

Table 2. Biomass estimates (above ground + below ground) used to calculate carbon savings and losses.

Land cover or land use	Carbon (10^6 g ha ⁻¹)	Reference(s)
Forest	130 ^a	Saatchi et al. 2007; Saatchi et al. 2009
	130	Houghton et al. 2001
Cerradão	98 ^a	Nogueira et al. 2008
	113 ^b	Saatchi et al. 2007
	195 ^c	Saatchi et al. 2007
Cerrado	13 ^a	Castro and Kauffman 1998
	33 ^b	Ministry of Science and Technology 2006
	45 ^c	Saatchi et al. 2009
Pasture (well managed)	10	Buschbacher et al. 1988

^a The low estimate used.

^b The estimate used here.

^c The high estimate used.

município, because a single farm may straddle two municípios and the cropland area will be reported in the município housing the farm headquarters. Comparing remote sensing results to the government estimates on a larger, aggregated level removed some of these smaller-scale artifacts.

2.4. Estimating greenhouse gas emissions

We used a bookkeeping model to calculate greenhouse gas emissions from the carbon losses associated with land-cover and land-use change as well as the nitrous oxide losses associated with nitrogen fertilizers applied in croplands. We focused on greenhouse gas emissions from the formation and fertilization of croplands. These components of the regional greenhouse gas budget have not been well studied to this point and compliment other well-studied components of the regional budget (e.g., DeFries et al. 2008; Steudler et al. 1996).

2.4.1. Carbon emissions from land-cover and land-use change

We estimated the biomass lost during land-use conversions to croplands by accounting for the area affected as determined from remote sensing inputs and for biomass per unit area for each of the major biome types using median values from the literature (Table 2). We assumed constant biomass values across each biome. In Mato Grosso, abandonment of croplands is rare (Rudel et al. 2005), so vegetation regrowth is not considered.

We assumed all natural biomass was completely lost by burning during land conversion because cultivation practices, such as plowing and harvesting with large machinery, require fields to be free of roots, stumps, and other forest remnants that could damage farm equipment. Unlike clearing for pastures, where some trees are left standing and many stumps and logs persist for decades, croplands are devoid of any signs of the former land cover.

Greenhouse gas emissions due to the loss of biomass in land-use transitions were calculated separately for forests and nonforest ecosystems. For forest clearing, carbon is released from biomass burning predominantly as carbon dioxide with a minor component released as methane (Andreae and Warneck 1994; Cofer et al.