Global Chapter 5 Tables

Table 5.1 Overview of quantitative modeling tools. Source: Compliled by authors.

Model name	Type	Features	Output indicators	Policy experiments
IMPACT-WATER	Partial equilibrium agricultural sector model with water simulation module	Simulates food production and water based on economic, demographic, and technological change	Food supply and demand, water supply and demand, Food price and trade, number of malnourished children	Investment in AKST, Trade liberalization, Organic/change in meat demand
SLAM	Simulated Livestock Allocation Model	Simulates the allocation of land to ruminant livestock based systems using livestock numbers	Areas and density of grazing ruminants	
IMAGE	Integrated Assessment model	Simulates energy supply and demand, translates energy outcomes and food outcomes from IMPACT into environmental consequences (land use change, climate change, emissions)	Energy demand and mix, greenhouse gas emissions, land use change, temperature and precipitation change, C and N fluxes	Climate change, Bioenergy
GTEM	CGE model	Simulates the economic structure		Trade liberalization
WATERSIM	Partial equilibrium agricultural sector model with water simulation module		Food supply and demand, water supply and demand, Food price and trade	Water productivity
GLOBIO3	Dose-response biodiversity model	Translates environmental pressures mainly from IMAGE into indicators of biodiversity	Mean Species Abundance Index	Bioenergy
ECO-OCEAN	Marine biomass balance model	Simulates world marine capture fisheries based on the 19 FAO fishing areas	Catch, Value, Diversity, and Marine Trophic Index	
GEN-CGE	CGE model for India	Multisectoral general equilibrium model for India with gender disaggregated data	Food and non food supply and demand at country level, employment by worker types distinguished by gender, wages of female and male workers and income by households	Trade liberalization
CAPSiM	CAPSiM	Partial equilibrium agricultural sector model for China	Simulates food production, consumption, and farmers' income based on major driving forces of demand and supply	

Table 5.2: Population growth. Source: UN, 2005

	2000-05	2005-10	2010-15	2015-20	2020-25	2025-30	2030-35	2035-40	2040-45	2045-50
NAE	0.3%	0.3%	0.2%	0.2%	0.1%	0.1%	0.0%	0.0%	0.0%	-0.1%
CWANA	2.0%	1.9%	1.8%	1.7%	1.5%	1.3%	1.2%	1.0%	0.9%	0.8%
LAC	1.4%	1.3%	1.2%	1.0%	0.9%	0.7%	0.6%	0.5%	0.3%	0.2%
SSA	2.3%	2.2%	2.2%	2.1%	2.0%	1.9%	1.7%	1.6%	1.5%	1.4%
ESAP	1.1%	1.0%	0.9%	0.8%	0.6%	0.5%	0.4%	0.3%	0.2%	0.1%

Table 5.3 Per capita income growth. Source: Authors (based on MEA 2005).

Region	2000-05	2005-10	2010-15	2015-20	2020-25	2025-30	2030-35	2035-40	2040-45	2045-50
NAE	3.3%	2.2%	2.8%	2.8%	2.7%	2.5%	2.3%	2.0%	1.8%	1.7%
CWANA	4.3%	3.6%	3.7%	3.6%	3.5%	3.8%	4.1%	4.5%	4.8%	5.0%
LAC	4.3%	1.1%	3.7%	4.6%	4.4%	4.4%	4.5%	4.6%	4.6%	4.5%
SSA	3.6%	3.4%	4.2%	4.3%	4.4%	4.6%	4.9%	5.1%	5.2%	5.2%
ESAP	3.2%	2.7%	3.7%	3.8%	3.6%	3.7%	3.7%	3.8%	3.8%	3.7%

Table 5.4 Per capita food availability, various agricultural commodities, by IAASTD region. Source: IFPRI IMPACT model simulations.

	2000	2025	2050	2000	2025	2050	2000	2025	2050	2000	2025	2050	2000	2025	2050
		NAE			CWANA			ESAP			LAC			SSA	
Meat															
Beef	24	26	25	6	8	11	4	7	9	25	28	30	5	7	11
Pork	32	32	31	0	0	0	16	20	19	9	10	11	1	2	3
Lamb	2	2	2	5	7	8	1	2	3	1	1	1	2	2	2
Poultry	25	31	30	8	11	13	7	12	19	23	29	33	3	4	6
Eggs	12	12	13	4	4	5	9	11	13	8	9	9	2	2	3
Milk	102	107	113	59	64	77	22	31	42	84	86	89	17	21	31
Cereals															
Rice	6	7	8	16	17	19	94	90	82	26	26	25	18	24	30
Wheat	108	112	112	146	141	142	58	59	60	51	49	49	20	24	33
Maize	9	9	10	14	14	16	14	13	13	48	45	45	49	40	39
Sorghum	0	0	0	8	8	11	3	2	2	0	0	0	20	21	28
Millet	0	0	0	1	2	3	3	3	3	0	0	0	16	21	29
Other grain	9	7	6	5	5	5	1	1	1	1	1	1	2	2	3
Root crops & Tubers															
Potato	86	74	70	29	25	25	23	21	24	27	25	29	10	9	9
Sweetpotato & yam	1	1	1	1	1	1	18	12	7	4	4	4	44	42	34
Cassava	0	0	0	2	2	2	9	8	6	25	22	19	117	111	94
Soybean	0	0	0	0	0	0	5	4	3	1	1	1	1	1	2
Vegetable	88	108	129	65	71	86	100	137	141	40	47	61	29	34	43
Sugar cane/ Beet	36	42	44	21	26	32	11	16	20	38	43	49	16	17	20
Sweetener	11	13	15	0	0	0	1	1	1	1	2	2	0	0	0
Subtropical fruit	55	66	76	59	66	85	47	65	79	90	98	122	33	38	44
Temperate fruit	24	29	37	26	28	32	10	13	14	5	6	9	0	0	0
Oils	28	31	35	13	15	20	10	16	25	14	17	26	8	10	15

Table 5.5 Bovines for the reference run, by IAASTD region (billion head). Source: ILRI SLAM model simulations.

Region	2000	2010	2020	2030	2040	2050
CWANA	0.124	0.162	0.192	0.218	0.237	0.248
ESAP	0.578	0.745	0.911	1.055	1.165	1.209
LAC	0.349	0.430	0.507	0.566	0.610	0.627
NAE	0.268	0.288	0.306	0.311	0.304	0.282
SSA	0.179	0.219	0.253	0.273	0.278	0.270
World	1.498	1.844	2.170	2.423	2.593	2.636

Table 5.6 Sheep and goats for the reference run, by region (billion head). Source: ILRI SLAM model simulations.

Region	2000	2010	2020	2030	2040	2050
CWANA	0.403	0.491	0.556	0.597	0.614	0.601
ESAP	0.723	0.871	1.008	1.115	1.184	1.210
LAC	0.116	0.136	0.154	0.168	0.175	0.174
NAE	0.195	0.218	0.235	0.244	0.244	0.231
SSA	0.271	0.346	0.406	0.443	0.459	0.457
World	1.707	2.061	2.359	2.566	2.677	2.673

Table 5.7 Pigs for the reference run, by region (billion head). Source: ILRI SLAM model simulations.

Region	2000	2010	2020	2030	2040	2050
CWANA	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
ESAP	0.539	0.622	0.669	0.664	0.627	0.558
LAC	0.080	0.096	0.110	0.119	0.123	0.122
NAE	0.274	0.295	0.307	0.304	0.290	0.262
SSA	0.019	0.024	0.029	0.032	0.034	0.034
World	0.912	1.038	1.115	1.121	1.076	0.978

Table 5.8 Poultry for the reference run, by region (billion head). Source: ILRI SLAM model simulations.

Region	2000	2010	2020	2030	2040	2050
CWANA	1.449	1.677	1.901	2.108	2.306	2.424
ESAP	7.478	10.112	12.979	15.712	18.168	19.687
LAC	2.286	2.893	3.531	4.151	4.762	5.245
NAE	4.180	4.677	5.180	5.542	5.780	5.750
SSA	0.784	0.991	1.170	1.306	1.407	1.445
World	16.178	20.350	24.760	28.819	32.423	34.551

Table 5.9 Grazing intensities in rangeland systems to 2030 and 2050 for the reference run, by region (TLU per ha). Source: ILRI SLAM model simulations.

Region	2000	2030	2050
CWANA	0.052	0.077	0.083
ESAP	0.044	0.067	0.067
LAC	0.188	0.293	0.318
NAE	0.052	0.063	0.060
SSA	0.062	0.090	0.090
World	0.064	0.094	0.098

Table 5.10 Selected international food prices, 2000 and projected 2025 and 2050, reference run. Source: IFPRI IMPACT model simulations.

	2000	2025	2050
Food	US$ per metric ton		
Beef	1,928	2,083	2,691
Pork	878	986	1,142
Sheep & goat	2,710	2,685	3,039
Poultry	1,193	1,192	1,399
Rice	191	223	232
Wheat	99	136	160
Maize	72	108	102
Millet	227	293	289
Soybean	186	216	216

Note: All values are three-year averages.

Table 5.11 Fisheries, reference run. Source: ECO-OCEAN.

FAO Area	Baseline		2% increase	
	% change in landings 2003 to 2048	% change in trophic level 2003 to 2048	% change in landings 2003 to 2048	% change in trophic level 2003 to 2048
Atlantic				
21	-39	-5.9	-35	-6.0
27	15	-1.5	22	-2.4
31	20	2.8	25	2.3
34	-30	1.1	3.9	-1.3
41	26	-1.2	34	-1.9
47	33	-3.1	13.9	-0.9
Pacific				
61	19	-2.3	14	-2.7
67	47	-2.8	44	-2.6
71	-15	0.5	11.4	-0.9
77	56	1.5	47	0.4
81	13	-0.1	2.8	-0.2
87	-38	3.9	13	-1.8
Indian				
51	-21	1.3	-10	-1.3
57	73	4.8	56	2.1
Med 37	71	-3.8	50	-3.1

Table 5.12 Share of global renewable water resources and population at 2000 and 2050, reference run. Source: IFPRI IMPACT model simulations.

Region	IRW (Km^3/year)		Share of Global IRW (%)		Share of Global Population (%)	
	2000	2050	2000	2050	2000	2050
North America and Europe (NAE)	8677	14802	21	32	18	13
East-South Asia and Pacific (ESAP)	12922	15218	31	33	54	49
Central-West Asia and North Africa (CWANA)	1328	1184	3	3	10	13
Latin America and Caribbean (LAC)	14000	11225	34	24	8	9
Sub-Saharan Africa (SSA)	4639	4345	11	9	10	17
Developed Countries	9946	15424	24	33	20	14
Developing Countries	31620	31349	76	67	80	86
World	41566	46773	100	100	100	100

Note: IRW = Internal renewable water resources

Table 5.13 Total water consumptive use, reference world. Source: IFPRI IMPACT model simulations.

Region	Total Water Consumption by all Economic Sectors ($Km^3\ yr^{-1}$)	
	2000	2050
North America and Europe (NAE)	737	778
East-South Asia and Pacific (ESAP)	1,384	1,570
Central-West Asia and North Africa (CWANA)	519	486
Latin America and Caribbean (LAC)	252	377
Sub-Saharan Africa (SSA)	61	146
Developed Countries	753	791
Developing Countries	2,199	2,567
World	2,952	3,358

Table 5.14 Potential and actual consumptive water use for irrigation, and irrigation water supply reliability for 2000 and 2050. Source: IFPRI IMPACT model simulations.

	Potential Irrigation Water Consumption ($Km^3\ yr^{-1}$)		Actual Irrigation Water Consumption ($Km^3\ yr^{-1}$)		Irrigation Water Supply Reliability (IWSR) (%)	
Region	**2000**	**2050**	**2000**	**2050**	**2000**	**2050**
North America and Europe (NAE)	731	960	598	615	82	64
East-South Asia and Pacific (ESAP)	1,950	2,277	1,256	1,259	64	56
Central-West Asia and North Africa (CWANA)	758	915	489	420	65	46
Latin America and Caribbean (LAC)	268	390	224	324	83	83
Sub-Saharan Africa (SSA)	50	101	50	88	99	87
Developed Countries	710	946	606	623	85	66
Developing Countries	3,047	3,697	2,010	2,085	66	56
World	3,757	4,643	2,616	2,707	70	58

Table 5.15 Non-irrigation consumptive water use for 2000 and 2050 (in $Km^3\ yr^{-1}$). Source: IFPRI IMPACT model simulations.

Region	Domestic		Industrial		Livestock		Total Non-Irrigation	
	2000	2050	2000	2050	2000	2050	2000	2050
North America and Europe (NAE)	41.0	47.8	91.2	109.7	6.0	5.3	138.2	162.9
East-South Asia and Pacific (ESAP)	64.1	153.3	48.3	133.7	16.0	23.7	128.4	310.6
Central-West Asia and North Africa (CWANA)	11.1	31.1	6.4	16.0	12.0	19.0	29.4	66.2
Latin America and Caribbean (LAC)	15.3	29.6	6.5	14.2	6.4	8.7	28.3	52.5
Sub-Saharan Africa (SSA)	6.6	45.3	1.0	6.6	4.0	6.7	11.5	58.6
Developed Countries	45.4	51.4	94.4	111.4	6.7	5.9	146.5	168.7
Developing Countries	92.6	255.6	59.0	168.9	37.7	57.5	189.3	481.9
World	138.0	307.0	153.4	280.2	44.4	63.4	335.8	650.7

Table 5.16 Assumptions for high/low agricultural investment variants. Source: Authors.

Parameter changes for growth rates	2050 REFERENCE RUN	2050 High AKST variant (#1)	2050 Low AKST variant (#2)
GDP growth	3.06 % per year	3.31 % per year	2.86 % per year
Livestock numbers and yield growth	Base model output numbers growth 2000-2050 Livestock: 0.74%/yr Milk: 0.29%/yr	Increase in numbers growth of animals slaughtered by 20% Increase in animal yield by 20%	Reduction in numbers growth of animals slaughtered by 20% Reduction in animal yield by 20%
Food crop yield growth	Base model output yield growth rates 2000-2050: Cereals: %/yr: 1.02 R&T: %/yr: 0.35 Soybean: %/yr 0.36 Vegetables: %/yr 0.80 Sup-tropical/tropical fruits: 0.82%/yr	Increase yield growth by 40% for cereals, R&T, soybean, vegetables, ST fruits & sugarcane, dryland crops, cotton Increase production growth of oils, meals by 40%	Reduce yield growth by 40% for cereals, R&T, soybean, vegetables, fruits & sugarcane, dryland crops, cotton Reduce production growth of oils, meals by 40%

Table 5.17 Assumptions for high/low agricultural investment combined with high/low Investment in other AKST-related factors (irrigation, clean water, water management, rural roads, and education). Source: Authors.

Parameter changes for growth rates	2050 BASE	2050 High AKST combined with other services (#3)	2050 Low AKST combined with other services Low (#4)
GDP growth	3.06 % per year	3.31 % per year	2.86 % per year
Livestock numbers growth	Base model output numbers growth 2000-2050 Livestock: 0.74%/yr Milk: 0.29%/yr	Increase in numbers growth of animals slaughtered by 30% Increase in animal yield by 30%	Reduction in numbers growth of animals slaughtered by 30% Reduction in animal yield by 30%
Food crop yield growth	Base model output yield growth rates 2000-2050: Cereals: %/yr: 1.02 R&T: %/yr: 0.35 Soybean: %/yr 0.36 Vegetables: %/yr 0.80 Sup-tropical/tropical fruits: 0.82%/yr	Increase yield growth by 60% for cereals, R&T, soybean, vegetables, ST fruits & sugarcane, dryland crops, cotton Increase production growth of oils, meals by 60%	Reduce yield growth by 60% for cereals, R&T, soybean, vegetables, fruits & sugarcane, dryland crops, cotton Increase production growth of oils, meals by 60%
Irrigated Area Growth (apply to all crops)	0.06	Increase by 25%	Reduction by 25%
Rainfed Area growth (apply to all crops)	0.18	Decrease by 15%	Increase by 15%
Basin efficiency		Increase by 0.15 by 2050, constant rate of improvement over time	Reduce by 0.15 by 2050, constant rate of decline over time
Access to water		Increase annual rate of improvement by 50% relative to baseline level, (subject to 100 % maximum)	Decrease annual rate of improvement by 50% relative to baseline level, constant rate of change over time
Female secondary education		Increase overall improvement by 50% relative to 2050 baseline level, constant rate of change over time unless baseline implies greater (subject to 100 % maximum)	Decrease overall improvement by 50% relative to 2050 baseline level, constant rate of change over time unless baseline implies less

Table 5.18 Selected international food prices, projected to 2050, reference run and AKST variations. Source: IFPRI IMPACT model simulations.

	Reference run	AKST-high	AKST_low	AKST_high_pos	AKST_low_neg
Food			**US$ per metric ton**		
Beef	2,756	-23%	36%	-31%	63%
Pork	1,164	-29%	48%	-40%	84%
Sheep & goat	3,079	-24%	36%	-34%	60%
Poultry	1,434	-34%	62%	-46%	114%
Rice	245	-46%	105%	-62%	232%
Wheat	173	-53%	173%	-68%	454%
Maize	114	-67%	311%	-81%	882%
Millet	312	-59%	204%	-72%	459%
Sorghum	169	-57%	200%	-70%	487%
Other coarse grains	104	-74%	545%	-86%	1952%
Soybean	225	-31%	56%	-43%	106%

Table 5.19 Irrigation water supply reliability, projected to 2050, reference run and AKST variations. Source: IFPRI IMPACT model simulations.

	Reference	AKST_high_pos	AKST_low_neg
Region	Percent		
North America and Europe (NAE)	64	72	60
East-South Asia and Pacific (ESAP)	56	66	51
Central-West Asia and North Africa (CWANA)	46	52	39
Latin America and Caribbean (LAC)	83	86	75
Sub-Saharan Africa (SSA)	87	92	85
Developed Countries	66	74	62
Developing Countries	56	65	51
World	58	67	53

Table 5.20 Regional variation in scope for productivity improvements and area expansion. Source: Derived from CA scenario analysis (CA, 2007)

Region	Scope for improved productivity in rainfed areas	Scope for improved productivity in irrigated areas	Scope for irrigated area expansion	Need for imports	High potential options in agricultural water management
Sub-Saharan Africa	+++	+	+++		▪ water harvesting and supplemental irrigation; resource-conserving agricultural practices to mitigate land degradation ▪ small-scale irrigation geared to smallholders ▪ multiple use water systems to alleviate poverty ▪ adopt development approaches that combine access to markets, soil fertility and irrigation infrastructure
MENA	+	+	-	+++	▪ use of low quality water ▪ coping with increased sectoral competition and water pollution ▪ integrating livestock with irrigation
C. Asia, E. Europe	+	++	+		▪ institutional reforms in irrigated areas ▪ restore ecosystems services ▪ modernize large-scale irrigation systems
South Asia	+++	+++	+	+	▪ institutional reforms in irrigated areas ▪ integrating livestock and fisheries ▪ water harvesting and supplemental irrigation; resource-conserving practices to mitigate land degradation
East Asia	++	+++	+	++	▪ water productivity in rice ▪ reducing groundwater overdraft
Latin America	++	+	+		▪ land expansion and sustainable land use ▪ support and regulation of private irrigation
OECD	+	+	+		▪ coping with increased sectoral competition

Key: +++ high, ++ medium, - low, - very limited

Table 5.21 Scenarios (policy experiment outcomes). Source: Watersim simulations (CA, 2007).

Region	Irrigated area		Rainfed area		Rainfed cereal yield		Irrigated cereal yield		Rainfed water productivity	
	m ha	% change	m ha	% change	t/ha	% change	t/ha	% change	kg/m3	% change
SSA	11.3	78%	174.2	10%	2.34	98%	4.37	99%	0.28	75%
MENA	21.5	5%	16.1	-12%	1.19	59%	5.58	58%	0.25	47%
C Asia, E Europe	34.7	6%	120.7	-5%	3	47%	6.06	78%	0.69	47%
South Asia	122.7	18%	83.9	-12%	2.54	91%	4.84	89%	0.46	82%
East Asia	135.6	16%	182.2	17%	3.96	51%	5.97	49%	0.57	36%
Latin America	19.5	18%	147.9	46%	3.9	58%	6.77	68%	0.63	50%
OECD	47.3	4%	179	4%	6.35	33%	8.03	22%	1.3	25%
World	394	16%	920	10%	3.88	58%	5.74	55%	0.64	31%

Region	Irrigated water productivity		Crop water depletion		Irrigation water diversions		Trade	
	Kg/m3	% change	km3	% change	km3	% change	M ton	% of consump-tion
SSA	0.5	58%	1379	29%	100	46%	-25	-12%
MENA	0.82	41%	272	7%	228	8%	-127	-61%
C Asia, E Europe	1.22	51%	773	0%	271	11%	66	22%
South Asia	0.79	62%	1700	15%	1195	9%	2	0%
East Asia	1.16	45%	1990	19%	601	16%	-97	-12%
Latin America	0.91	52%	1361	52%	196	12%	18	6%
OECD	1.6	20%	1021	4%	238	2%	151	26%
World	1.01	48%	8515	20%	2975	14%	490	***15%***

Table 5.22 Challenges for AKST. Source: Based on CA, 2007, pp 131-136.

Region	Challenges for AKST
Sub-Saharan Africa	• Development of affordable irrigation infrastructure, suitable for smallholders, including supporting roads, and markets • Development of suitable water harvesting techniques and small supplemental irrigation methods to upgrade rainfed areas • Creating the right institutional and economic environment for widespread adoption of these methods
MENA	• Development of environmentally sound ways to reuse return flows, often of low quality • Design of appropriate policies addressing sectoral competition and water pollution • Reduce adverse impacts of groundwater over-exploitation
C. Asia, E. Europe	• Design of politically feasible institutional reforms in irrigated areas • Measures to restore ecosystems services • Adapting yesterday's large-scale irrigation systems to tomorrow's needs
South Asia	• Design of politically feasible institutional reforms in irrigated areas • Water conserving and yield boosting technologies to increase the output per unit of water in irrigated areas • Water harvesting and supplemental irrigation; resource-conserving practices to mitigate land and water degradation and the creation of enabling environment for the adoption of available techniques
East Asia	• Techniques to enhance the water productivity, particularly in rice areas (such as alternative wet-dry) • Reduce adverse impacts of groundwater over-exploitation
Latin America	• Land expansion and sustainable land use • Support and regulation of private irrigation
OECD	• Policies addressing increased sectoral competition • Restoring ecosystem services

Table 5.23 Changes to average income demand elasticities for meat and vegetarian foods by IAASTD region under low growth in meat demand variant. Source: IFPRI IMPACT model simulations.

			2000	2010	2020	2030	2040	2050
Meat	Baseline	CWANA	0.7223	0.6673	0.6095	0.5576	0.5147	0.4806
		ESAP	0.5538	0.5145	0.4809	0.4507	0.4288	0.4169
		LAC	0.5679	0.5129	0.4582	0.4023	0.3468	0.2914
		NAE	0.2761	0.2402	0.2054	0.1732	0.1438	0.1161
		SSA	0.8121	0.7966	0.7808	0.7634	0.7443	0.7221
	Low Meat	CWANA	0.7223	0.6554	0.5867	0.5253	0.4755	0.4375
	Demand	ESAP	0.5538	0.4953	0.4460	0.4064	0.3853	0.3844
		LAC	0.5679	0.5046	0.4416	0.3781	0.3164	0.2562
		NAE	0.2761	0.2178	0.1672	0.1227	0.0858	0.0533
		SSA	0.8121	0.7931	0.7736	0.7529	0.7305	0.7044
Vegetarian Foods	Baseline	CWANA	0.2486	0.2299	0.2156	0.2063	0.2021	0.2025
		ESAP	0.2243	0.2003	0.1847	0.1660	0.1438	0.1222
		LAC	0.1579	0.1421	0.1343	0.1322	0.1311	0.1324
		NAE	0.2733	0.2547	0.2387	0.2235	0.2079	0.1930
		SSA	0.3359	0.2775	0.2364	0.2027	0.1790	0.1751
	Low Meat	CWANA	0.2486	0.2337	0.2223	0.2149	0.2120	0.2134
	Demand	ESAP	0.2243	0.2138	0.2098	0.2046	0.1954	0.1848
		LAC	0.1579	0.1436	0.1367	0.1345	0.1330	0.1337
		NAE	0.2733	0.2687	0.2644	0.2599	0.2539	0.2477
		SSA	0.3359	0.2834	0.2473	0.2164	0.1941	0.1887

Table 5.24 Change in average crop yields under integrated nutrient management variant. Source: IFPRI IMPACT model simulations.

Region	Crop	Irrigated	Rainfed
USA	Maize	-14	-14
European Union (15)	Maize	-14	-14
Other Developed	Maize	0	-14
Eastern Europe	Maize	0	0
USA	Wheat	-14	-14
European Union (15)	Wheat	-14	-14
Other Developed	Wheat	-14	-14
Eastern Europe	Wheat	0	0
USA	Soybean	-14	-14
European Union (15)	Soybean	-14	-14
Other Developed	Soybean	-14	-14
Eastern Europe	Soybean	-10	-10
USA	Other grains	-14	-14
European Union (15)	Other grains	-14	-14
Other Developed	Other grains	-14	-14
Eastern Europe	Other grains	0	0
USA	Potato	-20	-20
European Union (15)	Potato	-20	-20
Other Developed	Potato	-20	-20
Eastern Europe	Potato	-12.5	-12.5

Table 5.25 Change in average livestock carcass weight under integrated nutrient management variant. Source: IFPRI IMPACT model simulations.

Region	Meat	Livestock
USA	Beef	-12.5
European Union (15)	Beef	-7.5
Other Developed	Beef	-12.5
Eastern Europe	Beef	-10
USA	Sheep & goat	-5
European Union (15)	Sheep & goat	-7.5
Other Developed	Sheep & goat	-5
Eastern Europe	Sheep & goat	-10
USA	Dairy	-10
European Union (15)	Dairy	-7.5
Other Developed	Dairy	-5
Eastern Europe	Dairy	0

Table 5.26 Change in per capita food consumption of meats and cereals under low meat demand variant. Source: IFPRI IMPACT model simulations.

Crop	Region	2025	2050
Cereals	NAE	1.6%	3.1%
	CWANA	0.2%	0.9%
	ESAP	0.7%	1.8%
	LAC	0.3%	1.1%
	SSA	0.4%	1.0%
Meat	NAE	-1.2%	-0.6%
	CWANA	0.5%	-1.3%
	ESAP	-4.0%	-9.8%
	LAC	1.0%	-0.1%
	SSA	2.3%	4.6%

Table 5.27 Area and yield of major agricultural commodities, China (in million hectares and metric ton per hectare, respectively). Source: CAPSIM reference run.

	2004	2020	2050
Area (million ha):			
Cereal	83	75	70
Soybean + oil crops	24	21	19
Cotton	5	5	4
Sugar	2	2	2
Vegetable	18	19	20
Fruit	9	11	12
Sum of above crops	140	132	127
Yield (ton/ha):			
Rice (in milled rice)	4.3	5.2	5.7
Wheat	4.0	4.8	5.3
Maize	5.0	6.1	6.4
Cotton	1.1	1.6	1.8
Sugar	5.6	7.8	8.7
Vegetable	19.4	25.9	27.6
Fruit	9.5	15.2	17.1

Table 5.28 Self-sufficiency levels of selected major agricultural commodities in China (in percent). Source: CAPSIM reference run.

	2004	2020	2050
Cereal	102	92	86
Rice	101	107	112
Wheat	99	95	98
Maize	108	79	69
Soybean	49	41	38
Oil crops	67	63	58
Cotton	85	74	58
Sugar	91	79	65
Vegetables	101	105	106
Fruit	101	106	102
Pork	101	102	102
Beef	100	86	85
Mutton	99	94	95
Poultry	100	105	111
Milk	96	79	75

Table 5.29 Population shares by income group in rural China (in percent). Source: CAPSIM reference run.

Income group	2001	2010	2020	2030	2050
Under poverty	11.0	5.4	0.9	0.0	0.0
By household income in 2001	100	100	100	100	100
1st quintile	22.6	15.8	8.9	3.9	0.0
2nd quintile	21.3	24.0	25.2	25.2	12.3
3rd quintile	20.0	18.9	17.5	16.3	19.1
4th quintile	19.0	17.4	15.2	13.0	7.6
5th quintile	17.0	24.0	33.2	41.6	61.1

Note: Households under poverty means that per capita income is less than 1$/day in PPP. Rural population with less 1$/day income accounted for 11% of total rural households in 2001. Each quintile households accounted for 20% of total rural households in 2001, but the shares of population in lower quintiles are more than those in higher quintiles.

Table 5.30 Some key economic variables for India in the reference world. Source: GEN-CGE.

	2000	2025	2025-1	2050	2050-1
		Level		Annual Growth (%)	
CPI (Index)	100	2.44	2.2	1.42	1.4
Total Investment (Constant Prices) (Rs. 10 Million)	429741	5.36	5.77	7.56	7.53
GDP Real (Rs. 10 Million)	1962996	5.23	5.23	4.87	4.87

Table 5.31 Average real wage rate by skill for India in the reference world and under trade liberalization. Source: GEN-CGE.

	Base =2000	2025	2025-1	2050	2050-1
	Unit Rs.	Annual Growth Rate (%)			
Labor casual female	1476.32	3.00	2.77	-0.21	-0.22
Labor regular female	8443.14	3.23	3.32	-3.43	-3.96
Total Female	**2137.04**	**3.09**	**2.99**	**-0.93**	**-0.99**
Labor casual male	3183.97	2.70	2.52	0.40	0.41
Labor regular male	8865.69	0.87	0.80	-0.89	-0.89
Total Male	**4453.40**	**1.98**	**1.84**	**-0.08**	**-0.06**
Grand Total	3697.08	2.21	2.08	-0.21	-0.21

Note:
2025-1 = Peak tariff rate is reduced by 88 per cent over 2000
2050-1 = Peak tariff rate is reduced by 98 per cent over 2000

Table 5.32 Per capita private gross income (growth rate in %). Constant prices, India. Source: GEN-CGE.

	Base =2000	**2025**	**2025-1**	**2050**	**2050-1**
	Unit=Rs.	Annual Growth Rate (%)			
Rural Poor Formal	23633	0.88	1.12	0.64	0.66
Rural Non-Poor Formal	30433	0.88	1.12	0.64	0.66
Rural Poor Informal	19346	2.40	2.63	2.21	2.23
Rural Non Poor Informal	17554	1.79	1.99	3.31	3.33
Total Rural	**18359**	**2.01**	**2.23**	**2.92**	**2.94**
Urban Poor Formal	25952	2.77	3.01	2.13	2.16
Urban Non Poor Formal	31763	2.77	3.01	2.13	2.16
Urban Poor Informal	18274	4.13	4.38	3.94	3.96
Urban Non Poor Informal	23836	3.74	3.97	4.33	4.35
Total Urban	**25619**	**3.33**	**3.57**	**3.38**	**3.40**
Grand Total	20283	2.20	2.43	2.93	2.95

Note: 1 USD = Rs. 43.3 in 2000.

Table 5.33 Population deciles with per capita consumption expenditure changes over reference run India (in ascending order). Source: GEN-CGE.

		Per capita consumption				
	Population Deciles	**2000**	**2025**	**2025-1**	**2050**	**2050-1**
		(Rupees)				
Rural	1st Decile (poorest 10%)	1245	1874	2018	5349	5408
	2nd Decile	1606	2417	2603	6901	6976
	3rd Decile	1854	2790	3005	7965	8053
	Poorest 30%	1571	2364	2545	6748	6822
	4th Decile	2082	3134	3375	8946	9044
	5th Decile	2310	3476	3743	9922	10031
	6th Decile	2575	3874	4172	11060	11182
	7th Decile	2879	4333	4666	12368	12504
	8th Decile	3291	4952	5333	14137	14292
	9th Decile	3954	5949	6407	16984	17170
	10th Decile (richest 10%)	6281	9452	10179	26983	27279
	All Rural	2806	4222	4547	12054	12186
Urban	1st Decile (poorest 10%)	1260	1604	2059	4956	5017
	2nd Decile	1691	2152	2659	6651	6732
	3rd Decile	2010	2559	3145	7907	8004
	Poorest 30%	1653	2105	2621	6504	6583
	4th Decile	2323	2957	3466	9137	9248
	5th Decile	2678	3409	3866	10534	10663
	6th Decile	3092	3936	4286	12162	12311
	7th Decile	3604	4588	4811	14177	14351
	8th Decile	4337	5522	5435	17063	17272
	9th Decile	5512	7017	6595	21682	21948
	10th Decile (richest 10%)	10226	13019	10437	40227	40719
	All Urban	3672	4675	4675	14445	14622

Note: 1 USD = Rs. 43.3 in 2000.

Table 5.34 Total domestic supply of goods and services, India, reference run and trade liberalization variant. Source: GEN-CGE.

	Base = 2000	2025	2025-1	2050	2050-1
	Unit Rs. 10 million	Annual Growth (%)			
Rice	170095	1.7	0.62	2.91	2.79
Wheat	50853.5	4.62	4.1	4.96	4.86
Maize	5556.32	4.48	4.32	4.6	4.48
Other coarse grains	8833.8	4.53	4.16	5.6	6.36
Pulses	21635.1	4.59	4.28	5.03	4.93
Potatoes	7036.53	4.59	4.27	5.12	5.28
Other crops	230682	1.83	4.66	4.22	4.36
Oilseeds and edible oils	133039	1.14	1.14	2.44	2.46
Meat	39045.7	4.59	4.2	2.27	2.08
Fishing	21015	4.6	4.08	1.54	1.9
Other livestock	115019	4.63	4.2	5.19	5.34
Total Agriculture	802810	2.87	2.3	3.79	3.88
Fertilizers	34902.5	2.49	3.26	1.13	0.81
Other Manufacturing	1458410	2.59	2.71	1.58	1.58
Other services	1248214	2.7	2.89	1.4	0.89
Total Non-agriculture	2741526	2.64	2.8	1.5	1.35
Grand Total	3544336	2.69	2.69	2.28	2.24

Note: 1 USD = Rs. 43.3 in 2000.

Box 1 Outcomes for China

China's development has major impacts on both current and future food markets of the world. Key results from a disaggregated, partial agricultural equilibrium model are presented below:

Crop production

Under the baseline (or reference) run, total crop area will gradually decline. In addition, wages are predicted to rise as will the opportunity cost of land for agricultural production. Why? The main drivers of these shifts are: industrialization, urbanization and the slowing of the rate of growth of population (as well as labor supply). Sown area is projected to decline by about 10%, which implies an annual rate of 0.2 over the next 50 years (Table 5.27). The decline will be largest for the cereal sector. In contrast, the sown area of crops with positive income elasticities of demand (e.g., cash crops) will expand slightly. Non-staple crop yields will grow in the reference world since the rising demand for these commodities will lead to higher prices which, in turn, will induce enhanced productivity from investment in these sectors (both in R&D and in production).

[Insert Table 5.27]

Implications for food security, poverty and equity

China's economic growth and trade liberalization in the reference world will facilitate many changes in the basic structure of agricultural sector. China's agriculture will be gradually shifting from crops in which its farmers have less comparative advantage (i.e., land-intensive sectors, such as grains, edible oils, sugar and cotton) to those in which farmers have more comparative advantage (labor-intensive crops, such as vegetables, fruit, pork and poultry).

Overall, China's food security will remain high. While there will be a few agricultural and food commodities that could experience a significant decline in national self-sufficiency levels (for example maize, soybeans and edible oils, sugar and ruminant meats, as shown in Table 5.28, rising imports of these few commodities will not threaten the basic food security status of either China or the world. Cereal imports will rise, but cereal self-sufficiency will remain at about 90% in 2020 and above 85% through 2050. Cereal imports rise mainly because of increasing demand for feed (especially, maize). Rising feed demand is inextricably linked to the rapidly growing livestock sector. Self-sufficiency in maize will fall from the current level of more than 100% (China actually was a net maize exporter in the 1990s and 2000s) to less than 70% after 2020. However, due to declining demand for rice and wheat (on a per capita basis) and the falling rates of population growth (with nearly no growth in the 2020s and falling population numbers thereafter), our projections suggest that China could reach near self-sufficiency in wheat and become a large exporter of rice into international markets, as long as the rest of the world liberalizes their agricultural sectors.

[Insert Table 5.28]

Outside China, a rapidly growing Chinese economy will help those countries with a comparative advantage in land-intensive products. Such countries (such as Brazil, Argentina, Brazil, the US, Canada and Australia) will expand their production and increase their exports to China. Developing countries, in particular, will be able to export a fairly large number of agricultural products to China. China's open trade regime and rising demand will increase the consumption of imported soybeans and other edible oils, maize, cotton, sugar, tropical and sub-tropical fruits, as well as some livestock products (e.g., milk, beef and mutton).

Incomes will increase across all segments of the income distribution in China. The rises will come, in part from agriculture. However, most of the growth will be based on rising nonagricultural activities, including off farm wages and self employment earnings. On average, per capita income will rise about 6% annually over the next two decades and 3-5% annually during the period from 2020-2050. Income growth from agriculture will be positive, but much lower. China's rapid economic growth and the rise in the nation's overall wealth will be accompanied by widening income inequality unless substantial efforts are undertaken to directly support the poor. Since most of the poor in China have land, improving agriculture and other activities in farming areas will positive affect the welfare of the poorest people in rural China.

As growth proceeds, China will significantly reduce its population under the poverty line. In 2001, about 11% of China's rural population was below the US$1/day poverty line (Table 5.29). With rising incomes from both the agricultural and nonagricultural sectors, the share of the poor in the total rural population is expected to be reduced to 5.4% by 2010 and to less than 1% by 2020. Moreover, under the reference run, the share of the rural population that lives in poverty would essentially be completely eliminated after 2022, a level of reduction that is faster than the targets suggested under the Millennium Development Goals of the United Nations. Specifically, the poorest 20% of China's households (based on their income levels in 2001) are expected to reduce their population share from 22.6% in 2001 to 3.9% by 2030 (Table 5.29). After about 2035, the entire rural population in the lowest income class (quintile) is expected to have graduated to the second or even third income quintiles.

[Insert Table 5.29]

Box 2 Trade policy and gender, case of India

In the reference world the overall growth in agriculture would be slightly lower than the current long-term trend in Indian agricultural growth (i.e., 3%) in 2025 and would be slightly higher in 2050. Overall growth in manufacturing sector in the reference period is 10 % through the first 25

years and by about 8% in the next 25 years till 2050. With such growth rates projections taken from the IMPACT model and trend growth (for non-agricultural sectors) from Indian macro economic data sets, we find that the growth in resultant investment is healthy (see Table 5.30) and decelerating inflation that reaches the 1.4% by 2050. In brief, for India the macro picture is of robust with stable growth in the economy in the reference world. However, the rural-urban divide continues while urban households continue to improve their real income. In the longer run this gap somewhat declines. Moreover, the wage gap between men and women workers in the first 25 years declines. In the reference world the consumption of the lower deciles of the population improves continuously.

[Insert Table 5.30]

The impacts of trade policies on agriculture and AKST are studied as a variant to the reference run based on the GEN-CGE model for 2025 and 2050 for the case of India. The alternative run assumes that the peak tariff rate as an average of both agricultural and non-agricultural goods would fall by 88% in the first 25 years with the backdrop of WTO bindings. This alternative simulation for 2025 is noted as 2025-1. In 2050, the tariff would further fall by close to another 7%. Under this simulation, the tariff in 2050 would be around 2%.

By 2025, there would be positive growth of both casual and regular male and female workers' average real wage rate (Table 5.31). However, the rise would be higher for the female workforce, indicating a greater demand for female workers in 2025 compared to male workers. In India, the underlying production process reflected by the 2002 structure informs that female workers are less intensive in all sectors except in agro-based sectors. With AKST, there is improvement in agricultural growth, creating a higher growth for the interlinked agro-based sectors. Further, with tariff reduction, the manufacturing sector faces higher competition and experiences lower growth. Therefore, demand for more intensive factors of production in manufacturing experiences comparatively lower growth compared to agricultural and agro-based sectors. Hence wage rates of male workers rise less than wages of female workers, i.e., the low intensive factors of production.

[Insert Table 5.31]

The reference world out to 2050 and related sensitivity exercises are less accurate compared to 2025. This is because various structural factors that undergo changes cannot be captured very well in the economic analysis for a 50-year projection. By 2050 wage rates generally fall as there is a contraction of domestic production in manufacturing, mainly because of the way the economy has been driven together with lower protection. Only real wage rates of the male casual workforce would witness a marginal positive growth in 2050 and in 2050-1. Driving growth only through AKST without balanced growth in non-agriculture would lead to skewed growth and adversely affect real wages in general.

The findings show that the present trend of real wage growth of the female workforce may continue until 2025 narrowing the gender gap. The wage growth of both male and female workforce would then experience a downturn. The AKST measure is sustainable till 2025 as regards improvement of wages. In the next 25 years, i.e., by 2050, AKST needs enhanced market penetration to lead to real wage growth. Otherwise low end manufacturing may be the only expanding sector demanding casual male labor, which would explain their wage gains.

Per capita private income increases more in urban areas (at constant prices) than in rural areas during 2025-2050 (Table 5.32). Interestingly, income in the informal sector is growing faster than wages, causing a declining share of wages in total income. Moreover, as tariff rates are rationalized the situations of both rural and urban households improve relative to a situation with a more restrictive tariff regime. Any divergence occurs only in the case of the households earning from informal activities like petty trade and low-end manufacturing both in the rural and urban areas. Moreover, rural households gain gradually through the next 25 years and significantly in the following 25 years to 2050. So by the year 2050, the extent of inequality may not be as wide as one finds today, with further improvement with reduced protection.

[Insert Table 5.32]

Table 5.33 presents population deciles and per capita consumption expenditures. For the bottom 30% urban and rural population the per capita consumption level is similar. Moreover, per capita consumption of the lowest 30% of the population improves throughout 2025 to 2050 and more so in liberalized regimes; hence both rural and urban households improve their consumption. The marginally better performance in consumption of rural poor households under AKST reassures that a more agriculture oriented growth process lead to decline of the rural-urban consumption gap in the long run.

[**Insert Table 5.33]**

Table 5.34 shows an improvement of per capita availability of different agricultural crops through 2025 and further till 2050. The domestic supply in agriculture is projected to grow by 2.87% annually to 2050, and by 4.72% to 2050. The only sector showing a decline is the “meat” sector. However, apart from ‘meat’, ‘other livestock’ is expected to grow with annual growth rate of 23%. The availability of non-agricultural goods in the domestic market is also expected to grow ranging from 2-5% per annum. Overall, total domestic supply is expected to grow by 4-5% every year out to 2050. The availability of goods for the domestic market indicates that domestic production along with imports remains healthy even after fulfilling demand for exports. Domestic supply of goods grows more significantly for the non-agricultural sectors and then again for the later years from 2025 through 2050.

[Insert Table 5.34]