CARBON SEQUESTRATION - ADDITIONAL ENVIRONMENTAL BENEFITS OF FORAGES IN THE PFRA PERMANENT COVER PROGRAM

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ABSTRACT

International concern about greenhouse gases and their impacts on climate change has added to the need for an understanding of carbon sequestered in agricultural soils. This paper evaluates the carbon sequestration potentials of the 522 000 hectares converted from annual cultivation to forages under the Prairie Farm Rehabilitation Administration's (PFRA) Permanent Cover Program (PCP). The 15 000 PCP sites in the prairie provinces of Canada are matched to their dominant soil characteristics. Estimates of carbon losses due to annual crop cultivation are determined for these soil characteristics, and sequestration potentials under the permanent cover condition are presented. Estimates of societal benefits are calculated for the amounts of carbon sequestered. A $74 million program investment by government in permanent cover will have generated carbon benefits with an estimated value of $72 million to $362 million. Inclusion of these carbon benefits significantly increases earlier, positive net benefit calculations of the PCP.

INTRODUCTION

International concern about greenhouse gases and their impacts on global warming has led to discussions concentrating on possible mitigative activities. Environmental awareness, international conventions, and the linkage of the environment to trade agreements have heightened the interest in improving the environment through agricultural programming. Likely, new associations like the Commission for Environmental Cooperation under the North American Free Trade Agreement will be essential features of trade agreements. The Permanent Cover Program (PCP) was implemented primarily for soil conservation and grain program expenditure reduction by government, however, significant benefits accrue to other environmental objectives. The Program was delivered by the Government of Canada, through PFRA. It was announced in 1989 and extended in July, 1991. Marginal lands for agriculture, classes 4, 5 and 6 under the Canada Land Inventory system, were targeted for conversion to alternative sustainable uses under permanent cover. It was estimated that some 4.9 million hectares (PFRA, 1987) of marginal lands were in annual cultivation where a more environmentally sustainable management practice would be permanent cover. Producers were first provided with a financial incentive to convert eligible lands from annual crops to perennial forage or tree cover. Farmers who signed a 10 or 21 year land use agreement received a one-time payment after cover was established. No further payments were made. A caveat was registered on the PCP land to safeguard Canada's interests over the contract years. Producers primarily use the land for cattle grazing and forage production. There are 168 000 ha enrolled in PCP I and 354 000 ha in PCP II. This represents over 15 000 contracts of which 64 percent are for 21 years. The program cost to Canada totalled $74 million in payments for forage establishment and land use restriction.

MATERIALS AND METHODS

Three methodologies are used to estimate the potential of land in PCP to sequester carbon. In all three methods the PCP land is assigned to a Soil Landscape of Canada (SLC) polygon, using a Geographical Information System (GIS). Each SLC Polygon has an assigned Soil Type (ie: Black Chernozem) and Texture (ie: Clay Loam) appropriate for the dominant soil in the polygon. The first method assigns average native carbon and current carbon levels to each of the 15 000 PCP sites. This is performed at the Soil Type level only. Subtracting the native from the current carbon levels shows that approximately 5.4 million tonnes of carbon have been lost from the PCP land during an assumed 80 years of cultivation. It is assumed with proper management, this land has the potential to sequester at least this amount of carbon under permanent cover. The second method used is based on an estimation of native and current carbon levels, but by Soil Type and Texture. While native and current carbon levels change by SLC polygon, the ratio of the two carbon estimates remains constant. This provides a measurement of carbon loss as a percent. Since each PCP parcel falls into one of the estimated Soil Types and Textures, a total percent loss of carbon on the PCP sites can be estimated. The third method is the use of the SLC Carbon Layer Table. This Table has a measurement of bulk density and percent carbon for each SLC Polygon. The SLC Carbon Layer Table has the SLC Polygon broken down into a number of sub-regions. These are related to the SLC Polygon, by the SLC Component Table and the SLC Land Area Table. Calculating the average carbon content of the soil, is performed by using the carbon content of the sub-region, weighted by the percent of the sub-region in the SLC polygon. Using the ratios of Soil Type and Texture to relate calculated current carbon levels to the native carbon, the amount of carbon lost by each PCP site is calculated. The results of these three methodologies are presented by province in Table 1.

Economic assessments of the impacts of PCP illustrate the significant net benefits to society through positive benefit-cost ratios resulting from savings in other government programs, and by environmental improvements (PFRA, 1990, 1992 and 1993; Perlich, 1992; Burden, 1994). A literature review was conducted to determine accepted values of sequestered carbon. Value estimates for the Conservation Reserve Program (CRP) in the United States use $13.40 to $67 per ton of stored carbon (Dudek, 1990; and Paustian, 1996). Estimates, with a global perspective, suggest that the range in values could be as high as $348 to $790 per ton of carbon (Azar and Sterner, 1996). Using results from the three methodologies, a value for the carbon was calculated.

RESULTS AND DISCUSSION

The results of the three methodologies show the potential of the PCP land to sequester carbon is between 5.4 and 5.7 million tonnes of carbon. It is estimated that 4.9 million hectares in annual cultivation across the prairies would benefit from the more appropriate management practice of permanent cover. PCP converted 522 000 hectares, leaving an estimated 4.4 million hectares of marginal land currently in annual cultivation that if converted to permanent cover could potentially sequester an additional 50 million tonnes of carbon. The significance of this must be put into context of Canada's National Action Program on Climate Change which states that Canada contributes 2% of net global greenhouse gas emissions resulting from human activity and CO_2 represents the largest challenge since it accounts for 80% of the greenhouse gas emissions. Altering management practices on marginal lands can further increase carbon sequestration. Factors affecting carbon retention in soils include: increasing the cycle time of carbon in plant materials and soil organic matter by reducing tillage; taking full advantage of the growing season to produce more plant and root material by including perennial forages in the crop rotation; increasing the use of fertilizer to enhance plant and root production; optimal forage varieties selected for yield and root mass production affects carbon retention (Anderson and

Coleman, 1985). Planting of trees on land in forage can enhance carbon sequestration efforts (Anderson, 1996). In addition to improved crop yields and erosion control, 50% of the biomass of trees is carbon (Kort, 1996). In addition to the value of carbon sequestered, converting marginal lands to permanent cover provides other tangible benefits including: reduced soil degradation; improved water quality in surface and aquifer waters; enhanced wildlife habitat; reduced summerfallow acreage; and reduced fossil fuel use per unit of output. Further initiatives designed to promote land use conversion must consider carbon values, in addition to the more immediate conservation benefits. The price range of $13.40 to $67 per ton of carbon results in PCP carbon sequestration values ranging from $72 million to $362 million. These values can be significantly further enhanced through management considerations and the inclusion of trees. There is an increasing appreciation of the multiple benefits of PCP and forages accruing not only to producers, but to society as well. The PCP contracts start expiring in the year 2000 and according to a prairie survey of PCP participants, 18% plan to return the land to annual cropping after the contract period (Western Opinion Research, 1994). Carbon gains are rapidly lost if the land is returned to annual crop production. The value of forages and their role in land use decisions to address environmental issues will remain an important challenge for agriculture. The challenge is to institute a mechanism, such as a carbon credit program, that allows society to encourage and reward environmentally positive practices, including conversion of cultivated marginal lands and continued maintenance of PCP and lands in permanent forages. Note: Values are presented as Canadian dollars.

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Table 1

	Method I					Method II	Method III		
PROVINCE	Hectares	Total Loss tonnes	tonnes/ha	kg/yr	Percent Loss	Percent Loss	Total Loss tonnes	tonnes/ha	Percent Loss
Alberta	144,190	2,559,783	17.75	209	24.5	24.9	2,591,737	17.97	25.1
Saskatchewan	179,837	2,872,194	15.97	188	23.6	22.5	2,015,500	11.21	22.2
Manitoba	54,935	1,453,453	26.46	311	25.5	26.0	1,116,877	20.33	25.6
Total	324,028	5,431,976	18.20	214	24.3	23.9	5,740,422	15.15	23.9