LEAKAGE

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Prepared for Agriculture's Role in Mitigating Climate Change Workshop
American Farmland Trust/Farm Foundation/USDA Economic Research Service

August 13-14, 2008

Washington, DC

In the context of greenhouse gas (GHG) mitigation, "leakage" refers to the potential for a policy, such as a cap-and-trade system, to encourage actions or projects on the part of some entities that reduce emissions or sequester carbon, which in turn, result in actions or projects by other entities that increase emissions. Viewed in aggregate, a portion of the GHG benefits achieved by the first set of entities is offset (or "leaks" out of the system) as a result of the actions of the second set. Hence, what looks like GHG mitigation at the action or project level is, in effect, a shift of emissions from one set of entities to another.

Four illustrative examples illustrate different dimensions of leakage.

1. Internal leakage: If an entity is only required to report on the emissions and sequestration associated with specific projects, GHG emitting activities can be shifted to other lands that are under control of the entity. For example, assume a farmer has 400 acres of cropland, of which, one half are managed with conventional tillage and one half of which are managed with no-till. In a GHG cap-and-trade system that focuses narrowly on offset projects, the farmer could acquire GHG offset credits by switching the lands managed with the two tillage systems.

2. Within sector leakage: A landowner is planning to sell the right to harvest 100 acres of trees to a timber company but instead opts to participate in a new GHG mitigation program. The program requires the land be put under a long-term conservation easement and that it remain in trees. In return, the farmer is allowed to sell CO_2 offset credits to equal to the additional carbon sequestered in each year of the easement. The offsets may be purchased by entities with emissions reduction obligations under the program. In response the timber company purchases 100 acres of timber from another land owner who opts not to participate in the program. Assuming the two parcels have similar quantities of timber, the GHG mitigation achieved by the actions of the participating landowner is completely offset by the actions of the nonparticipating landowner.

3. Cross sector leakage: A GHG mitigation program allows farmers to acquire offset credits by reducing the use of nitrogen fertilizers. In response to the policy, farmers collectively reduce farm-sector demand for nitrogen fertilizers by 36 million metric tons. The decrease in farm-sector demand affects a decrease in the price of nitrogen fertilizer. In response to the lower fertilizer prices, homeowners—who are not covered by the policy—respond by applying 5 million metric tons more nitrogen fertilizer to residential properties. The net effect then is that the collective actions of home owners offset about 14 percent of the GHG benefits achieved by the farm sector.

4. International leakage: Assume a large country like the United States, or a group countries like those in Annex B of the Kyoto Protocol, adopt measures that decrease aggregate CO_2 emissions by significantly reducing the consumption of gasoline and diesel fuel. Such measures could include a carbon tax on liquid transportation fuels, higher fuel economy standards and/or increased use of certain biofuels. From a global perspective, the reductions in CO_2 emissions related to the decreased combustion of fossil fuel will only help mitigate global climate change if the fuel that is now not being combusted in the United States or Annex B countries is not diverted to and combusted in other countries. To the extent such diversions occur, the decrease in emissions related

to the reduced fossil fuel consumption in the United State or Annex B countries is offset by increased emissions in other countries.[1]

While leakage is often discussed in terms of actions or projects, the above examples show that it is really a boundary issue. For a variety of reasons the GHG mitigation frameworks that have been proposed to date, have generally been limited in scope. Some cover specific economic sectors while others cover economic entities with emissions above a specified threshold. Frameworks that are limited in scope need to specify the conditions (or boundaries) that distinguish those entities that are covered, and hence have obligations, from those that are not.[2] To the extent that the economic behavior of cover entities (those within the boundaries) affect changes in the economic behavior of uncovered entities (those outside the boundaries) there is the potential for leakage.

Leakage has been a central issue in discussions relating to the potential role of agricultural and forestry offsets in cap-and-trade systems. The principal reason to include such offsets is that agriculture and forestry have the potential to supply significant quantities of low-cost GHG mitigation. One recent study estimated that if CO_2 was priced at $30 per metric ton, actions in the agriculture and forestry sectors could supply 1.4 million metric tons of GHG offsets and mitigate 25 percent of U.S. GHG emissions (EPA, 2005). Based on these estimates, it would cost about $42 billion to mitigate one quarter of all U.S. GHG emissions. While these estimates do not include transaction costs and assume a number of issues are adequately addressed (like leakage and permanence), it is unlikely that any other economic sector could deliver near this much mitigation for $42 billion per year. Hence, agricultural and forestry offsets have the potential to significantly lower the cost of achieving any given level of GHG mitigation.

On the other hand the structure of U.S. agriculture and forestry, and, the way the sectors have been included in proposed GHG mitigation frameworks to date, make agricultural offsets susceptible to leakage. First, agriculture and forestry are competitive sectors meaning they consist of numerous small entities each with no ability to affect market prices, quantities or behavior. Second, in the frameworks that have been proposed to date, agriculture and forestry have not been covered sectors (i.e., included within the boundaries). Individual farmers and landowners, however, may opt to participate as suppliers of offsets provided they meet certain criteria. Together, these conditions imply situations where large numbers of farmers and forest land owners are both inside and outside the system's boundaries. At the entity level then, it is virtually impossible to link actions taken by an entity inside the boundaries with actions outside the boundaries. This makes it difficult to accurately credit farm-level actions and projects with the amount of GHG mitigation they produce.

Possible Approaches to Leakage:

In the context of a GHG mitigation program, the potential for leakage to reduce the mitigation value of agricultural and forestry offsets will vary depending on the nature of the activity or action generating the offset and the magnitude to which activity or action is adopted within the sector. In a model run with CO_2 priced at $15 per mt, the EPA studied cited above estimated leakage rates of -0.1 percent (i.e., slightly beneficial) for agricultural management, 5.7 percent

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[1] Leakage is often discussed with respect to offsets generated in agriculture and forestry. This example shows that the issue is applicable to emission reductions in other economic sectors as well.
[2] The boundaries of a national cap-and-trade system might be based on entity emissions, key gases, specific activities, economic sectors and/or geographic areas.

for agricultural soil management, 24.0 percent for afforestation, and -2.8 percent for afforestation and forest management together. In a study of forest sequestration programs, Murray et al (2002) estimated leakage rates of less than 10 percent to greater than 90 percent depending on the activity and region.

The results of these studies have two important considerations for addressing leakage in a GHG mitigation framework. First, for a given activity or project, it will generally be possible to estimate aggregate leakage (i.e., across all entities). Second, with respect to the agriculture and forestry offsets, the best approach for dealing with leakage might differ based on the activities generating the offset.

Finally, the competitive structure of agriculture and forestry also has an important consideration for addressing leakage. Because all farmers and forestland owners respond to aggregate commodity market conditions, the potential for leakage will be greater when the offset generating activities affect changes in commodity market prices and quantities (Schneider and Kumar: 2008). Activities that change the way a farmer produces a given product (such as adopting no-till or installing an anaerobic waste digester) will be much less prone to leakage than activities that change sector level production patterns (such as shifting large areas of cropland into trees or biofuel crops).

With the above considerations in mind, several approaches for addressing leakage in the context of agriculture and forestry GHG offsets are discussed below.

Expand the Coverage (entities, sectors, states, countries, etc)

Since leakage is a result of linkages between the economic activities of entities and sectors covered by a GHG mitigation program and the economic activities of entities and sectors that are not covered, one approach to reducing problems with leakage in a GHG mitigation program is to expand the set of covered entities and sectors. In the internal leakage example described above, the leakage could be accounted for if the entity is required to report and be responsible for all of the emissions and carbon sequestration that result from actions under control of the entity.

Similarly, in the within-sector example described above, expanding the cap to include all of forestry and agriculture would address leakage. While conceptually straight forward, the costs of extending program coverage to large numbers of very small emitters/offset suppliers would likely be prohibitive relative to the GHG benefits achieved.

Discount Credits

While it may be difficult to accurately assess the degree to which the GHG mitigation benefits of a particular action on a given farm are offset through leakage, several studies have shown that, at least under static conditions, it is possible to estimate the total amount of leakage that occurs across all similar actions across all farms (see studies by EPA and Murray et al. cited above). Assuming defendable estimates of the total leakage associated with given offset activities can be developed, one approach to addressing leakage is to adjust the value of the offset accordingly. For example, using the leakage estimate for afforestation in the EPA study cited above (i.e., 24.0 percent), a metric ton of carbon sequestration from converting agricultural land to trees would be worth 0.76 metric tons of emissions reduction in the covered sectors.

Assuming the leakage adjustment factor is approximately correct; the discount approach has the advantage of being simple and straight forward to apply. Additionally, because it is valid on average, it would credit the correct amount of GHG mitigation in aggregate.

A potential complication with the discount approach is that leakage rates are not likely to be constant. If offset activities are to be effective in addressing greenhouse gas emissions, the scales of adoption will need to be large. As this occurs, the adoption of offset generating activities will likely reach a scale sufficient to affect changes in market prices. For example, Wang et al (2007) estimate the GHG benefits of replacing gasoline with corn ethanol at 21.0 percent. This value, however, assumes a domestic ethanol production of about 5.0 billion gallons per year. The ethanol industry, however, is currently engaged in refinery construction that will increase capacity by another 6.0 billion gallons a year. To produce the corn necessary to supply these additional refineries will likely require bringing millions of acres of new land into agricultural production. Accounting for the GHG emissions associated with these land-use changes will decrease the GHG benefits associated with of corn ethanol.

Document that Leakage has not Occurred

A third approach to addressing leakage is to require (or allow) suppliers of offset credits to provide documentation verifying their offsets are free of leakage. Assuming the documentation requirements are sufficiently rigorous, the offset credits will be of high quality and hence of most interest to entities that must reduce emissions under a cap-and-trade system.

The documentation approach, however, is likely to be of limited use for agricultural and forestry offsets due to the competitive structure of the sectors (see above). Its application then will only be possible in instances where the offset generating activities do not occur on a scale sufficient to affect changes in market prices. As noted above, these are likely to be the activities that are naturally not prone to leakage.

Accept It and Adjust National Goal Accordingly

A final approach to leakage in GHG mitigation policy is to accept it and to adjust national mitigation goals to accommodate the consequences. If the overall policy objective is to mitigate GHG emissions, then one option is to implement a cap-and trade system that simply encourages entities to change their behavior in ways that, on average, reduce emissions or increase sequestration. The focus would be on achieving a national GHG mitigation goal and the cap-and-trade system would be the instrument chosen to achieve the goal. It would not be necessary, however, that each emission reduction and offset credit generated within the system actually exists.

Such an approach would require an independent assessment of whether or not the mitigation goal was being achieved. In the United States, the annual EPA inventory of GHG emissions and sinks could serve this function. If the annual inventory indicated that the national GHG mitigation goal was not being reached, the cap could be adjusted.

The benefits and weaknesses of this approach are largely a matter of perspective. The approach explicitly accepts that leakage will occur and that some (perhaps many) entities will be rewarded for more GHG mitigation than their offsets actually produce. Those who favor a strict accounting between the number offset credits in a cap-and-trade system and the actual units of emissions reduction and carbon sequestration created will see the approach as ignoring the leakage issue. Those who do not feel a strict accounting is necessary will see the main benefit as the time and resource savings associated with not having to estimate the degree to which leakage occurs and how to credit individual actions or projects to reflect it.

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