn decisions. Open burning rule specifically allows burning of orchard clippings and burning for weed control.
12	Bob Habeck, MT State Dept Environmental Quality, ERG/ETC Informal Survey 2001: Data on acreage burned are not tracked. State has permit authority Sept-Feb otherwise burner gets to decide when to burn and not burn. Program is geared toward wildlands and forest management, not agricultural. Rarely allowed to

Table 7-1a. Continued

No.	Comments
	burn in summer months because of fire danger. Burning that does occur addresses ditches and sagebrush land conversion.
13	Chuck McDonald, ND State Health Dept., ERG/ETC Informal Survey 2001: Wheat is burned in Fall and only in N. Eastern areas of Red River Valley. Yields are high, similar to rice in CA re the straw situation. Do not track emissions at all. agricultural is exempt. Open burning is prohibited but variances are issued for prescribed burning of forest lands. One particle/fiber board plant is highly successful in the state.
14	Brad Musick, NM State Dept of Environment, ERG/ETC Informal Survey 2001: Orchard prunings are the main issue. No emissions data is kept. Wheat is burned in Eastern portion of the State. Pecans are the main crop. Prunings, hulls etc. are burned in the Donja Ana (Rio Grande) areas of state. Tumble weeds and irrigation ditches are burned routinely as a way of life in some areas to supply pecan orchards with water.
15	Colleen Cripps, NV State Dept of Environmental Quality, ERG/ETC Informal Survey 2001: Western Governor's Association "Agricultural Burning Smoke Management Program Survey", EC/R Incorporated, 2/16/01: agricultural burning is essentially not regulated. Some self regulation occurs in parts of the state with greater community concerns. This includes the Lovelock Valley.
16	Brian Finneran, OR State Dept of Environmental Quality, ERG/ETC Informal Survey 2001: Grains burned July, August and September. Basically track emissions through three separate geographically distinct field burning programs. All three programs publish annual emissions reports. Largest source of burning is the Willamette Valley. Complex State run program. Orchard burning is typically allowed statewide.
17	Chris Hansen, SD Dept of Environment and Natural Resources, ERG/ETC Informal Survey 2001; Tim Rogers, SD State Dept of Environment and Natural Resources, ERG/ETC Informal Survey 2001: agricultural burning is not regulated in the state. No Tracking, no records kept, and no permits required for agricultural burning in the state. Grasses burned in Spring (March, April and May) and Fall (Sept, Oct). Grain is burned in March and April. Open burning of rubbish, treated woods, wastes etc. is prohibited.
18	Francis Bernards, UT State Department of Environmental Quality, ERG/ETC Informal Survey 2001; Steven Parkin, UT State Division of Air Quality, WESTAR (1998): State does not track acres burned. Large agri-farming occurs in nearly every county. No burning occurs during Ozone season, June, July and August. Burn season is Sept-May.
19	Grant Pfeifer, WA State Dept of Ecology, agricultural Burn Task Force, ERG/ETC Informal Survey 2001; Chad Akins, WA State Dept of Ecology, WESTAR, 1998: Burning occurs in Benton, Columbia, Island, Skagit and Wathcom counties. Wheat is burned in March, April and July-Nov. Fall burning occurs Aug-Nov. Spring Burning Accurs March-May. Crops burned include wheat, barley, grass seed, pasture and alfalfa seed. A post-burn "Report Card" is required. Emissions from these sources are tracked. Burning incidental to agricultural residue is allowed to burn without a permit. This type of burning includes orchard prunings, fencelines, irrigation and drainage ditches. Emissions are not tracked from these sources. State of WA does support research to explore alternatives to burning.
20	WRAP 2001a: Most of the burning in the county is Orchard removal.
21	WRAP 2001a: Spring Burning= March through April and Fall Burning= Mid-Sept through October
22	WRAP 2001a: Very small amount of acreage burned. 475 total in year 2000.
23	WRAP, 2001a: Little agricultural burning occurs in this county. Less than 50 acres in 2000, none were grain or grass seed crops. Burning is allowed year round because so little occurs in the county.
24	WRAP, 2001a: Most burning is done in Spring. Fall burning is being phased out.
25	Darla Potter, WY Dept of Environmental Quality, ERG/ETC Informal Survey 2001: Emissions are not tracked at all. Burn permits are required for forestry and rangeland. Recently grass seed companies from OR and WA have been relocating to WY which may increase burn emissions from these sources.
26	WRAP, 2001b: There are 240 indian reservations in the Western Regional Air Partnership (WRAP) region representing more than 54 million acres of land. Historically each tribal entity manages their own lands independently. No centralized agricultural burning activity data presently exists. Historically burning occurs on approximately 50% of the indian reservations within the WRAP region of the 15 western states. Types of burning include wildland, rangeland and agricultural. Often burns are part of an overall annual burn or land management plan but some are completely independent. Most tribal entities do not have a formal smoke management program although some do. Coordination with other off-site land management entities and air quality authorities is highly variable

Table 7-1a. Continued

No.	Comments
	among the tribes.
27	State of Alaska, Department of Environmental Conservation, Open Burning Policy and Guidelines document. http://www.state.ak.us/dec/dawq .
28	State of Arizona, Department of Environmental Quality, Arizona Guidelines for Open Burning and Permit Application Form, Title 49. http://www.adeq.state.az.us/enviro/air .
29	State of Hawaii, Administrative Rules, 11-60.1-51: Open Burning, and Application for Agricultural Burning Permit, http://www.state.hi.us/doh/rules/emd/11-60.PDF .
30	State of Idaho, Statute Title 22, agricultural and Horticulture, Chapter 48, Smoke Management and Crop Residue Disposal, http://www.state.id.us/idstat
31	State of Montana, Department of Environmental Quality, Rules Title 17, Chapter 8, Air Quality, Open Burning. http://www.deq.state.mt.us/dir/legal
32	State of North Dakota Air Pollution Control Rules, Chapter 33-15-04, Open Burning Restrictions, http://www.health.stat.nd.us/ndhd/enviro
33	State of Nevada, Division of Environmental Protection, Smoke Management Program, NAC 445B.381 Open Burning, http://www.state.nv.us/ndep/bao/smoke1.htm .
34	State of Oregon, Department of agricultural, "Field Burning Rules", http://arcweb.sos.state.or.us/rules
35	State of Oregon, Department of agricultural Natural Resources Division, http://www.wloda.state.or.us/Natural_Resources/smoke.htm .
36	State of Oregon, Administrative Rules, Department of Environmental Quality, "Pollution Control Tax Credits", http://arcweb.sos.state.or.us/rules/OARS_300/OAR_340/340_tofc.html
37	State of South Dakota, Department of Environment and Natural Resources, "Air Quality Guidelines for Open Burning", http://www.state.sd.us/denr/DES/airquality/regulations
38	State of Utah, Administrative Code, Title R307, "Environmental Quality, Air Quality", Section 307-202-1, http://www.rules.state.ut.us/publicat/code
39	State of Utah, Statute, Title 19, "Environmental Quality code" Chapter 2, "Air Conservation Act", http://www.le.state.ut.us
40	State of Washington, Department of Air Quality, Best Management Practices and Administrative Code, "Agricultural Burning", RCW 70.94.656 Open Burning, http://www.ecy.wa.gov
41	State of Wyoming, Air Quality Standards and Regulations, Chapter 10, Section 2, "Open Burning Restrictions", http://deq.state.yw.us .
42	State of New Mexico, Environmental Protection Air Quality, "Open Burning", Title 20, Chapter 2, Part 60.
43	State of California, Title 17 "Smoke Management Guidelines for Agricultural Burning and Prescribed Burning", California Code of Regulations, Section 80100, et. Seq. California Air Resources Board. http://www.arb.ca.gov
44	State of California, Lake County Air Quality Management District, Rules and Regulations: Chapter VIII, Agricultural Burning. http://www.arb.ca.gov/DRDB/lak/CURHTML/LKRulebook7-13-01-PDF
45	State of California, Sacramento Metropolitan Air Quality Management District, Rule 407: Open Burning, http://www.arb.ca.gov/DRDB/SAC/CURHTML/R407.htm and Rule 501: Agricultural Burning, http://www.arb.ca.gov/DRDB/SAC/CURHTML/R501.htm
46	State of California, San Joaquin Valley Unified Air Pollution Control District, Rule 4103: Open Burning, http://www.arb.ca.gov/DRDB/SJU/CURHTML/R4103.PDF
47	State of California, South Coast Air Quality Management District, Rule 444.Open Fires, http://www.arb.ca.gov/DRDB/SC/CURHTML/R444.htm

7.1.2 Level Two and Level Three Sources

As appropriate, contact was made with the secondary sources identified at or by the level one sources. Also, a focussed review of relevant prior agricultural burning survey reports, documents and other information produced by larger more comprehensive multi-agency environmental and or governmental organizations was conducted. These organizations included the WGA, WRAP, and its various task forces such as the FEJF. Relevant documents identified from these and other sources include: GCVTC, 1996; WESTAR, 1999; WRAP, 2001a; WRAP 2001b.

7.2 Accountability Mechanisms Identified

To date, 17 accountability mechanisms which appear to be important to the use of non-burning alternatives to agricultural burning in the West have been identified. These are identified as accountability mechanisms 1 through 17 in Table 7-1 and include the following:

1. Agricultural Burning is Exempt from all Regulations or Rules.
2. Agricultural Burning is Effectively Exempt from Regulations or Rules.
3. Agricultural Burning is Included in Regulations or Rules.
4. Agricultural Burning has Specific Regulations or Rules Exist.
5. General Open Burning Regulations or Rules Exist.
6. Other Burning Sources are More Important.
7. Formal Agricultural Burning Approval Process Exists.
8. Agricultural Burning Permit is Required.
9. Agricultural Burning Permit Fees are Charged.
10. Smoke Management is Required.
11. Agricultural Burning Activity Enforcement Process Exists.
12. Requirement to Estimate Fuels, Acreage and Emissions on a Pre-Burn Permit.
13. Requirement to Confirm Fuels, Acreage and Emissions on a Post-Burn Report .

14. Agricultural Burning Activity Data is Reviewed and Included in Inventories.
15. Requirements to Consider the Use of Alternatives Exist.
16. Financial Incentive(s) are Available for Using Alternatives.
17. List of Alternatives is Available from Air Agency.

These results suggest that the presence or in some cases the absence of identified accountability mechanisms effectively determines whether non-burning alternatives will be used in the 15 Western states. The 17 mechanisms identified above fall into five main categories of accountability. These categories, (a) through (e), are shown in Table 7-2. The 17 accountability mechanisms are discussed in detail below.

7.2.1 Accountability Mechanisms 1 through 3

The most important mechanisms in the initial determination of whether non-burning alternatives will be employed are found in category (a): Accountability Initiated at the State or Regional Level. These mechanisms either absolutely (mechanism 1) or in practice effectively (mechanism 2) exempt agricultural burning from regulation. Or, they actively include agricultural sources for potential regulation in statute (mechanism 3). Mechanism 3 establishes whether agricultural burning is defined and/or included in any state or local regulation or rule.

State environmental regulatory agencies throughout the 15 Western states either include agricultural burning in statute or they exempt agricultural burning completely from their regulations and rules. They may do this for a variety of reasons. Absolute exemption may occur because agricultural burning may not be a significant source of air pollution in the region, state or air basin. Agricultural burning may not be a source of air pollution because climate, topography, crops planted and current agricultural practices may not support the need to burn. Or, agriculture activities may not exist or occur in a given state or air basin such that burning of residues or stubble is not needed. In contrast, agricultural burning may be an important and/or significant source of pollution in the state or an air basin in general. It may also be an important, significant source at certain times of the year and not others. However, in spite of this, some states still exempt agricultural burning sources from regulation. In these cases political, social,

**Table 7-2. General Categories of Accountability Mechanisms
Identified in the
15 Western States**

General Category and Description	Accountability Mechanism
(a) Accountability Initiated at the State or Regional Level	1. Agricultural Burning is Exempt from all Regulations or Rules 2. Agricultural Burning is Effectively Exempt from Regulations or Rules 3. Agricultural Burning is Included in Regulations or Rules
(b) Accountability at a State or Local Level that Supports the Active Regulation of Agricultural Burning Activities	4. Agricultural Burning Specific Regulations or Rules Exist 5. General Open Burning Regulations or Rules Exist 6. Other Burning Sources are More Important
(c) Accountability at a Programmatic Level that Supports a Formal Approval and/or Permitting Process	7. Formal Agricultural Burning Approval Process Exists 8. Agricultural Burning Permit is Required 9. Agricultural Burning Permit Fees are Charged 10. Smoke Management is Required 11. Agricultural Burning Activity Enforcement Process Exists
(d) Mechanisms that Encourage Accountability at the Local Level that Support the Tracking of Emissions and Program Effectiveness	12. Requirement to Estimate Fuels, Acreage and Emissions on a Pre-Burn Permit 13. Requirement to Confirm Fuels, Acreage and Emissions on a Post-Burn Report 14. Agricultural Burning Activity Data is Reviewed and Included in Inventories
(e) Mechanisms that Facilitate and Encourage the Use of Non-Burning Alternatives	15. Requirements to Consider the Use of Alternatives Exist 16. Financial Incentive(s) are Available for Using Alternatives 17. List of Alternatives is Available from Air Agency

economic or regulatory resource and/or climate factors may make it impractical for states to include agricultural burning in their regulations as a source of air pollution for control.

In other cases, state agencies or local air authorities may essentially, in practice, exempt agricultural burning even if it is identified in regulations as a source of air pollution. This occurs for a variety of reasons but for the most part it results from either a programmatic focus on other areas or sources of air pollution of greater concern, or from political, social, economic or regulatory resource and/or regulatory climate factors that de-emphasize regulation of agricultural burning sources. Regardless of the reasons why this may occur, if agricultural burning is absolutely exempted or effectively exempted in practice from regulation at the state or regional level there is little practical incentive, private or governmental, to develop or implement alternatives to agricultural burning. When agricultural burning is identified in statute as a source of air pollution the chances of identifying, developing and employing non-burning alternatives increase substantially.

7.2.2 Accountability Mechanisms 4 through 6

If agricultural burning activities are included in state environmental or health statutes, there is a greater likelihood that non-burning alternatives will be identified, developed and used. If agricultural burning is not otherwise exempted from regulation, the degree to which it will or may be regulated is closely tied to the regulatory strategy embraced by the environmental agency or air quality authority. The degree to which agricultural burning is practically regulated is also dependent on the form and subsequent effectiveness of the regulations used to address agricultural burning as a source of air pollution. The degree to which agricultural burning regulations serve as motivating factors in the identification, development and use of non-burning alternatives can often be predicted based on the following:

- Whether there is a formal rule or regulation in place to address agricultural burning;
- The type or types of regulations or rules in place which address agricultural burning; and

- The relative degree to which agricultural burning is important as a source of air pollution compared to other sources in the state, regional or air basin.

Accountability mechanisms 4 and 5 support the active regulation of agricultural burning at the state and local levels. Mechanism 4 provides for clearly defined regulations or rules specifically designed to address agricultural burning activities. Mechanism 5 provides for the inclusion of agricultural sources in a more general open burn regulation or rule. Both mechanisms increase the likelihood that non-burning alternatives will be identified, developed and used. However, the more specific the regulation, typically the more detailed and ideally effective a regulation or rule may be in addressing a particular source or class of pollutant sources.

Mechanism 6 is also important in the identification, development and use of non-burning alternatives since it has the potential to deter, under some circumstances, the active addressing of agricultural burning sources. In mechanism 6 other burning activities such as range management, land clearing or forest management may be more important sources of air pollution from a programmatic implementation standpoint. This may develop because of technical, political or economic factors, or a combination of the same. In these cases, even though rules or regulations to address agricultural burning are in place at the state level, other vegetative burning sources receive higher implementation priority. In some cases this may contribute to the effective exemption of agricultural burning activities (see Table 7-1).

7.2.3 Accountability Mechanisms 7 through 11

Accountability mechanisms that support regulation of agricultural burning fall into category (c): Accountability at a Programmatic Level that Supports a Formal Approval and/or Permitting Process. Mechanisms in this category support more systematic approaches to the review and approval of proposed burn activities, overall program implementation and consistent enforcement of programs which include regulations or rules that address agricultural burning. Accountability mechanism 7 provides for a formal burn activity approval process. Accountability mechanisms 8 and 9 address pre-burn permit requirements and associated permit fees. Mechanism 10 provides for the accountability of smoke released from ongoing burn activities. Mechanism 11 supports compliance with existing regulations or rules as well as

provides a forum for education on smoke program benefits through a formal enforcement process. All of these mechanisms provide information and in some cases economic motivation that supports the identification, development and use of non-burning alternatives.

7.2.4 Accountability Mechanisms 12 through 14

Mechanisms that provide information for applying non-burning alternatives to current agricultural burning practices fall into category (d): Mechanisms that Encourage Accountability at the Local Level That Support the Tracking of Emissions and Program Effectiveness. Mechanisms 12 through 14 support the formal identification, tracking and inventorying of burn activity parameters important in the implementation and review of an agricultural burning program effectiveness and extent of implementation. Some of the most important parameters addressed include fuel types burned, the number of acres burned and the resulting emissions from all identified agricultural burning sources. Mechanism 12 requires potential burners to estimate parameters such as fuel type, fuel loading, acreage impacted and in some cases, potential emissions released from any proposed burn activity. This information is usually provided on a pre-burn permit application or even the permit itself. Mechanism 13 increases the assurance of quality data collection by requiring a post-burn report that confirms the parameters initially estimated on the pre-burn permit or permit application.

Mechanism 14 increases the likelihood that non-burning alternatives will be identified and used since it provides a mechanism for formal burn permit data review and the inclusion of important data in statewide inventories and implementation plans. As significant agricultural burning emissions are identified and documented at the state and regional levels, comparison to other more traditionally well document sources of air pollution becomes possible. If agricultural activities remain important in a state or air basin, often for a number of reasons including at a minimum economics, despite the release of potentially significant air emissions motivation to continue agricultural production and related activities typically remain high. This type of atmosphere can provide motivation and support for, as well as stimulate interest in, the identification, development and use of effective non-burning alternatives if agricultural source contributions can be documented and the stakeholders can be assured their efforts to use non-burning alternatives will be worthwhile. A more comprehensive discussion of these

mechanisms and how they might be used in the effective implementation of non-burning alternatives can be found in the Implementation Plan portion (Section 9.0: To be provided in Final Report) of this research effort.

7.2.5 Accountability Mechanisms 15 through 17

The fifth and final category is category (e): Mechanisms that Facilitate and Encourage the Use of Non-Burning Alternatives. While it might seem in some cases that these mechanisms should be the only ones considered within the scope of this research effort, it is unlikely that these mechanisms alone will produce the desired results in any but the most advanced agricultural burning management programs settings. Mechanisms 1 through 14 are essential for the support and validation of mechanisms 15, 16 and 17. Mechanisms 15, 16 and 17 provide accountability at the state or local level that facilitates the active identification of and encourages the consistent use of effective non-burning alternatives in conjunction with or as a substitute to existing, more traditional agricultural burning practices. Mechanism 15 provides incentive to actively consider non-burning alternatives by making it a requirement of pre-burn approval. This usually occurs during the pre-burn permitting process. If no pre-burn permitting process exists, in all but the most unique of circumstances it is impractical and unrealistic to expect non-burning alternatives will be considered.

Mechanism 16 provides financial assistance in one form or another to burners who implement non-burning alternatives. This serves to help overcome one of the most often voiced oppositions to the use of non-burning alternatives which is that of cost “ineffectiveness”. Mechanism 17 has the potential to provide useful, practical incentives to the increased use of non-burning alternatives by providing a list of alternatives that are available and/or in use successfully in the area. This mechanisms would eliminate another readily voiced opposition to the use of non-burning alternatives which is that non-burning alternatives don’t exist or cannot be used effectively. A more comprehensive discussion of these mechanisms and how they might be used in the effective implementation of non-burning alternatives can be found in the Implementation Plan portion of this research effort.

7.3 Review and Discussion of the Accountability Mechanisms in Place in the 15 Western States

The presence or in some cases the absence of mechanisms 1-17 appears to effectively determine whether non-burning alternatives will be used in the 15 Western states. In general, for states with aggressive mandates to reduce agricultural burning, such as Washington, Oregon and California, a large number of the accountability mechanisms identified in Table 7-1 were found to be in place. These states have put in place mechanisms that fall into all five categories of accountability, a, b, c, d and e. These states also, interestingly enough, have the largest number and greatest variety of non-burning alternatives in use at the time this document was produced.

In those states with less aggressive smoke reduction programs or no formal requirements to address agricultural burning essentially no effective accountability mechanisms were found to be in place. This was the case for the states of Colorado, Nevada, South Dakota, and Utah. As a consequence, little or no direct information on non-burning alternatives was available for these states. However, this finding in and of itself may not be significant. For states such as Colorado where agricultural burning is not a source of air pollution it makes sense that their programs would focus on other more relevant sources.

For those states that effectively, in practice, exempt agricultural burning from regulation, few if any effective accountability mechanisms were found to be in place. Those that were found to be in place were often in place to address other overall sources of open burning such as forest and range land management activities. This was the case for the states of Alaska, Arizona, New Mexico, Montana, North Dakota and Wyoming. For those states that have overall excellent air quality and essentially very little air pollution from agricultural burning sources, such as Alaska, Montana and Wyoming, air quality programs may of practical necessity be focussed on other sources such as forest or range land management practices. Burn programs in general may also be in place to address fire safety issues. However, in other states where a number of accountability mechanisms appear to be in place, political, social, economic and practical programmatic resource factors may play a significant role in the overall de-emphasis on

addressing agricultural burning as a source of air pollution in the state or region. This may be the case in states such as North Dakota, Arizona and New Mexico.

In other states such as Idaho and Hawaii a number of accountability mechanisms appear to be in place. In fact there appear to be mechanisms in place for these states in all five categories of accountability. However, the number of non-burning alternatives identified and in use for these states remain insignificant. Patterns such as this suggest that additional research may be needed to better identify and characterize the nature of the apparent inconsistency. It may be that significant political, social, economic or practical programmatic resource factors have a role here as well in the overall de-emphasis on addressing agricultural burning as a source of air pollution in the state or region.

In Tribal communities there appear to be agricultural burning review and approval mechanisms in place. However, these appear to be less formal in nature with little emphasis on agricultural burning per se and essentially no coordination with neighboring non-tribal land managers. The implementation of these mechanisms also appear to be more widely distributed across local, county, tribal, state, and federal authorities than any of the 15 states in general. This is likely a reflection of the wide variety of types of burning that occurs on the more than 54 million acres of tribal lands. It is also likely a reflection of the historically independent and self-reliant nature of more than 240 Indian reservation communities found in the 15 Western states of the Western Regional Air Partnership. However, this may also simply be a reflection of the fact that very little air pollution from agricultural burning sources may result from Tribal activities and that air quality programs may of practical necessity be focussed on other sources such as forest or range land management practices. Burn programs in general may also be in place to address fire safety issues on Tribal properties. As more information is gathered on the subject a more detailed assessment of agricultural burning activities, the identification and use of non-burning alternatives and the presence of absence of accountability mechanisms in place at Tribal government levels should be possible.

Overall, the incentive and motivation to identify and use non-burning alternatives are lacking in many of the 15 Western states. This is largely due to a lack of effective accountability mechanisms noted in this section in place at the state and local programmatic

levels. In some states there are formal requirements to consider alternatives to infield agricultural burning of residues prior to carrying out field burning activities (Alaska, California, Hawaii, Idaho, New Mexico, Oregon, and Washington). Although in some cases economic incentives appear to exist, such as in Oregon and California, there are typically no formal requirements to actually implement non-burning alternative management practices in any states. Furthermore, routine information regarding the availability, applicability, and cost effectiveness of non-burning alternatives is typically not provided by the states in any comprehensive or coordinated fashion. If alternatives are routinely used, the degree to which non-burning alternatives are implemented is often not formally tracked. This makes it difficult to credit more proactive participants in the non-burning alternatives community appropriately. This is an important finding of this research effort that warrants further discussion. A more comprehensive discussion of the role these mechanisms might play in furthering the identification, development, consideration and use of non-burning alternatives in those of the 15 western WRAP member states and Tribal communities where agricultural burning appears to be a significant source of air pollution in the region, state or air basin can be found in the Implementation Plan portion (Chapter 10: To be provided in Final Report) of this research effort.

Lastly, a critically important aspect of the burn program and accountability mechanism review effort that was not addressed to any great extent in this portion of the assessment effort is the issue of definition of agricultural burning. How agricultural burning is defined varies extensively throughout the regulations and rules reviewed for the Western states. In some cases agricultural burning defines only row or field crops. In some cases orchard and vineyard prunings are included as agricultural residues while in others they are not. There is no consistency at all within the state regulations and rules with respect to how irrigation ditch, fence line, weed or land clearing for agricultural purposes are addressed. This complicates the interpretation of the findings of the accountability mechanisms provided here. How this impacts the further identification, development, consideration and use of non-burning alternatives in those of the 15 Western WRAP member states and Tribal communities where agricultural burning appears to be a significant source of air pollution in the region, state or air basin will be discussed in greater detail in the Implementation Plan portion of this research effort.

8.0 NON-STATUTORY ADMINISTRATIVE BARRIERS

This section describes the strategies used to research, identify and characterize non-statutory administrative barriers. In practice, non-statutory administrative barriers have the potential to limit new program development and implementation to a greater extent than do statutory barriers. Non-statutory administrative barriers are those situations, circumstances, activities or elements that typically minimize, deter or prevent the active use of non-burning alternatives. These barriers are not grounded or defined in statute, rules or regulations. These typically result from or are defined by administrative practices associated with the implementation of agricultural or open burning programs in the west. They can also develop as a result of political, social, economic, cultural, and religious pressures that hinder or impede the development and use of non-burning alternatives.

Because work on this task was still underway, the results presented here should be considered preliminary. It is expected that this section may change as a result of ongoing efforts to outline potential implementation strategies to address recommendations provided in the draft final report.

In the final report for this effort, the non-statutory administrative barriers currently in place or are actively in use at the state level for each of the 15 Western states where possible, at the county, local levels, tribal level, will be identified. A discussion of how each non-statutory administrative barrier may be addressed to increase the support, development and use of non-burning alternatives in each case identified will be included.

8.1 Research Strategy and Sources of Information

For this task, the same comprehensive three-tiered approach to identifying and researching the various potential sources of information discussed in detail in prior chapters of this report was used. The three-tiered approach included contacting and/or researching the availability of information from three different levels of information sources.

8.1.1 Level One Sources

The first level of information sources investigated included state environmental agencies, boards and departments, county and local air pollution control authorities, their respective administrative and statutory rules and regulations, formal published reports and documents, and articles or summary information posted on official state level or county level websites. As expected, the presence or in some cases absence of non-statutory administrative barriers relevant to non-burning alternatives were known to staff at the state and county or local level environmental agencies and air authorities having responsibility for implementing agricultural or open burning programs.

8.1.2 Level Two Sources

The second level of information sources researched were the agricultural extension services agencies for all 15 Western states. The third level of sources included private sector stakeholders identified during the first and second level research efforts. To date the most relevant and comprehensive information regarding the identification and characterization of non-statutory administrative barriers has come from informal survey information collected from state and local air quality program staff, agricultural extension research staff and individual stakeholders who currently use or desire to use to some degree, non-burning alternatives. As the results of informal survey work are reviewed and other information source research is completed, other information sources may be identified and the results will be provided in the final report.

8.2 Non-Statutory Administrative Barriers Identified to Date

There are many non-statutory administrative barriers (i.e. situations, circumstances, activities and elements) which may minimize, deter and/or prevent the active use of non-burning alternatives in the west. Non-statutory administrative barriers include the following categories:

- *Public acceptance* of a practice or program result, which may be closely tied to aesthetics:

- *Aesthetics* (i.e. visual or olfactory and possibly auditory, but also possibly nuisance factors such as plant debris or dust infiltration or deposition in or near homes and businesses);
- *Economic challenges*, such as labor costs, increased liability and/or disposal, storage, packaging or transport costs, capitol for investing in new technologies, availability of investors, market return, crop yield, crop quality, and production rates;
- *Practical issues* such as supply and demand of essential materials like seed or seedlings, storage facilities, machinery for planting, harvesting, delivery mechanisms, reporting mechanisms, timing and effectiveness of the non-burning alternative, and short- or long-term effects on the farm unit or agricultural operation;
- *Geographic* limits due to climate or topography; and,
- *Political, cultural or religious* practices.

To date, 12 non-statutory administrative barriers, which fall into at least three categories as defined above, have been identified. These currently exist in specific situations in the 15 Western states, and are summarized in Table 8-1. As the research for this task is completed it is anticipated that the information summarized in Table 8-1 will be addressed more comprehensively, and assuming other barriers are identified, the list may be expanded in the draft final report for this research effort.

**Table 8-1. Non-Statutory Administrative Barriers Identified to Date
in the 15 Western States**

General Category and Description	Non-Statutory Administrative Barriers
(1) Economic Challenges: such as labor costs, increased liability and/or disposal, storage, packaging or transport costs, capitol for investing in new technologies, availability of investors, market return, crop yield, crop quality, and production rates;	<ul style="list-style-type: none"> • Transport costs to remove agricultural residues from the field, orchard or vineyard must be incurred. • Labor and machine costs to bail and stack or otherwise collect field residues for offsite use. • Capitol for investing in new technologies is limited. • Availability of investors and willingness to invest in new methodologies is limited. • Decreased market return, crop yield, crop quality, and production rates can occur with increased damage from pests or disease. • Availability of economic incentives for burners to try new non-burning alternatives is limited. • Program implementation of existing economic incentive programs is fractured and untimely. • Water costs in the arid west and southwest increase costs substantially of field residue soil incorporation non-burning alternatives.
(2) Geographic Limits: due to climate and/or topography.	The steep terrain in some mountainous states make it impractical to implement some non-burning alternatives.
(3) Political, Cultural and/or Religious Practices.	<ul style="list-style-type: none"> • Cultural practices in at least one state center around agricultural burning activities. Changes in burning practices may significantly impact local community cultural events. • In at least one circumstance historical promises play a roll in the social and cultural acceptance of the use of non-burning alternative. During the great dust bowl times state officials lured farmers away from other states by promises of land and an agricultural way of life. Any changes to that way of life are difficult to address programmatically.
(4) Practical Issues: such as supply and demand of essential materials like seed or seedlings, storage facilities, machinery for planting, harvesting, delivery mechanisms, reporting mechanisms, timing and effectiveness of the non-burning alternative, and short- or long-term effects on the farm unit or agricultural operation;	Research is ongoing.
(5) Public Acceptance: of a practice or program result, which may be closely tied to aesthetics:	Research is ongoing.
(6) Aesthetics: visual or olfactory and possibly auditory impacts but also possibly nuisance factors such as plant debris or dust infiltration or deposition in or near homes and businesses;	Research is ongoing.

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