

**Appendix 1.** Story line assumptions, scenario interpretation, and quantification of Carbiocial scenarios for MT/PA as well as BR-163 corridor.

**Table A1.1.** Translation of story line statements to model drivers (Trend Scenario).

Storyline Assumption	Scenario Interpretation	Quantification
<b>Population</b>		
population dynamics and growth continue according to agricultural pioneer frontier dynamics	population growth according to past observations	trend projection (method of the least squares) until 2030
<b>Agricultural Development</b>		
agricultural production is expanding and intensifying	agricultural production growth according to past observations	trend projection (method of the least squares) until 2030
livestock numbers continue to rise	livestock number growth according to past observations	trend projections (method of the least squares) until 2030
<b>Land-use policy</b>		
conversion of natural ecosystems is taking place	no further constraint regarding conversion of natural ecosystems	transition probability forest: 50% (due to cost of conversion) transition probability Cerrado: 70% (due to cost of conversion)
law enforcement in place but rather inefficient due to resource deficiency	MT/PA: no further land-use change in protected areas (strictly protected, sustainable use, military, indigenous)  BR-163 corridor: some land-use changes may occur in strictly protected areas and sustainable use areas	MT/PA: land-use type within protected areas is not changed  BR-163 corridor: no land conversion within protected areas; every second year: land conversion allowed within areas of sustainable use; every fourth year: land conversion allowed within strictly protected areas
infrastructural development continues as planned: BR-163 paved	BR-163 will be paved from Cuiabá to Satarém	BR-163 is integrated into database road-map layer as paved road

**Table A1.2.** Translation of story line statements to model drivers (Legal Intensification Scenario).

Story line Assumption	Scenario Interpretation	Quantification
<b>Population</b>		
population dynamics and growth continue according to agricultural pioneer frontier dynamics	population growth according to past observations	trend projection (method of the least squares) until 2030
<b>Agricultural Development</b>		
agricultural production is expanding and intensifying	agricultural production is expanding and intensifying further accelerated due to demand from Asian countries	trend projections (method of the least squares) until 2030 + additional growth according to population growth in Asian countries
livestock numbers continue to rise	livestock numbers continue to rise further accelerated due to demand from Asian countries	trend projections (method of the least squares) until 2030 + additional growth according to population growth in Asian countries
tendency toward intensification of pasture management	increases of livestock production are realized through intensification rather than expansion of productive land to an increasing extent	net primary productivity of pasture cells is successively increased until 2030 (MT: +9% per time step, max: +50%; PA: +4.5% per time step, max: +30%)
<b>Land-use policy</b>		
conversion of natural ecosystems is taking place	no further constraint regarding conversion of natural ecosystems	transition probability forest: 50% (due to cost of conversion) transition probability Cerrado: 70% (due to cost of conversion)
effective law enforcement	no further land-use change in protected areas (strictly protected, sustainable use, military, indigenous)	MT/PA: land-use type within protected areas is not changed  BR-163 corridor: and-use according to TerraClass land cover classification
conversion of forest according to Brazilian Forest Code	of every converted forest cell, a portion of 80% remains unchanged while 20% are converted into agricultural land	MT/PA: all newly established agricultural land-use on former forest cells as mosaic land-use type ( <i>Mosaic "Legal Reserve"</i> ) 20% cropland or pasture/80% rainforests  BR-163 corridor: 80% of available forest cover per municipality remains forest throughout simulation
infrastructural development continues as planned: BR-163 paved	BR-163 will be paved from Cuiabá to Satarém	BR-163 is integrated into database road-map layer as paved road

**Table A1.3.** Translation of story line statements to model drivers (Illegal Intensification Scenario).

Story line Assumption	Scenario Interpretation	Quantification
<b>Population</b>		
population dynamics and growth continue according to agricultural pioneer frontier dynamics	population growth according to past observations	trend projection (method of the least squares) until 2030
<b>Agricultural Development</b>		
agricultural production is expanding and intensifying	agricultural production is expanding and intensifying further accelerated due to demand from Asian countries	trend projections (method of the least squares) until 2030 + additional growth according to population growth in Asian countries
livestock numbers continue to rise	livestock numbers continue to rise further accelerated due to demand from Asian countries	trend projections (method of the least squares) until 2030 + additional growth according to population growth in Asian countries
tendency toward intensification of pasture management	increases of livestock production are realized through intensification rather than expansion of productive land to an increasing extent	net primary productivity of pasture cells is successively increased until 2030 (MT: +9% per time step, max: +50%; PA: +4.5% per time step, max: +30%)
<b>Land-use policy</b>		
conversion of natural ecosystems is taking place	no further constraint regarding conversion of natural ecosystems	transition probability forest: 50% (due to cost of conversion) transition probability Cerrado: 70% (due to cost of conversion)
ecological protected areas are used for illegal agricultural expansion; sporadic law enforcement	MT/PA: no land use within protected areas (military, indigenous); land use/land use change allowed in ecological protected areas  BR-163 corridor: road between BR-163 and Terra do Meio protected areas are used for illegal agricultural expansion	MT/PA: land-use type within military/indigenous areas is not changed; land-use type within ecological protected areas may change  BR-163 corridor: road construction between Novo Progresso and Felix do Xingu; military/indigenous areas considered protected; sustainable use, strictly protected and riparian protected areas not protected
infrastructural development continues as planned: BR-163 paved	BR-163 will be paved from Cuiabá to Satarém	BR-163 is integrated into database road-map layer as paved road

**Table A1.4.** Translation of story line statements to model drivers (Sustainable Development Scenario).

Story line Assumption	Scenario Interpretation	Quantification
<b>Population</b>		
population growth stabilizing; less migration of land-less from other Brazilian regions	population growth rate decreasing	trend projections (method of the least squares) until 2030 – growth rate correction (MT: -10%; PA: -5%) per time-step
<b>Agricultural Development</b>		
agricultural production specializing on fresh products (niche market); the better the development of trade structures, the stronger smallholder and medium business production	agricultural production focusing on production of vegetarian products; focus on crops for domestic use; focus away from cash crops	trend projections (method of the least squares) until 2030 + additional production growth (pulses, fruits, vegetables, soy); production correction of soybean (exported fraction) due to less export demand
worldwide trend toward vegetarian diet	livestock numbers decrease considerably; meat consumption substituted by vegetarian products	trend projections (method of the least squares) until 2030 -70% of total livestock numbers due to healthy and sustainable diet
high intensification regarding agricultural practices	crop yield data increases further	crop yield growth adapted by an additional +30% of crop biomass over 30 years
<b>Land-use policy</b>		
effective law enforcement; Soy Moratorium continues after 2016; Cattle Moratorium continues after 2019	MT/PA: conversion of areas defined as Cerrado less likely to happen; conversion of forest areas not possible;  BR-163 corridor: Soy Moratorium prohibits the conversion of deforested lands to cropland after 2006; Cattle Moratorium prohibits conversion of deforested land to pasture after 2009	MT/PA: transition probability forest: 0%; transition probability Cerrado: 30%;  BR-163 corridor: no conversion to cropland on areas deforested after 2006; no conversion to pasture on areas deforested after 2009
protected areas continue to play an important role in conservation of natural ecosystems	MT/PA: no further land-use change in protected areas (strictly protected, sustainable use, military, indigenous)	MT/PA: land-use type within all protected areas is not changed
infrastructural development continues as planned: BR-163 paved	BR-163 will be paved from Cuiabá to Satarém	BR-163 is integrated into database road-map layer as paved road

**Table A1.5.** Population development in Pará and Mato Grosso; population numbers in 2010 and change rates until 2030.

State	2010	Change 2010 – 2030 [%]		
	Population	Trend	Legal/Illegal Intensification	Sustainable Development
Pará	6,913,180	+35	+35	+32
Mato Grosso	2,795,890	+35	+35	+29

**Table A1.6.** Agricultural development.

	Crop type	Crop yield				Crop production			
		[t/ha]	Change 2010 – 2030 [%]			[kt]	Change 2010 – 2030 [%] <sup>1</sup>		
	2010	Trend	Legal/Illegal Intensification	Sustainable development	2010	Trend	Legal/Illegal Intensification	Sustainable development	
Pará	Fruits	16.05	+42.35	+42.35	+85.06	740.67	+123.52	+123.52	+273.58
	Maize	3.81	+70.32	+70.32	+121.42	519.25	+89.36	+129.13	+55.59
	Groundnut	2.1	+40.37	+40.37	+82.48	0.19	+109.73	+109.73	+57.93
	Beans	0.76	+49.41	+49.41	+94.23	36.49	+146.83	+146.83	+1978.76
	Rice	2.64	+61.56	+61.56	+110.03	263.87	+145.35	+145.35	+125.74
	Cassava	16.49	+45.92	+45.92	+89.70	4596	+67.11	+67.11	+88.82
	Soybean	2.86	+39.16	+39.16	+80.91	243.61	+177.75	+236.07	+2447.96
	Sugarcane	81.31	+51.40	+51.40	+96.82	668.74	+8.12	+8.12	+8.12
Mato Grosso	Fruits	16.05	+42.35	+42.35	+85.06	57.77	+226.64	+226.64	+542.83
	Maize	3.81	+70.32	+70.32	+121.42	8164	-0.53	+20.36	+69.15
	Groundnut	2.1	+40.37	+40.37	+82.48	4.52	-13.19	-13.19	+55.02
	Beans	0.76	+49.41	+49.41	+94.23	133.81	-24.39	-24.39	+701.28
	Rice	2.64	+61.56	+61.56	+110.03	686.3	+97.44	+97.44	+125.74
	Cassava	16.49	+45.92	+45.92	+89.70	496	+8.79	+8.79	+103.03
	Soybean	2.86	+39.16	+39.16	+80.91	4921	+42.05	+71.88	+119.70
	Sugarcane	81.31	+51.40	+51.40	+96.82	9390	+71.88	+71.88	+71.88

<sup>1</sup> high change rates (beans, soy) due to substitution of dietary meat intake and relatively low production values in 2010