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Carbon prices and greenhouse gases abatement from agriculture, forestry and land use in Nepal

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ABSTRACT

The Agriculture, forestry and other land use (AFOLU) sector as a whole accounts for more than 80% of the total greenhouse gas (GHG) emission in Nepal. This study estimates the GHG emissions from the AFOLU sector in the business as usual (BAU) case during 2010–2050 and identifies the economically attractive countermeasures to abate GHG emissions from the sector at different carbon prices. It also estimates the carbon price elasticity of GHG abatement from the sector. The study finds that enteric fermentation processes in the livestock and emissions from agricultural soils are the two major contributors of GHG emission in AFOLU sector. It identifies no-regret abatement options in the AFOLU sector that could mitigate about 41.5% of the total GHG emission during 2016–2050 in the BAU scenario. There would be a net cumulative carbon sequestration of 16 million tonnes of carbon dioxide equivalent ($MtCO_2e$) at $10 per tonne of carbon dioxide equivalent (tCO_2e) during the period. Carbon price above $75/$tCO_2e$ is not found to be much effective in achieving significant additional reduction in GHG emissions from the AFOLU sector.

1. Introduction

The Agriculture, forestry and other land use (AFOLU) sector plays a predominant role in GHG emission/carbon sequestration in many developing countries although the sector is reported to contribute to about only one-fourth of the total greenhouse gas (GHG) emission at the global level. In the case of a low income developing country like Nepal, the AFOLU sector accounts for as high as over 80% of the total GHG emission. At the same time, the forestry sector is reported to have sequestered 69% of the total GHG emissions from the country (MOSTE, 2014).

At the 21st Conference of Parties (COP 21) of the United Nations Framework Convention on Climate Change (UNFCCC) held in Paris, the participating nations agreed to make their commitments towards reducing their GHG emission (also known as Nationally Determined Contributions (NDCs)). As the AFOLU sector is likely to continue playing a major role in developing countries for a considerable period of time in the future, identification of economically attractive GHG abatement/sequestration options and quantitative assessment of their future GHG mitigation/sequestration potential would be an important part of the process of determining NDCs in these countries. As such, such analyses would be of considerable interest to developing country climate policy makers.

There are a number of studies that have discussed the GHG emission mitigation options in the AFOLU sector of developed as well as developing countries (Jolley, 2006; Bates, 1998; USEPA, 2006; Graus et al., 2004; DeAngelao et al., 2006; Smith et al., 2008; FAO, 2013a; Hristov et al., 2013). USEPA (2013) quantified the baseline non-CO_2 emission up to 2030 and estimated the marginal abatement cost (MAC) curves and mitigation potential by sector and regions. Similar analysis was carried out for the agriculture sector in the year 2020 and 2050 by Graus et al. (2004). There are only a few studies in the context of Southeast and South Asian countries that have identified cost effective GHG abatement countermeasures in the AFOLU sector and their corresponding mitigation/sequestration potential (Hasegawa and Matsuoka, 2012, 2015; Hoa et al., 2014; Jilani et al., 2014). In a recent study, Hasegawa et al. (2016) have carried out a general equilibrium analysis of land-based mitigation measures in the case of Indonesia by integrating the AFOLU-B model with AIM/CGE model. IPCC

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(2014) estimated that the total economic mitigation potential in Asia in 2030 would be about 1.25 $GtCO_2e$ and 3.1 $GtCO_2e$ at carbon price of \$20 and \$100 per tCO_2e (According to IPCC (2014), economic potential refers to the mitigation that can be achieved at a given carbon price, but without taking into consideration any socio-cultural barriers in technology adoption.).

MOSTE (2014) estimates the GHG emission projection up to 2030 and suggests possible countermeasures for GHG abatement in the AFOLU sector of Nepal. MOPE (2016) has identified improvements in agricultural technology and practice as well as reducing deforestation as the priority areas for reducing GHG emissions as a part of preliminary NDCs in the AFOLU sector. Shrestha et al. (2013a) have estimated the non-energy related GHG emissions from the agriculture and forestry sectors in Nepal during 2005–2030; it has also estimated the GHG abatement cost and potential in these sectors for South Asia as a whole. However, the study does not consider the role of carbon price in determining the GHG abatement measures in the sector. A study by Freitas et al. (2014) has estimated GHG emissions during 2015–2030 based on historical trends and identified various countermeasures in the agriculture sector; however, it does not estimate their GHG abatement potential. To the authors' knowledge, there is no study in the existing climate change literature that has determined the cost effective countermeasures in the AFOLU sector under various carbon price scenarios and quantified their GHG abatement potential in the case of Nepal – a low income developing country. The present study assesses the GHG emissions from the AFOLU sector during 2010–2050 in the BAU scenario; it also identifies the optimal (i.e., profit maximizing) set of GHG mitigation/sequestration options from the sector at wide ranging values of the carbon price and estimates their corresponding GHG mitigation potential during the period. Further the present study estimates the carbon price elasticities of GHG mitigation at various values of the carbon price; these elasticity values reflect the relative effectiveness of the carbon price to mitigate the emissions in the respective price ranges.

The paper is divided into seven sections. The next section deals with the methodology. Section 3 describes the scenarios considered in the present analysis. This is followed by a discussion of the emission outlook in the BAU scenario while Section 5 discusses the optimal (i.e., profit maximizing) countermeasures at different carbon price scenarios and their mitigation/sequestration potential. Section 6 presents the carbon price elasticities of GHG emission at different carbon prices. The final section presents the conclusions as well as final remarks.

2. Methodology

This study has used a bottom-up model called "AFOLU-B model" to analyze the potential for GHG emission mitigation and sequestration of different options. The AFOLU-B was developed by researchers of Kyoto University and National Institute for Environmental Studies (NIES) (Hasegawa and Matsuoka, 2012). The AFOLU-B model comprises of two component bottom up models: one for the agriculture sector called "AG/Bottom-up model" and the other for land use, land use change and forestry (LULUCF) sector called "LULUCF/Bottom-up model" (see Fig. 1). The AFOLU-B model can be used for analysis at both national and regional levels. The greenhouse gases considered in the model include CO_2, CH_4 and N_2O.

The AG/Bottom-up model determines the profit maximizing set of countermeasures to be employed in the production of commodities or services as well as the corresponding GHG abatement potential at given commodity and carbon prices. The model requires three types of inputs: 1) future scenario of agricultural production, 2) per unit cost and potential of GHG reduction/carbon sequestration countermeasures and 3) emission taxes under consideration. It identifies the optimal (i.e., profit maximizing) countermeasures under a given emission tax. Total GHG emission is calculated as the sum of the emissions from different agricultural productions and the emission from each agricultural production activity is estimated as a product of the activity level (e.g., number of animals, crop area) and the corresponding emission factor. Note that the model deals only with non-energy GHG emissions from the sector.

The AG/Bottom-up model uses the level of domestic production of agricultural products as an exogenous input and determines the optimal countermeasures used to reduce GHG emissions in producing the estimated levels of agricultural products. Total profit is calculated as the sum of total revenue from agricultural products and revenue from energy recovery minus the total cost of production and mitigation. In this study, the revenue of energy recovery from the use of dome digester is considered to be the cost saving in cooking from biomass. The cost of production includes the cost of carbon emission, initial cost as well as the costs of labor and energy.

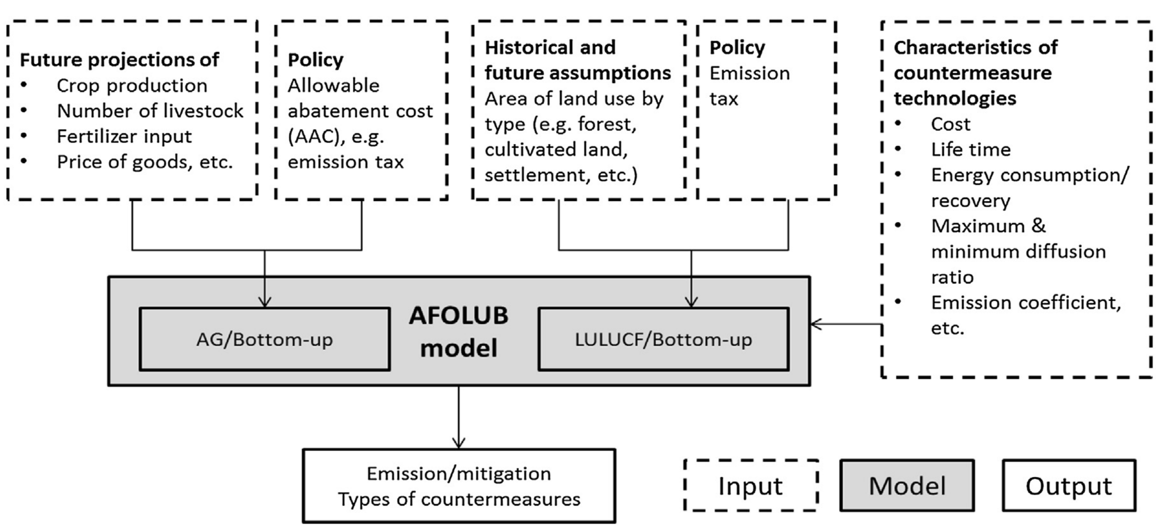

Fig. 1. Input and Output of AFOLU model (Hasegawa and Matsuoka, 2012).