Supplement to Selected Paper #470282

AJAE appendix for Biofuels and Rural Economic Development in Latin America and the Caribbean

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Annex 1. Fundamental Economic Indicators Latin America and the Caribbean

Table1.1 Selected Fundamental Economic Indicators for Latin America and the Caribbean

Country	GDP (Millions, Constant 2000 US$)	Population in 2004 (Millions)	Annual Population Growth (%)	Expected Population 2050 (Millions)	Average GDP per capita 2000-2004 (Millions, 2000 international dollars)	Value added agriculture (% of GDP)	Industry Value Added (% of GDP)
Argentina	275,606	38	1.0	49	7,168	7	32
Bolivia	9,081	9	2.0	14	1,015	16	30
Brazil	636,319	179	1.4	228	3,480	9	37
Chile	84,756	16	1.2	19	5,136	6	42
Colombia	91,018	44	1.6	65	2,019	13	32
Costa Rica	17,573	4	2.1	6	4,136	11	30
Dom. Republic	21,322	9	1.5	14	2,455	12	31
Ecuador	18,452	13	1.5	20	1,370	12	29
El Salvador	13,978	7	1.9	12	2,090	12	32
Guatemala	20,711	12	2.4	23	1,723	23	19
Honduras	6,559	7	2.4	13	939	18	31
Mexico	602,730	101	1.5	148	5,871	5	27
Nicaragua	4,260	5	2.0	9	799	21	30
Panama	12,745	3	1.9	5	3,979	8	17
Paraguay	8,070	6	2.4	15	1,380	24	25
Peru	58,539	27	1.5	38	2,098	10	30
Uruguay	19,608	3	0.7	4	5,723	8	26
R. B. Venezuela	116,948	25	1.8	37	4,530	5	49
Average for all countries in Latin America/Caribbean	112,126	28	2	40	3,106	12	31

Source: WB World Development Indicators 2006 and FAOSTAT (2007)

Table 1.2 Selected Land Availability Indicators

Country	Land Area (Km^2)	Arable Land (1000 ha)	Arable and permanent Crops (1000 Ha)	% Arable Land (% of Land Area)	Irrigated land (% of cropland)
Argentina	2,736,690	27,367	28,900	10	5
Bolivia	1,084,380	3,253	3,256	3	4
Brazil	8,459,420	59,216	66,600	7	4
Chile	748,800	2,246	2,307	3	82
Colombia	1,038,700	2,077	3,850	2	23
Costa Rica	51,060	204	525	4	21
Dominican Rep.	48,380	1,113	1,596	23	17
Ecuador	276,840	1,661	2,985	6	29
El Salvador	20,720	663	910	32	5
Guatemala	108,430	1,410	2,050	13	6
Honduras	111,890	1,119	1,428	10	6
Mexico	1,908,690	24,813	27,300	13	23
Nicaragua	121,400	1,942	2,161	16	3
Panama	74,430	521	695	7	6
Paraguay	397,300	3,178	3,136	8	2
Peru	1,280,000	3,840	4,310	3	28
Uruguay	175,020	1,400	1,412	8	14
Venezuela	882,050	2,646	3,400	3	17
TOTAL	19,524,200	138,669	156,821	-	-

Notes: a) Source: FAOSTAT(2007), b) Indicators estimated as averages from years 2003-2005, except for Arable and Permanent Crops which is for year 2003.

Annex 2. Estimation of ethanol/biodiesel potential based on current area and yield

Formula for Ethanol

The current maximum ethanol production achievable in crop i and country j (CPE_{ij}) is defined as:

$$CPE_{ij}^{max} = \left(\frac{Aij \times Yij \times C}{1 + E} \right)$$

where, A_{ij} is the area harvested to crop i in country j, Y_{ij} is the yield per hectare of crop i in country j, C is the ethanol yield per ton of feedstock. E is a variable that measures the volume displacement of ethanol compared to gasoline. We used a value of 15% based on our review of literature. Values used in our estimations for variable C is presented in Table A1-1.

Formula for Biodiesel

The current maximum biodiesel production achievable in crop i and country j (PB_{ij}) is defined as:

$$CPB_{ij}^{max} = \left(Aij \times Yij \times OC \times BY \times F \right)$$

where A_{ij} is the area harvested to crop i in country j, Y_{ij} is the yield per hectare of crop i in country j, OC is the oil content of the feedstock expressed as a percent are presented in Table A1-1. BY is the biodiesel yield from oil, equivalent to 80%. F is a conversion factor converting Kilograms of oil per hectare to liters of oil per hectare equivalent to 1.19.

Table A1-1Ethanol and Biodiesel Yields per Ton of Feedstock Used in Estimations

Feedstock	Ethanol yield per ton of feedstock (lt/ton)	Value range for ethanol yields	Oil content of feedstocks for biodiesel production (% Oil)	Value range for oil content of feedstocks	Biodiesel yield per ton of feedstock (lt/ton)
Cassava	200	200-280			
Maize	400	396-400			
Sorghum	359				
Sugar Cane	75	75-85			
Wheat	362				
Sugar beet	98				
Cottonseed			18	18-22	274
Soybeans			20	18-22	304
Rapeseed			40	38-45	608
Oil palm fruit			22	18-22	334

Notes: a) C=Ethanol yield per ton of feedstock, b) OC= Oil content of feedstocks for biodiesel

Table A1.2 Current Area Harvested of Potential Target Crops by Country

Country	**Cassava**	**Cotton**	**Maize**	**Oil palm fruit**	**Sorghum**	**Soybean**	**Sugar Cane**	**Wheat**	**Sugar Beet**
Argentina	17	258	2,481	0	522	13,595	302	7,453	0
Bolivia	36	80	315	0	64	841	107	110	0
Brazil	1,758	632	12,324	54	826	21,006	5,598	2,576	0
Chile	0	0	124	0	0	0	0	419	29
Colombia	178	70	645	159	76	40	426	22	0
Costa Rica	21	0	0	0	0	0	49	0	0
Dom. Rep.	15	0	27	10	2	0	90	0	0
Ecuador	22	4	449	133	6	52	90	13	1
El Salvador	2	2	237	0	90	1	62	0	0
Guatemala	5	1	603	21	43	12	189	5	0
Honduras	4	1	318	45	41	81	75	2	0
México	2	93	7,272	14	1,801	3	638	586	0
Nicaragua	12	2	368	2	48	0	45	0	0
Panamá	2	0	68	6	2	1,772	33	0	0
Paraguay	293	244	428	13	13	1	67	302	0
Perú	88	36	469	11	0	0	70	131	0
Uruguay	0	0	48	0	17	201	3	151	0
Venezuela	45	17	639	24	250	1	138	0	1
TOTAL	2,500	1440	26,815	492	3,801	37,606	7,982	11,770	31

Source: Area Harvested (Av. 2003-5, 1,000 ha) in FAOSTAT (2007)

Table A1.3 Yields of Potential Target Crops by Country

Country	Cassava	Cotton seed	Maize	Oil palm fruit	Sorghum	Soybeans	Sugar Cane	Wheat	Sugar Beet
Argentina	10.0	0.8	6.7	-	4.9	2.6	64.5	24.0	-
Bolivia	10.1	0.6	2.1	-	2.6	1.9	46.8	10.0	-
Brazil	13.6	2.0	3.4	10.1	2.2	2.6	72.2	19.0	-
Chile	0.0	-	10.8	-	-	-	-	43.0	-
Colombia	10.9	0.9	2.6	18.7	3.6	2.1	88.7	20.0	-
Costa Rica	15.0	0.5	1.9	14.5	1.4	-	75.6	-	-
Dominican Republic	6.8	-	1.4	15.3	2.1	-	47.7	-	-
Ecuador	4.1	0.4	1.8	13.5	1.8	1.8	73.9	7.0	58.0
El Salvador	11.6	0.7	2.8	-	1.6	2.3	76.4	-	-
Guatemala	3.2	1.1	1.8	28.5	1.2	2.9	93.6	21.0	-
Honduras	3.7	1.1	1.5	25.3	1.0	1.9	71.3	5.0	-
Mexico	15.0	1.9	2.8	15.9	3.5	1.5	73.5	48.0	427.0
Nicaragua	8.8	1.2	1.4	24.6	2.0	2.0	88.1	-	-
Panama	12.5	-	1.3	10.4	3.4	0.8	49.0	-	-
Paraguay	17.0	0.6	2.3	9.6	1.9	2.4	42.0	17.0	-
Peru	10.9	1.1	2.7	18.4	2.8	1.6	114.5	13.0	-
Uruguay	-	-	4.6	-	4.1	2.1	52.2	22.0	-
Venezuela	11.7	0.7	3.2	12.0	2.1	2.8	67.2	3.0	190.0
AVERAGE	8.7	0.8	3.1	12.0	2.3	1.7	72.4	14.0	37.5

Notes: a) Source is FAOSTAT (2007), b) Yield is estimated as the average for years 2003-5, c) Yield units are ton/ha

Annex 3 Estimates of Maximum Production and Share of Production to Meet Ethanol and Biodiesel Demand for Selected Target Countries and Crops

Table A2-1 Maximum Production and Share of Production to Meet Ethanol Demand for Selected Target Countries and Crops Using Fixed per Hectare Yield of Ethanol

				Sugar cane			**Cassava**			**Maize**	
Ethanol	**Mandatory or projected ethanol standard (% of motor gas)**	**Ethanol required to meet mandatory or projected standard (1000 lts /year)**		**If all targeted crop area was used for ethanol (1,000 lts)**	**% current production to meet standards**		**If all targeted crop area was used for ethanol (1,000 lts)**	**% current area to meet standards**		**If all targeted crop area was used for ethanol (1,000 lts)**	**% current area to meet standards**
Argentina	0.05	246,493		1,960,833	13		85,000	290		7,690,697	3
Bolivia	0.20	137,797		695,998	20		179,667	77		977,678	14
Brazil	0.23	3,704,658		36,388,192	10		8,791,450	42		38,205,630	10
Chile		0		0	0		0	0		385,020	0
Colombia	0.10	538,032		2,765,923	19		888,700	61		1,998,746	27
Costa Rica	0.07	55,065		316,788	17		105,300	52		22,031	250
Dominican Republic	0.05	67,746		585,195	12		75,050	90		84,454	80
Ecuador		0		584,567	0		110,833	0		1,390,732	0
El Salvador	0.09	50,657		399,750	13		7,933	639		733,925	7
Guatemala	0.10	106,874		1,230,667	9		25,000	427		1,869,300	6
Honduras	0.30	129,795		490,187	26		21,167	613		987,267	13
Mexico	0.10	3,411,838		4,148,863	82		8,000	42,648		22,542,001	15
Nicaragua		0		293,388	0		60,400	0		1,141,162	0
Panama	0.10	54,658		213,352	26		11,267	485		211,875	26
Paraguay	0.20	45,028		436,497	10		1,467,300	3		1,325,446	3
Peru	0.08	86,430		455,260	19		440,033	20		1,455,088	6
Uruguay		0		20,518	0		0	0		149,265	0
Venezuela	0.10	1,209,386		894,205	135		226,967	533		1,981,365	61

Table A2-2 Maximum Production and Share of Production to Meet Biodiesel Demand for Selected Target Countries and Crops Using Fixed per Hectare Yield of Biodiesel

				Palm oil			Soybeans			Cotton seed	
Biodiesel	**Mandatory or projected biodiesel standards (as % of diesel)**	**Biodiesel required to meet mandatory or projected standard (Million lts/year)**		**If all targeted crop area was used for biodiesel (Million lts)**	**% current area to meet standards with palm oil**		**If all targeted crop area was used for biodiesel (Million lts)**	**% current area to meet standards**		**If all targeted crop area was used for biodiesel (Million lts)**	**% current area to meet standards**
Argentina	0.05	332		0	0		9,517	3		144	230
Bolivia	0.10	46		0	0		589	8		45	104
Brazil	0.05	1,366		287	476		14,704	9		354	386
Chile		0		0	0		0	0		0	0
Colombia	0.05	103		843	12		28	365		39	264
Costa Rica		0		247	0		0	0		0	0
Dominican Republic		0		55	0		0	0		0	0
Ecuador		0		703	0		37	0		2	0
El Salvador		0		0	0		1	0		1	0
Guatemala		0		110	0		9	0		1	0
Honduras		0		239	0		57	0		1	0
Mexico		0		74	0		2	0		52	0
Nicaragua		0		12	0		0	0		1	0
Panama		0		33	0		1,240	0		0	0
Paraguay		0		70	0		1	0		136	0
Peru		0		56	0		0	0		20	0
Uruguay	0.05	26		0	0		141	19		0	0
Venezuela	0.05	84		129	65		1	8,144		10	875

Annex 4 Institutions and Governance Issues

Table 3.14 Selected Institutional and Governance Indicators

Country	Biofuels Regulatory framework in place	Biofuels related laws	Incentives and Tax Breaks	Mandatory fuel blending standards	Year starting	Potential crop	Foreign investment	Operational ethanol distilleries	R&D investment
Argentina		Ley de Biocombustibles (SFL) 26-093 2006	Exempt of assumed minimum gain tax and hydrological infrastructure rates	5% (art 7 & 8, SFL), equivalent to 600 mill lt biodiesel 250 mill lt ethanol	2010		Repsol, Probable Japan Mitsui	20	Repsol, plans for a Research Center
Bolivia		Regulations approved by congress		10-25% alconafta	2010	Sugarcane		0	very little
Brazil	Brazilian National Alcohol Program, ProAlcóol, launched in 1975	Strong government involvement and investment. Innovation Law of 2004. States programs with own incenstives.	Many incentives in place, reinforced in 1993, along with deregulation of the sector	Mandatory since 1993, 20-25% for ethanol, and 3% for biodiesel for 2008	1993	Sugarcane. Palm oil, Cotton, Castor	Substantive investing from France and Japan firms, as well as from many other countries.		Ministry of S&T has invested heavily in the sector (i.e. in 2004 invested $4 mill in biofuels related programs). Private sector plays a major role investing R&D (around least 75% of total)
Chile		Biofuels under development, Renewables Law 2003				Rapeseed?	Petrobras has shown interest		
Colombia	2004 first steps to develop	Law 693 2001. Law 788 2002, other regulations	no VAT	10% ethanol blend	25% target next 20 years	African palm for biodiesel, sugarcane and cassava for ethanol	Svenks ethanol / signed agreement between Ecopetrol and Petrobras	5	Corpodip

Costa Rica		Law 7447 1994		Established in 2005, declared unconstitutional later					
Dominican Republic		Decree 732 2002	100% tax exemptions, grants10 year income tax holiday for business	5% ethanol	2006				
Ecuador		Decree 2332 (Programa de Biocombustibles		5% ethanol (one city) 10% biodiesel	2006 ?				
El Salvador		in the making	tariff-free imports, and tax exemptions	8 to 10% ethanol	2007				
Guatemala	lack of a clear reg. framework			(5% min ethanol, for new distilleries, currently producing at 10%)					
Honduras	draft of legal framework						Grupo Pellas (Nicaragua) to invest $150 mill sugarcane for ethanol.		All run by foreign investors
Mexico	2006		VAT exempts, plus others	8% renewable energy use	2012				
Nicaragua	None	biofuels declared a national strategic interest (Decree 42 2006)							Nat. U of Engineering and Petronic researched alternatives Jatropha
Panama	None			Proposed 10% blend	2008				
Paraguay	Launched ethanol program in 1999	Biofuel Law 2005	reduced standard fuel tax of 50% to 10%	20% raised to 24%					

Peru	2003 PMB Law, 2005 Supreme decree 03	Program for biofuels promotion		7.8% ethanol 5% biodiesel	Current				
Uruguay	2003 law 17-567	national biofuels commission							
Venezuela	None	Plan 474 2006, sugarcane							

Table 3.15 Selected Indicators of Innovative Capacity

Country	R&D expenditures (% of GDP)	Researchers in R&D (Number per million people)	Public expenditure on education(% of GDP)	Average publications scientific/tech. journals 1986-1999 (Number)	Number of Personal Computers (Number per 1,000 persons)	Enrollment in third level education (Number)	Enrollment in third level education per million inhabitants (Number per million persons)
Argentina	0.42	706	4.2	1837	81	1,953,453	51,901
Bolivia	0.29	97	6.0	18	24	315,146	36,382
Brazil	0.97	344	4.3	3166	75	3,370,900	18,843
Chile	0.58	423	4.0	838	114	530,429	33,632
Colombia	0.18	93	4.8	149	50	1,000,065	22,978
Costa Rica	0.36	n.a.	4.8	62	197	81,277	19,853
Dom. Rep.	n.a.	n.a.	2.1	7	0	290,260	34,087
Ecuador	0.06	45	1.2	22	35	206,541	16,301
El Salvador	0.08	39	2.7	2	29	114,954	17,625
Guatemala	n.a.	n.a.	n.a.	20	15	111,739	9,533
Honduras	0.05	n.a.	n.a.	6	13	108,094	16,045
Mexico	0.40	248	5.3	1585	83	2,143,461	21,254
Nicaragua	0.05	n.a.	3.5	7	30	100,140	19,389
Panama	0.35	97	4.4	34	38	122,510	40,000
Paraguay	0.09	83	4.6	6	36	117,623	20,485
Peru	0.10	n.a.	2.9	66	59	847,856	31,684
Uruguay	0.25	287	2.7	84	115	98,579	29,073
R. B. Venezuela	0.38	n.a.	n.a.	389	62	859,720	34,090

Notes: Sources: a) USAID-LAC Social and Economic Indicators (2007), UNESCO (2007), CEPAL/ECLA (2006), World Bank Development Indicators (2006). b) Enrollment in third level education per million persons was estimated by authors from data contained in sources cited previously. c) Indicators presented here are averages from 2001-2003, with the exception of enrollment in third level education which is for 2003.

Annex 5 Energy Indicators

Table 3.7 Selected Indicators of Energy Security by Country

Country	Oil production (Thousand barrels per day)	Petroleum consumption (Thousand barrels per day)	Energy imports, net (% of energy use)	Total electricity consumption, net (Billion Kwt-hrs)	Electricity consumption per capita (Kwt-hrs per person)	Primary energy consumption per dollar of GDP using Purchasing Power Parities, Total (Btu per 2000 U.S. Dollars)	Energy use (kt of oil equivalent)
Argentina	866	458.2	-41	83.5	2,220	6,409	58,195
Bolivia	39	46.7	-63	3.7	432	6,853	4,384
Brazil	1,848	2133.3	18	354.3	1,980	6,279	190,161
Chile	17	235.3	67	42.9	2,723	5,983	25,941
Colombia	555	269.7	-159	40.5	931	4,201	28,099
Costa Rica	-0.3	40.8	53	6.5	1,581	4,927	3,526
Dominican Rep.	0.01	124.1	81	10.3	1,214	5,856	7,983
Ecuador	411	143.9	-162	10.8	850	6,832	8,847
El Salvador	-0.5	40.9	46	4.1	623	6,189	4,352
Guatemala	22	65.6	27	5.7	483	3,292	7,330
Honduras	0	35.7	52	4.1	614	5,973	3,420
Mexico	3,799	1969.2	-50	188.8	1,872	6,489	155,807
Nicaragua	-0.4	25.9	44	2.4	464	1,062	2,898
Panama	0	78.4	73	4.7	1,543	8,627	2,687
Paraguay	-0.03	25.5	-65	2.4	412	14,651	3,940
Peru	92	154.1	23	20.0	747	4,129	12,047
Uruguay	0.5	36.5	56	7.3	2,161	5,108	2,577
R. B. Venezuela	2,581	553.9	-266	81.8	3,243	16,578	56,088

Notes: a) Oil Production includes the production of crude oil, natural gas plant liquids, and other liquids, and refinery processing gains. Negative data values indicate net refinery processing losses, b) Source is the International Energy Annual 2005 – IEA (2005)

Table 3.8 Selected Indicators of Energy Security and Environmental Drivers by Country

Country	Crude oil imports (1000s barrels per Day)	Apparent consumption of motor Oil (1000s Barrels per Day)	Dry natural gas production (1000s Barrels per Day)	Natural gas plant liquids production (Trillion Cubic Feet)	Carbon dioxide emissions from the consumption of petroleum (million metric tons of carbon dioxide)	Carbon dioxide emissions from the consumption of petroleum per capita (Metric tons of carbon dioxide per person)
Argentina	32.7	84.9	1.58	64.4	64.9	1.72
Bolivia	-	11.9	0.35	12.5	6.8	0.79
Brazil	351.2	277.5	0.34	61.5	257.7	1.44
Chile	200.2	48.7	0.04	5.0	31.8	2.02
Colombia	1.2	92.7	0.22	4.0	36.5	0.84
Costa Rica	10.6	13.6	-	-	6.0	1.47
Dom. Rep.	41.8	23.3	-	-	18.2	2.14
Ecuador	-	41.9	0.01	2.0	20.3	1.60
El Salvador	20.1	9.7	-	-	6.1	0.94
Guatemala	-	18.4	-	-	9.6	0.82
Honduras	-	7.5	-	-	5.6	0.83
Mexico	-	587.9	1.46	442.0	253.0	2.51
Nicaragua	17.9	3.9	-	-	4.2	0.81
Panama	-	9.4	-	-	12.8	4.18
Paraguay	1.6	3.9	-	-	3.9	0.68
Peru	83.6	19.1	0.03	14.2	22.4	0.84
Uruguay	32.8	5.8	-	-	5.6	1.65
Venezuela	-	208.4	0.96	180.0	75.0	2.97

Notes: Source of crude oil imports and apparent consumption of motor oil is EIA (2003). Rest of indicators in table extracted from EIA (2004), b) Emissions per capita of carbon dioxide is estimated from data in total emissions divided by population totals in Table 3.1.

Annex 6. Technical and Methodological Issues Related to IMPAC-WATER Approach

In this technical annex, we discuss the methodological approach that was used in the forward-looking modeling analysis of biofuel growth impacts, in more detail. We describe the partial-equilibrium modeling framework of IMPACT-WATER, itself, as well as the quantitative approach that is taken to assess malnutrition impacts that are associated with each of the scenarios.

Given the importance of assessing the potential impacts of large-scale expansion of bio-fuel production on food security and poverty both globally as well as in Latin America and the Caribbean, we make use of a global modeling framework that can capture important linkages between regions of high demand growth in energy and those with rapidly developing potential in bio-energy supply and agricultural growth. While a simplified representation of ethanol and biodiesel trade are embedded into the model framework, a land use modeling component could not be integrated with the market equilibrium modeling of agricultural supply and demand within the short timeline of this study. Nevertheless, we feel that the results that are presented in this desk study are adequately representative of the types of impacts that might be expected under the scenarios presented.

Description of IMPACT-WATER Model

In this section we describe the main features of the IMPACT-WATER model, which represents a central component of the quantitative approach used in this study. In particular, we highlight the way in which it is adapted to study the growth potential of biofuel production within Latin America.

IFPRI developed the global food projection model: the International Model for Policy analysis of Agricultural Commodities and Trade or IMPACT, in the beginning of the nineties. Its development was motivated by a lack of a long-term vision and consensus about the actions that are necessary to feed the world in the future, reduce poverty, and protect the natural resource base. In 1993, these same long-term global concerns launched the 2020 Vision for Food, Agriculture and the Environment Initiative. This initiative created the opportunity for further development of the IMPACT model, and in 1994 the first results from the IMPACT model were published as a 2020 Vision discussion paper: World Supply and Demand Projections for Cereals, 2020 (Agcaoili-Sombilla and Rosegrant, 1994).

Since then, the IMPACT model has been used for a variety of research analyses which link the production and demand of key food commodities to national-level food security. For example, the paper Alternative Futures for World Cereal and Meat Consumption (Rosegrant, Leach and Gerpacio, 1999), examines whether high-meat diets in developed countries limit improvement in food security in developing countries, while the article Global Projections for Root and Tuber Crops to the Year 2020 (Scott, Rosegrant and Ringler, 2000) gives a detailed analysis of roots and tuber crops. Livestock to 2020: The next food revolution (Delgado et al., 1999) assesses the influence of the livestock revolution, which was triggered by increasing demand through rising incomes in developing countries the last decade.

IMPACT also provided the first comprehensive policy evaluation of global fishery production and projections for demand of fish products in the book Fish to 2020: Supply and Demand in Changing Global Markets (Delgado, Wada, Rosegrant, Meijer and Ahmed, 2003). Besides these global projections, regional studies have also been completed such as Asian Economic Crisis and the Long-Term Global Food Situation (Rosegrant and Ringler, 2000) and

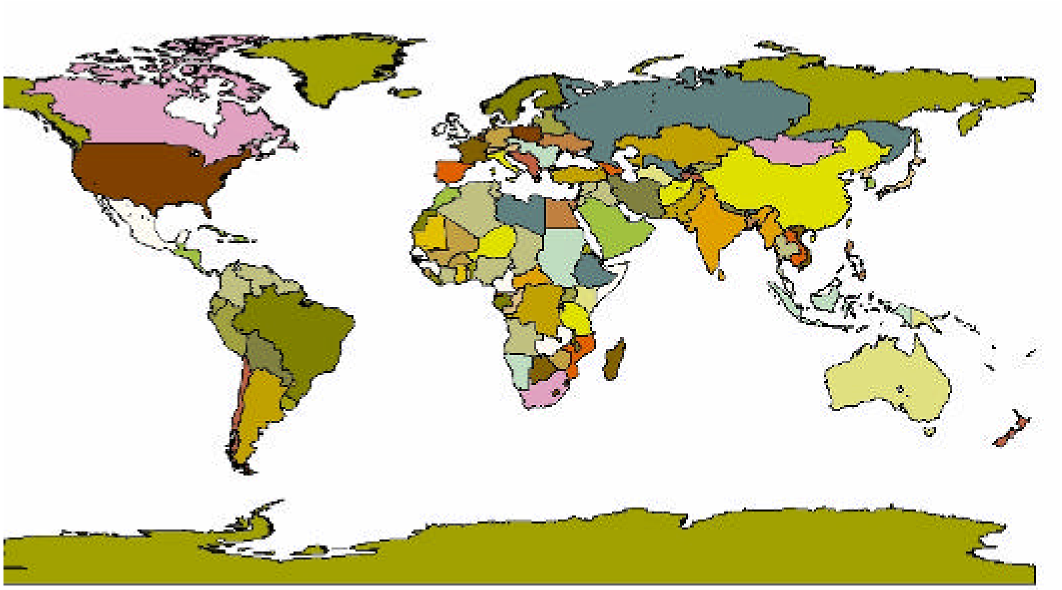
Transforming the Rural Asian Economy: the Unfinished Revolution (Rosegrant and Hazell, 2000). These studies were a response to the Asian financial crisis of 1997 and analyzed the impact of this crisis on future developments of the food situation in that region.

More recently, the IMPACT model has been applied to looking at scenario-based assessments of future food production and consumption trends, under both economic and environmentally-based drivers of change. The most comprehensive set of results from the IMPACT model were published in the book Global Food Projections to 2020 (Rosegrant et al., 2001), which gives a baseline scenario under which the best future assessment of production and consumption trends are given, for all IMPACT commodities. In addition to the baseline, alternative scenarios are also offered, based on differing levels of productivity-focused investments, lifestyle changes and other policy interventions. These scenarios describe changes that are both global as well as regional in nature – such as those which are specific to meeting the MDG goals in Sub-Saharan Africa (Rosegrant et al., 2005). Policy analyses based on alternative scenarios that are more environmentally-focused were published in an IFPRI book titled World Water and Food to 2025: Dealing with Scarcity (Rosegrant, Cai and Cline, 2002). The version of IMPACT that was used to generate the results for this study (IMPACT-WATER) will be used to discuss the scenarios examined in this study.

The Modeling Methodology of IMPACT

IFPRI's IMPACT model offers a methodology for analyzing baseline and alternative scenarios for global food demand, supply, trade, income and population. IMPACT coverage of the world's food production and consumption is disaggregated into 115 countries and regional groupings (see figure A6-1 below), and covers 32 commodities, including all cereals, soybeans, roots and tubers, meats, milk, eggs, oils, oilcakes and meals, vegetables, fruits, sugarcane and beet, and cotton. Most importantly, it now incorporates key dry land crops such as millet, sorghum, chickpea, pigeon pea and groundnuts.

Figure A6-1 Economic Regions within IMPACT-WATER Model



IMPACT models the behavior of a competitive world agricultural market for crops and livestock, and is specified as a set of country or regional sub-models, within each of which supply, demand and prices for agricultural commodities are determined. The country and regional agricultural sub-models are linked through trade in a non-spatial way, such that the effect on country-level production, consumption and commodity prices is captured, through the net trade flows in global agricultural markets. The model uses a system of linear and nonlinear equations to approximate the underlying production and demand relationships, and is parameterized with country-level elasticities of supply and demand (Rosegrant et al., 2001). World agricultural commodity prices are determined annually at levels that clear international markets. Demand is a function of prices, income and population growth. Growth in crop production in each country is determined by crop prices and the rate of productivity growth. Future productivity growth is estimated by its component sources, including crop management research, conventional plant breeding, wide-crossing and hybridization breeding, and biotechnology and transgenic breeding. Other sources of growth considered include private sector agricultural research and development, agricultural extension and education, markets, infrastructure and irrigation.

A wide range of factors with potentially significant impacts on long-term, future developments in the world food situation can be used as exogenous drivers within IMPACT. Among these drivers are: population and income growth[5], the rate of growth in crop and livestock yield and production, feed ratios for livestock, agricultural research, irrigation and other investment, price policies for commodities, and elasticities of supply and demand. For any specification of these underlying parameters, IMPACT generates long-term projections for crop area, yield, production, demand for food, feed and other uses, prices, and trade; and livestock numbers, yield, production, demand, prices, and trade. The version of the model used for this paper has a base year of 2000 (a three-year average of 1999-2001 FAOSTAT data) and makes projections out to the year 2025.

Incorporating Water Availability into IMPACT

The primary IMPACT model simulates annual food production, demand, and trade over a 25-year period based on a calibrated base year. In calculating crop production, however, IMPACT assumes a “normal” climate condition for the base year as well as for all subsequent years. Impacts of annual climate variability on food production, demand, and trade are therefore not captured in the primary IMPACT model.

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[5] Projections of population are taken from those of the UN Statistics Division (medium variant projections, 2004 revision), while those of income are consistent with the *Technogarden* scenario of the Millennium EcoSystem Assessment (MA, 2005).

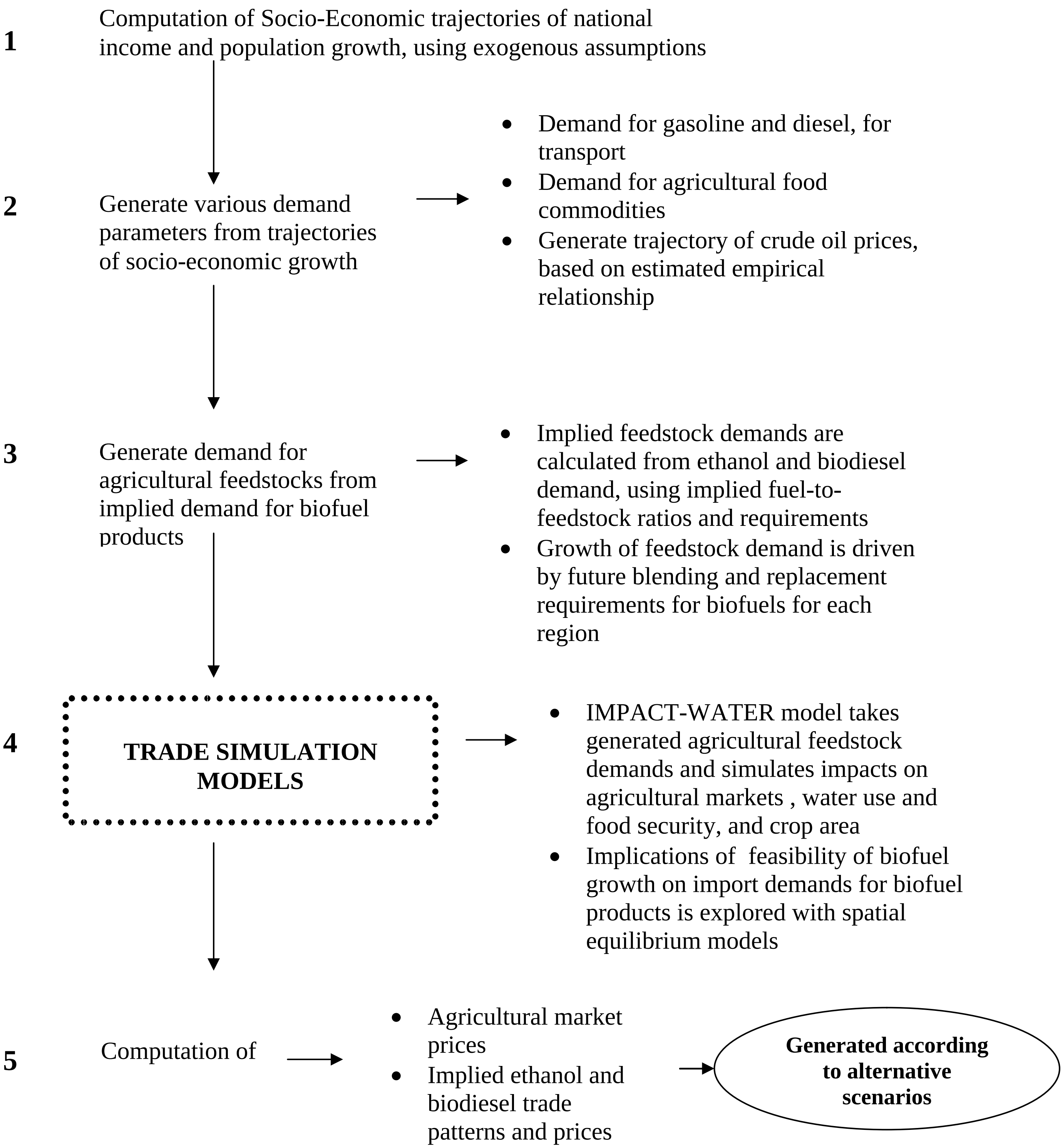
In reality, however, climate is a key variable affecting food production, demand, and trade. Consecutive droughts are a significant example, especially in areas where food production is important to local demand and interregional or international trade. More importantly, water demand is potentially increasing but supply may decline or may not fully satisfy demand because of water quality degradation, source limits (deep groundwater), global climate change, and financial and physical limits to infrastructure development. Therefore future water availability—particularly for irrigation—may differ from water availability today. Both the long-term change in water demand and availability and the year-to-year variability in rainfall and runoff will affect food production, demand, and trade in the future. To explore the impacts of water availability on food production, water demand and availability must first be projected over the period before being incorporated into food production simulation. This motivates an extension of IMPACT using a simulation model for inter-sectoral water allocation that operates at the global scale.

The Water Simulation Module (WSM) simulates water availability for crops accounting for total renewable water, nonagricultural water demand, water supply infrastructure, and economic and environmental policies related to water development and management at the river basin, country, and regional levels. Crop-specific water demand and supply are calculated for the eight of the key crops modeled in IMPACT—rice, wheat, maize, other coarse grains, soybeans, potatoes, sweet potatoes and yams, and cassava and other roots and tubers—as well as for crops not considered (which are aggregated into a single crop for water demand assessment). Water supply in irrigated agriculture is linked with irrigation infrastructure, permitting estimation of the impact of investment on expansion of potential crop area and improvement of irrigation systems.

IMPACT-WATER—the integration of IMPACT and WSM—incorporates water availability as a stochastic variable with observable probability distributions to examine the impact of water availability on food supply, demand, and prices. This framework allows exploration of water availability's relationship to food production, demand, and trade at various spatial scales—from river basins, countries, or regions, to the global level—over a 25-year time horizon.

Although IMPACT-WATER divides the world into 115 spatial units, significant climate and hydrologic variations within large countries or regions make large spatial units inappropriate for water resources assessment and modeling. IMPACT-WATER, therefore, conducts analyses using 126 basins, with many regions of more intensive water use broken down into several basins. China, India, and the United States (which together produce about 60 percent of the world’s cereal) are disaggregated into 9, 13, and 14 major river basins, respectively. Water supply and demand and crop production are first assessed at the river-basin scale, and crop production is then summed to the national level, where food demand and trade are modeled. By intersecting the 115 economic regions with the 126 river basins, we get a total of 281 spatial units that are represented within the current IMPACT-WATER modeling framework. An graphical depiction of the estimation process is presented in the following diagram.

Descriptive Outline of Analytical Modeling Components



1 Computation of Socio-Economic trajectories of national income and population growth, using exogenous assumptions

2 Generate various demand parameters from trajectories of socio-economic growth

- Demand for gasoline and diesel, for transport
- Demand for agricultural food commodities
- Generate trajectory of crude oil prices, based on estimated empirical relationship

3 Generate demand for agricultural feedstocks from implied demand for biofuel products

- Implied feedstock demands are calculated from ethanol and biodiesel demand, using implied fuel-to-feedstock ratios and requirements
- Growth of feedstock demand is driven by future blending and replacement requirements for biofuels for each region

4 **TRADE SIMULATION MODELS**

- IMPACT-WATER model takes generated agricultural feedstock demands and simulates impacts on agricultural markets , water use and food security, and crop area
- Implications of feasibility of biofuel growth on import demands for biofuel products is explored with spatial equilibrium models

5 Computation of

- Agricultural market prices
- Implied ethanol and biodiesel trade patterns and prices

Generated according to alternative scenarios

Representation of Crude Oil Prices

In this study, we represent the world market prices of oil exogenously, and driven purely by a relationship fitted to average historical prices and with an ‘error’ term that represents market-level ‘noise’ in price movements. Using data that is freely available, on international oil prices (BP, 2005), we fit the following relationship over time

$$\mathrm{P}_{\mathrm{t}} = a + b\left[\tfrac{1}{3}\sum_{t-1}^{t-4} P_t\right] + c\left[\tfrac{1}{3}\sum_{t-1}^{t-4} P_t - \tfrac{1}{3}\sum_{t-2}^{t-5} P_t\right]^d$$

Where P is the price of crude oil at time t, and the constants a, b, c and d, are parameters to be estimated from the data. This relationship maintains the ‘inertia’ of past prices, and uses a non-linear relationship to capture the shape of the historical profile. While world energy prices are, clearly, driven by more than just ‘memory’, and are subject to a number of socio-economic and geo-political factors. However, given the scope of this study, we were not able to fully capture those dynamics and inter-linkages within the global oil market, and rely on this ‘reduced-form’ relationship.

This relationship gave a fit to the observed data that is shown in figure A6-2, below, and shows a reasonable degree of congruence to the historical record of global market prices for crude oil. Using this relationship, to which we add randomly generated ‘noise’, we are able to project a forward-looking trajectory for crude oil prices that is used within our modeling framework, to determine the economic feasibility of domestic biofuel production. The future profile of prices is shown below and relies upon the specification of the random term, which is specified with a uniform distribution. The selected interval determines the shape and trajectory of the outward trend shown in Figure A6-3, and can be subjected to alternative assumptions.

Figure A6-2: Fit of Oil Price Relationship to Observed Data

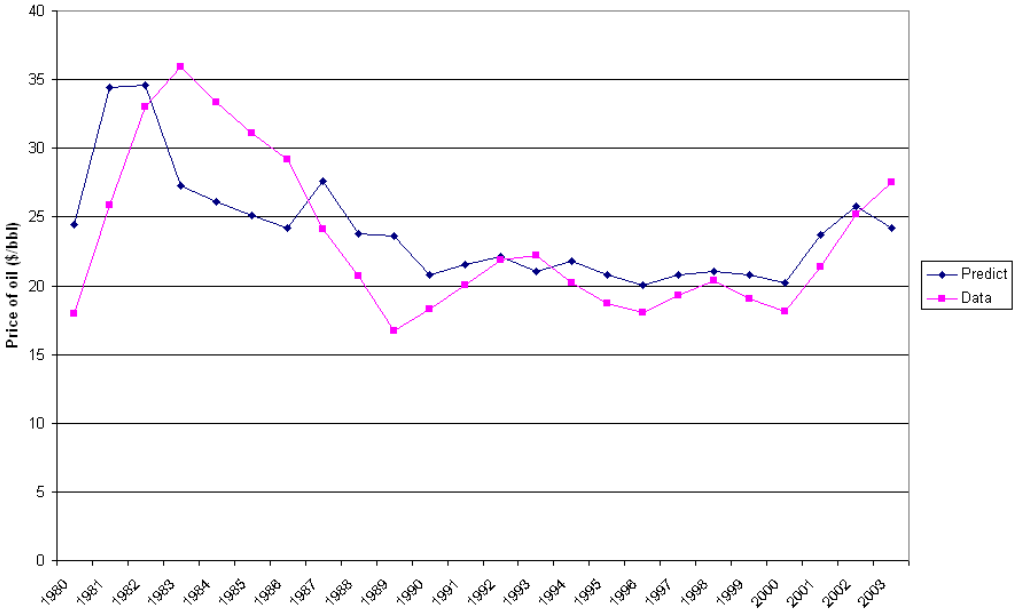
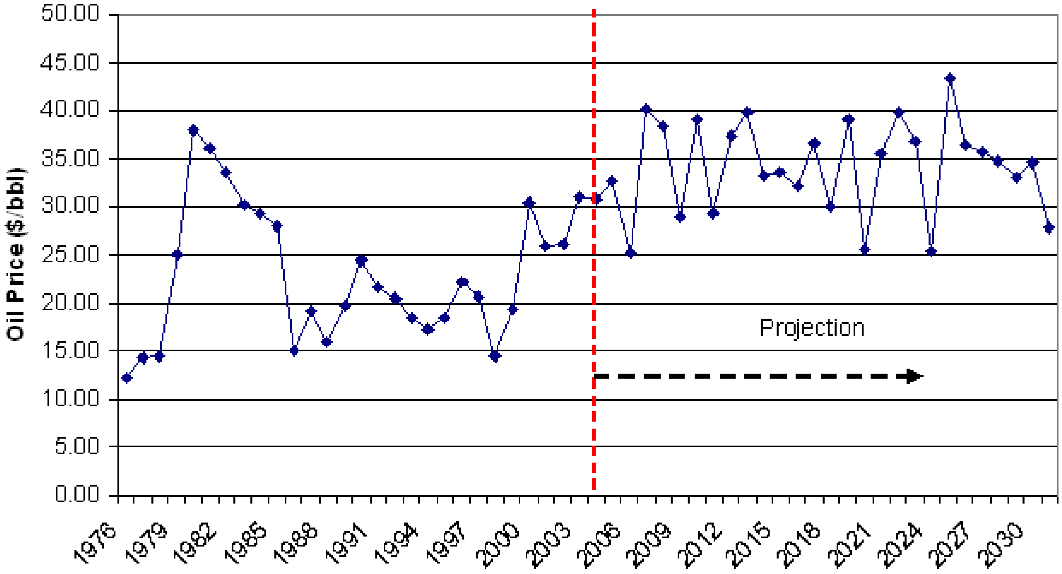


Figure A6-3: Projection of Crude Oil Prices in Future



Measures of Malnourishment in IMPACT

To determine how the aforementioned scenarios affect food security within Sub-Saharan Africa, we project their nutritional impacts, namely the resultant percentage and number of malnourished children under the age of five. Any child whose weight-for-age is more than two standard deviations below the weight-for-age standard set by the U.S. National Centre for Health Statistics/ World Health Organization is considered malnourished. The IMPACT-WATER model is able to project this number for each scenario, thereby allowing us to compare the relative abilities of various scenarios to foster improvements in food security. The percentage of malnourished children under the age of five is estimated from the average per capita calorie consumption, female access to secondary education, the quality of maternal and child care, and health and sanitation (Rosegrant et al., 2001). The precise relationship used to project the percentage of malnourished children is based on a cross-country regression relationship of Smith and Haddad (2000), and can be written as follows:

$$\Delta_{t,t-1}\mathrm{MAL} = -25.24 \cdot \ln\left({}^{\mathrm{KCAL}_t}\!/\!{}_{\mathrm{KCAL}_{t-1}}\right) - 71.76 \cdot \Delta_{t,t-1}\mathrm{LFEXPRAT} \quad 0.22 \cdot \Delta_{t,t-1}\mathrm{SCH} - 0.08 \cdot \Delta_{t,t-1}\mathrm{WATER}$$

where *MAL* = percentage of malnourished children

KCAL = per capita kilocalorie availability

LFEXPRAT = ratio of female to male life expectancy at birth

SCH = total female enrollment in secondary education (any age group) as a percentage of the female age-group corresponding to national regulations for secondary education, and

WATER = percentage of population with access to safe water.

$\Delta_{t,t-1}$ = the difference between the variable values at time t and t-1.

Most of this data comes from the following sources: the World Health Organization’s Global Database on Child Growth Malnutrition, the United Nations Administrative Committee on Coordination- Subcommittee on Nutrition, the World Bank's World Development Indicators, the FAO FAOSTAT database, and the UNESCO UNESCOSTAT database. The per capita calorie consumption variable is derived from two components; these include the amount of calories obtained from commodities included in the model as well as calories from commodities outside the model. Knowing this percentage, the projected number may be calculated using the following equation:

$$\mathrm{NMAL}_t = \mathrm{MAL}_t \times \mathrm{POP5}_t ,$$

where $NMAL$ = number of malnourished children, and

$POP5$ = number of children 0–5 years old in the population.

Observed relationships between all of these factors were used to create the semi-log functional mathematical model, allowing an accurate estimate of the number of malnourished children to be derived from data describing the average per capita calorie consumption, female access to secondary education, the quality of maternal and child care, and health and sanitation.

Modeling

As was explained , the quantitative framework used in this study does not completely integrate the agricultural and energy modeling components. The IMPACT-WATER model is a stand-alone model into which we input crop feedstock requirements that are driven by the scenarios for crop-based biofuel production. The supply side of the model, responds to the additional 'other' demand for crop tonnage that is consistent with the amounts needed for biofuel conversion, as is shown in Figure 1. The portion of biofuel demand that cannot be met through domestic, feedstock-based production is 'passed' to the energy model as a 'demand' for imports. The trade model then adjusts to the implied demand to give the corresponding spatial trade patterns that correspond to the implied import demands. In a more integrated framework, there would be a biofuel demand ‘function’ that would be embedded as part of the IMPACT-WATER model, itself, such that it responds to and adjust to available levels of feedstock, and induces additional production or international trade of the biofuel product, itself, if needed. While this is not a part of the modeling framework, currently, we hope to integrate this functionality more closely into the main model in the near future.

Modeling Energy Demand for Biofuels

Given the close inter-connections between the demand for energy products and the demand for agricultural products that are consumed as feedstocks, in the production of biofuels, we have included some key quantitative relationships that tie the socio-economic growth trajectories to the demand for energy products[6]. We have used available data to construct a population and income-driven representation of transport energy demand growth across time, and have linked that with projections of oil prices and scenario-driven blending requirements with renewable energy sources, to quantify the demand for biofuel products.

Numerous empirical studies have attempted to link the long-term trends in socio-economic growth to the demand for energy products and the intensity of energy use within national economies, such as that of Galli (1998), which looked at trends within Asia, and the global study of Price *et al.* (1998). In these studies, a quantitative relationship between per-capita income and the demand for energy were used to describe likely long-term trends for energy production, and the implied economic and environmental consequences. For the purposes of this

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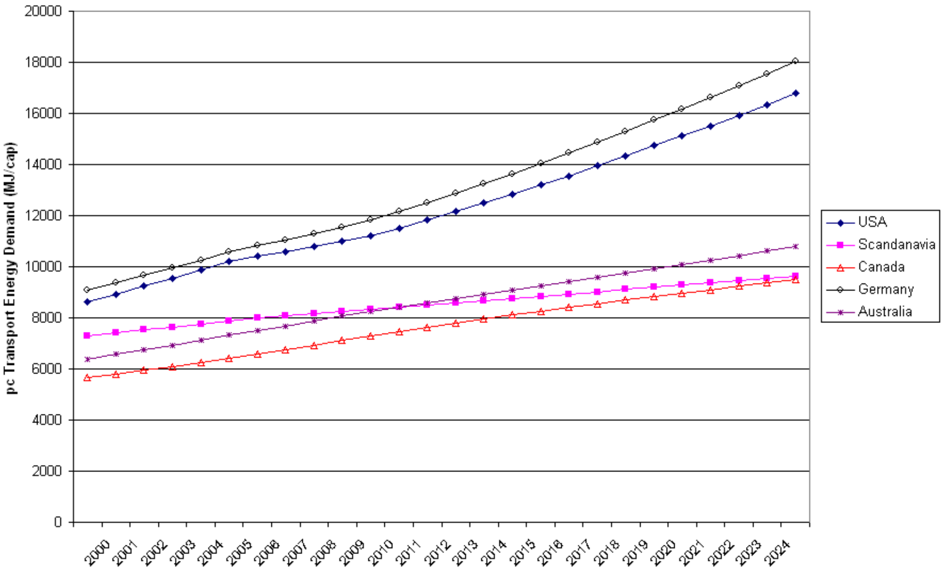
[6] . Given the limited scope of this desk study, we were unable to construct a model that fully captures the interactions between socio-economic growth and energy demand for all uses and for all economic sectors. While this could be done with an economy-wide, computable general equilibrium model, there is a global-level model, which has sufficient spatial disaggregation to adequately represent the Latin American region – neither do such models typically have the kind of disaggregation among the agricultural commodities that allows one to look at the impacts on the specific feedstocks of interest.

study, we focus specifically on energy for transportation, as it provides the primary motivation for biofuel production and utilization, globally, and is the central focus of most biofuels studies. We draw on the empirical relationship between per-capita energy demand for transport and per-capita GDP (income) that was estimated across 122 countries, by Price et al. (1998), and use the exogenous projections of population and national income within IMPACT-WATER, to drive this relationship over time. The equation linking energy demand and income, estimated by Price *et al.*, is given below.

$$Energy = 154.1\left(pcGDP\right)^{1.16} \qquad R^2 = 0.8$$

where Energy is in units of Mega Joules per capita and per capita GDP is in thousands of dollars. Using the socio-economic drivers within our model database, and this empirical relationship, we are able to derive projections of per-capita transportation energy demand shown in figure 6.2, below.

Figure 6.2: Projections of Per-Capita Transport Energy for Selected Countries



This figure shows a comparable trajectory of per-capita energy growth among the top industrialized countries, and represents a range of overall average annual growth from 1.1% for the Scandinavian region to an average rate of 2.8% for Germany. Looking more specifically at the Latin American Region, we see the growth trajectories shown in Figures 6.3a and 6.3b below.

Figure 6.3a: Projections of Per-Capita Transport Energy for LAC region

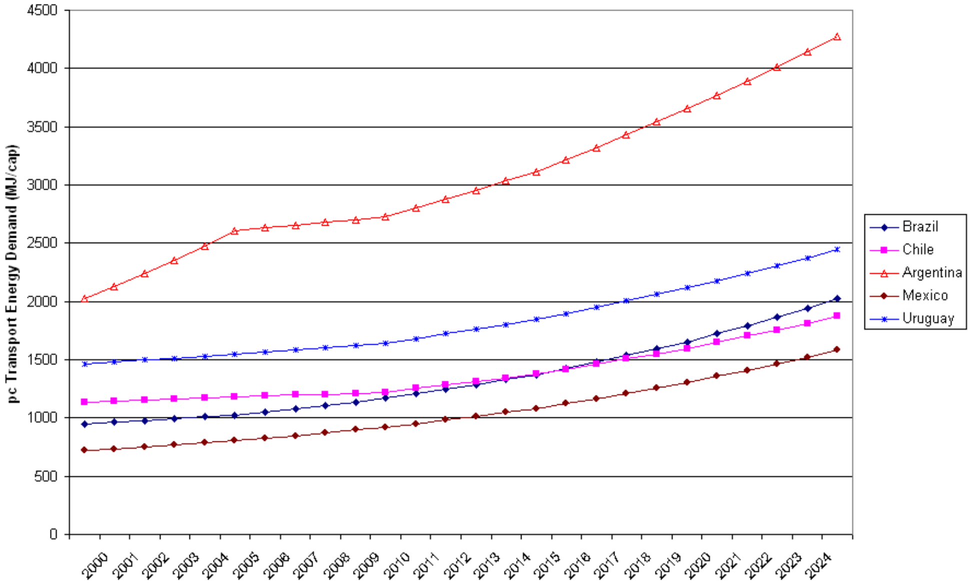
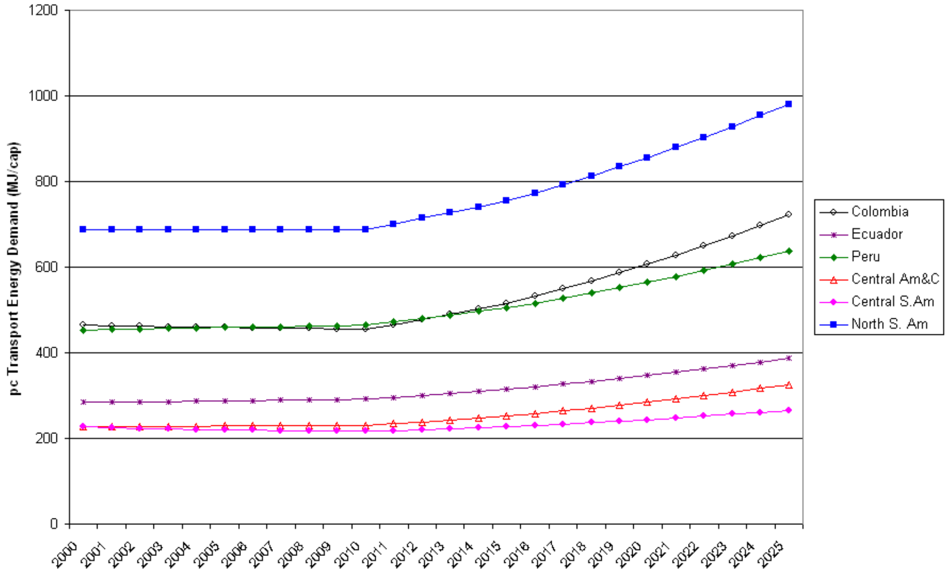


Figure 6.3b: Projections of Per-Capita Transport Energy for LAC region



Figures 6.3a and 6.3b show the distinction between the ‘high growth’ regions and those which show a steady, but lower profile of energy demand growth. It should be noted, again, that

these are per-capita measures, which must be multiplied by national population to give the total domestic demand for transportation energy. Therefore, the relative ranking among countries will likely appear quite different, when expressed in terms of total demand terms. Undoubtedly, there are technological and policy-driven factors that might very well change the trajectory of these energy trends – necessitating other variables to be present within the empirical relationship. The inclusion of these factors, such as transportation technology and national energy policy are beyond the scope of this desk study, and will be explored further in future work. In the following section, we discuss the design of the modeling component which captures international trade in energy products.

Modeling Trade in Biofuel Products

Based on the inferred demand for transport fuel, and the feasibility of domestic biofuel production that is possible within each region, any deficit that cannot be met by own-production must be satisfied through international trade in biofuel products. Given that the IMPACT-WATER model only treats international trade in agricultural commodities, at present, we construct a separate spatial equilibrium model to represent the adaptation that is plausible within international biofuel markets.

Borrowing on the basic principle of spatial equilibrium models, presented in the seminal paper of Takayama and Judge (1964), we can express the basic framework as follows

$$\max_{x_{i,j},m_{i,j},q_i^S,q_i^D,p_i,p_j\geq 0} \sum_{i=1}^{N}\left[\int P^S(q_i^S)dq+\int P^D(q_i^D)dq\right]-\sum_{i=1}^{N}\sum_{j=1}^{N}\tau_{i,j}x_{i,j}$$

$$s.t.$$

$$q_i^S=q_i^D+\sum_{j\neq i}\left(x_{i,j}-m_{i,j}\right)$$

$$\sum_i\sum_j x_{i,j}=\sum_i\sum_j m_{i,j}$$

$$q_i^D=P^D\left(p_i\right),\, q_i^S=P^S\left(p_i\right)$$

$$p_i\leq p_j+\tau_{i,j}$$

Where the quantities of supply and demand for region i are denoted by q_i^S, q_i^D , and where the associated price for region i is embedded in the functional supply and demand relationships $q_i^S=P^S\left(p_i\right), q_i^D=P^D\left(p_i\right)$, which can be integrated to describe the producer and consumer surplus for each region $\int P^S(q_i^S)dq\,, \int P^D(q_i^D)dq$. The quantities of exported and imported biofuel in region *i* are denoted by x_i and m_i, respectively. The sum of the producer and consumer surplus form the objective function of the problem, from which the costs due to trade tarrifs $\left(\tau_{i,j}\right)$ are subtracted. The trade balance is imposed for each region, in this problem, as well as the ‘no arbitrage’ constraint on prices – such that the gains in spatial price differences are exhausted by the unit tariff.

This type of model is fairly standard, and can be easily applied to the study of biofuels trade, once it has been parameterized. Using elasticity values from a variety of sources, the model was calibrated for the observed trade in ethanol and biodiesel, and simulated for the scenarios being investigated in this study. The results of the scenario analysis will now be examined in more detail, in the section which follows.

Key Limitations

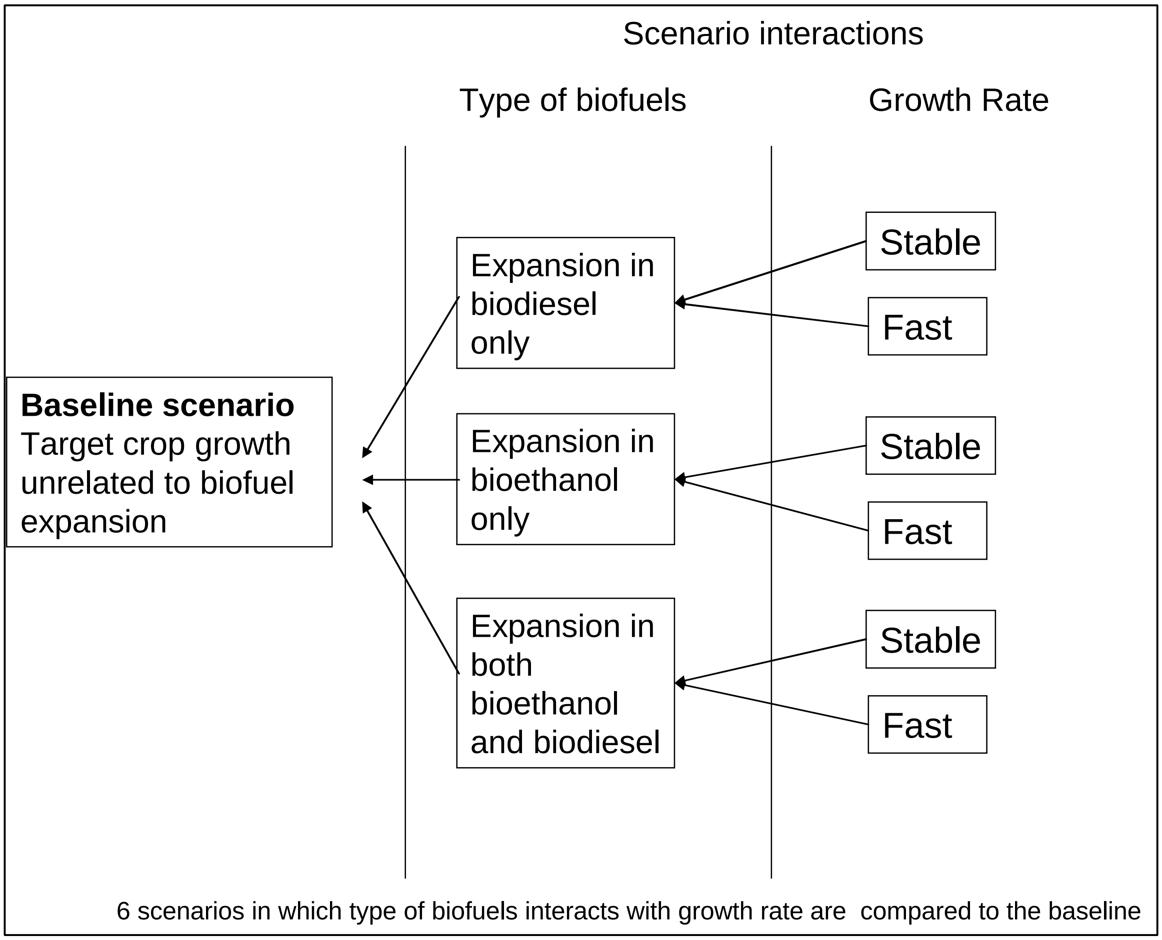
Data

In carrying out this study, we came across a number of limitations relating to data – mostly relating to the parameterization of the behavioral characteristics of the model. Given the relatively ‘thin’ economic literature on biofuel production, utilization and trade, there have been very few studies that can provide guidance as to what the long-term response of biofuel supply and demand is to market conditions. While Brazil has been fairly well-studied, compared to most regions of Latin America, and the world, there is not nearly as much empirical evidence for other regions. Most studies are heavily biased toward OECD countries, and tend to leave out much of the developing world, when discussing behavioral response and growth potential.

In this study, we draw upon a number of behavioral parameters used in the OECD study of von Lampe (2006), and adjusted them for other non-OECD regions, according to our best estimate of how such parameters could vary across regions. We also looked for guidance to published studies, to provide some comparison for our forward-looking assessments of biofuels growth, and pulled from a variety of data sources to give reliable starting values for the base year of the biofuels projections – 2005.

Annex 7. Basic scenario schematic and baseline data

Figure A7.1. Scenario schematic for biofuels simulations



6 scenarios in which type of biofuels interacts with growth rate are compared to the baseline

Table A7-1 Baseline Production Levels of Major Biofuels Feedstock Crops (thousands of metric tons)

Countries	***Ethanol***								***Biodiesel***	
	Wheat		**Maize**		**Cassava**		**Sugar**		**Oils**	
	2000	2025	2000	2025	2000	2025	2000	2025	2000	2025
Argentina	15757	23965	15307	28137	168	196	21573	31508	5655	8613
Brazil	2477	4907	35331	53093	22228	28122	445213	2428415	5823	9936
Central America and Caribbean	10	20	3126	7465	1240	1449	97129	156898	537	1054
Central South America	376	765	1415	3503	3886	6954	7599	13079	473	843
Chile	1487	2698	685	1208					275	540
Colombia	37	60	1134	2009	1908	2563	40944	60337	730	1521
Ecuador	15	34	483	1106	89	125	6784	11978	339	665
Mexico	3280	3636	18608	35149	102	112	64506	92131	1205	2082
Northern South America	1	1	1551	3527	753	844	13330	23168	244	479
Peru	180	354	1206	2760	1213	1422	9416	16913	600	1179
Uruguay	284	467	190	445			193	333	82	161

Table A7-2 Baseline Net Trade Levels of Major Biofuels Feedstock Crops (thousands of metric tons)

Countries	***Ethanol***								***Biodiesel***	
	Wheat		**Maize**		**Cassava**		**Sugar**		**Oils**	
	2000	2025	2000	2025	2000	2025	2000	2025	2000	2025
Argentina	10535	16231	9991	18944	-12	56	-135	-216	4689	7289
Brazil	-7606	-8668	-664	-16564	-131	-3326	6839	85191	1189	2342
Central America and Caribbean	-2974	-4524	-2652	-2584	239	56	4413	6778	-739	-944
Central South America	-464	-563	304	1280	-4	1037	20	-2	291	529
Chile	-467	-16	-1165	-2505	0	0	-859	-1179	-172	-118
Colombia	-1183	-1683	-1816	-2791	-7	76	1268	1372	-128	149
Ecuador	-473	-664	-118	-272	13	-113	-14	12	-17	135
Mexico	-2469	-4543	-5567	1080	23	22	2755	2121	-1252	-1705
Northern South America	-1360	-1995	-1095	-473	-35	-210	-162	-287	-346	-407
Peru	-1345	-1751	-921	-1845	-5	-173	-429	-612	80	368
Uruguay	19	-19	-113	54	-4	-4	-93	-125	28	87

Note: positive net trade denotes exports, while negative values denote country imports

Table A7-3 Baseline Total Demand Levels of Wheat for Ethanol (thousand of metric tons) with utilization shares

Ethanol					
Countries	**Wheat**				
	2000	2025	Food	Feed	Other
Argentina	5524	7734	81%	2%	17%
Brazil	9042	13575	89%	4%	7%
Central America and Caribbean	2861	4544	75%	21%	4%
Central South America	786	1327	62%	23%	15%
Chile	1964	2714	85%	8%	6%
Colombia	1199	1743	98%	0%	2%
Ecuador	489	698	99%	0%	1%
Mexico	5713	8179	65%	1%	34%
Northern South America	1311	1996	93%	4%	3%
Peru	1441	2104	96%	0%	4%
Uruguay	378	486	81%	10%	9%

Table A7-4 Baseline Total Demand Levels of Maize for Ethanol (thousand of metric tons) with utilization shares

Ethanol					
Countries	**Maize**				
	2000	2025	Food	Feed	Other
Argentina	5344	9193	5%	58%	37%
Brazil	35999	69657	5%	84%	11%
Central America and Caribbean	5620	10049	38%	55%	6%
Central South America	1264	2223	44%	38%	19%
Chile	1854	3713	8%	86%	6%
Colombia	2969	4800	47%	51%	2%
Ecuador	703	1378	16%	75%	9%
Mexico	22525	34069	48%	34%	17%
Northern South America	2300	4000	44%	45%	12%
Peru	2161	4605	10%	86%	4%
Uruguay	235	391	28%	55%	17%

Table A7-5 Baseline Total Demand Levels of Cassava for Ethanol (thousand of metric tons) with utilization shares

Ethanol					
Countries	**Cassava**				
	2000	2025	Food	Feed	Other
Argentina	181	141	61%	22%	17%
Brazil	22364	31452	27%	57%	16%
Central America and Caribbean	1097	1489	67%	12%	21%
Central South America	3894	5920	25%	63%	12%
Chile	0	0	8%	0%	92%
Colombia	1921	2493	76%	11%	12%
Ecuador	325	488	27%	67%	5%
Mexico	81	92	90%	0%	10%
Northern South America	776	1043	63%	9%	28%
Peru	1218	1596	73%	0%	27%
Uruguay	4	4	27%	0%	73%

Table A7-6 Baseline Total Demand Levels of Sugar for Ethanol (thousand of metric tons) with utilization shares

Ethanol					
Countries	**Sugar**				
	2000	2025	Food	Feed	Other
Argentina	1643	2435	91%	9%	0%
Brazil	10036	16565	84%	3%	13%
Central America and Caribbean	2191	3891	76%	13%	11%
Central South America	471	865	72%	9%	20%
Chile	650	1058	95%	3%	2%
Colombia	1459	2652	81%	6%	13%
Ecuador	476	803	92%	6%	3%
Mexico	4032	7683	81%	7%	12%
Northern South America	1009	1803	83%	4%	13%
Peru	942	1635	83%	0%	17%
Uruguay	82	124	95%	5%	0%

Table A7-7 Baseline Total Demand Levels of Oils for Biodiesel (thousand of metric tons) with utilization shares

Biodiesel					
Countries	**Oils**				
	2000	2025	Food	Feed	Other
Argentina	742	1100	85%	1%	15%
Brazil	4729	7688	57%	0%	42%
Central America and Caribbean	1248	1971	59%	2%	40%
Central South America	204	336	80%	0%	20%
Chile	456	667	46%	43%	11%
Colombia	853	1367	64%	0%	36%
Ecuador	354	529	80%	1%	18%
Mexico	2395	3724	53%	0%	47%
Northern South America	502	798	67%	13%	20%
Peru	536	827	51%	0%	49%
Uruguay	57	77	58%	0%	41%