



**Food and Agriculture  
Organization of the  
United Nations**

# **The Global Agriculture Perspectives System (GAPS)**

**Version 1.0**

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# **The Global Agriculture Perspectives System (GAPS)**

**Version 1.0**

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**Food and Agriculture Organisation of the United Nations**

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## Recommended citation

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# The Global Agriculture Perspectives System (GAPS)

Version 1.0

## Abstract

**Keywords**

**JEL classification**

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## Acknowledgments



# 1 Introduction

## 1.1 History of long-term projections at FAO

*et al.,*

*et al.,*

*et al.,*

*inter alia*

## **1.2 Long-term projections for food and agriculture: what for and how?**

- 

-

•

*inter alia*

---

## 2 Model specification

*r i ac al alp*

### 2.1 Supply

#### 2.1.1 Crop production

*ac fs,*

*PC fs t r ac<sup>3</sup> PP r ac t*

---

*acp ac*

$$YLD_{r,ac,fs,t}^{cr} = a_{r,ac,fs}^{yld} \lambda_{r,ac,fs,t}^{yld} \prod_{acp} PP_{r,acp,t}^{\omega_{r,ac,acp,fs,t}^{yld}}$$

$$A_{r,ac,fs,t}^{cr} = a_{r,ac,fs}^{area} \lambda_{r,ac,fs,t}^{area} \prod_{acp} PP_{r,acp,t}^{\omega_{r,ac,acp,fs,t}^{area}}$$

$$XP_{r,ac,fs,t}^{cr} = YLD_{r,ac,fs,t}^{cr} A_{r,ac,fs,t}^{cr}$$

$$XP_{r,ac,t} = \sum_{fs} XP_{r,ac,fs,t}^{cr}$$

## 2.1.2 Cropping intensity

*CI*

$$CI_{r,fs,t} = \frac{\sum_{ac} A_{r,ac,fs,t}^{cr}}{Arable\ land_{r,fs,t}}$$

## 2.1.3 Livestock production

*al*

*al*

*alp*

*HERD*

$\chi^{sr}$

$YLD^{lv}$

$\lambda$

*PP*

*PFEED*

$\omega^{herd}$

$\omega^{fd}$

*lv*

$XP_{al}$

$$HERD_{r,al,lv,t} = a_{r,al,lv,t}^{herd} \lambda_{r,al,lv,t}^{herd} PP_{r,al,t}^{\omega_{r,al,lv,t}^{herd}} PFEED_{r,al,lv,t}^{\omega_{r,al,lv,t}^{fd}}$$

$$\chi_{r,al,t}^{sr} = \alpha_{r,al}^{oftk} \lambda_{r,al,t}^{oftk}$$

$$YLD_{r,al,t}^{lv} = \alpha_{r,al}^{yldlv} \lambda_{r,al,t}^{yldlv} PP_{r,al,t}^{\omega_{r,al,t}^{yldlv}}$$

$$XP_{r,al,t} = YLD_{r,al,t}^{lv} \chi_{r,al,t}^{sr} HERD_{r,al,lv,t}$$

lvp      HERD  
PP

PFEED

al

$$HERD_{r,al,lvp,t} = \alpha_{r,al,lvp,t}^{herd} \lambda_{r,al,lvp,t}^{herd} PP_{r,al,t}^{\omega_{r,al,lvp,t}^{herd}} PFEED_{r,al,lvp,t}^{\omega_{r,al,lvp,t}^{fd}}$$

$$YLD_{r,al,alp,t}^{lvp} = \alpha_{r,al,alp,t}^{yldlvp} \lambda_{r,al,alp,t}^{yldlvp} PP_{r,alp,t}^{\omega_{r,alp,t}^{yldlvp}}$$

$$XP_{r,alp,t} = \sum_{al} YLD_{r,al,alp,t}^{lvp} HERD_{r,al,lvp,t}$$

## 2.1.4 Final agricultural output

i

a  
make

$\alpha^{mk}$

---

$\chi^{dx}$ 

$$XS_{r,i,t} = \chi_{r,i,t}^{dx} \sum_a a_{r,a,i,t}^{mk} XP_{r,a,t}$$

## 2.2 Domestic demand

$$YPC_{r,t} = \left( \frac{GDP_{r,t}}{Pop_{r,t}} \right) / \left( \frac{GDP_{r,t_0}}{Pop_{r,t_0}} \right)$$

$$Y_{r,t} = \frac{GDP_{r,t}}{GDP_{r,t_0}}$$

$$CD_{r,i,t} = Pop_{r,t} \alpha_{r,i}^c \lambda_{r,i,t}^c YPC_{r,t}^{\eta_{r,i,t}^c} \prod_j PC_{r,j,t}^{\varepsilon_{r,i,j,t}^c}$$



$$BF_{r,i,t} = \alpha_{r,i}^{bf} \lambda_{r,i,t}^{bf} Y_{r,t}^{\eta^{bf}} \prod_j PC_{r,j,t}^{\varepsilon_{r,i,j,t}^{bf}}$$

$$OD_{r,i,t} = \alpha_{r,i}^{od} \lambda_{r,i,t}^{od} Y_{r,t}^{\eta^{od}} \prod_j PC_{r,j,t}^{\varepsilon_{r,i,j,t}^{od}}$$

$$SEED_{r,i,t} = \alpha_{r,i}^{sd} \lambda_{r,i,t}^{sd} XS_{r,i,t}$$

$$XFD_{r,al,lvt,t} = \chi_{r,al,lvt}^{xfd} \lambda_{r,al,lvt,t}^{xfd} HERD_{r,al,lvt,t} (PFEEED_{r,al,lvt,t})^{\varepsilon_{r,al,lvt,t}^{pfd}}$$

$$FEED_{r,i,al,lvt,t} = \alpha_{r,i,al,lvt}^{fd} \frac{XFD_{r,al,lvt,t}}{\lambda_{r,i,al,lvt,t}^{fd}} \left( \frac{\lambda_{r,i,al,lvt,t}^{fd} PFEEED_{r,al,lvt,t}}{PC_{r,i,t}} \right)^{\sigma_{r,al,lvt,t}^f}$$

$$PFEEED_{r,al,lvt,t} = \left[ \sum_i \alpha_{r,i,al,lvt}^{fd} \left( \frac{PC_{r,i,t}}{\lambda_{r,i,al,lvt,t}^{fd}} \right)^{(1-\sigma_{r,al,lvt,t}^f)} \right]^{1/(1-\sigma_{r,al,lvt,t}^f)}$$

$$TFEED_{r,i,t} = \sum_{al} \sum_{lvt} FEED_{r,i,al,lvt,t}$$

---

$\varepsilon^{pfd}$

$\sigma^f$

*DISC*

*XA*

*STB*

$$WASTE_{r,i,t} = \alpha_{r,t,t}^w (CD_{r,i,t} + BF_{r,i,t} + OD_{r,i,t} + SEED_{r,i,t} + TFEED_{r,i,t})$$

$$XA_{r,i,t} = CD_{r,i,t} + BF_{r,i,t} + OD_{r,i,t} + SEED_{r,i,t} + TFEED_{r,i,t} + WASTE_{r,i,t} \\ + STB_{r,i,t} + DISC_{r,i,t}$$

### 2.3 Trade, prices and market equilibrium

$$NT_{r,i,t} = XS_{r,i,t} - XA_{r,i,t}$$

*PW*

*GBAL*

$$\sum_r NT_{r,i,t} = GBAL_{r,t}$$

*a*

*i*

---

$\chi^{pp}$ 

$$PC_{r,i,t} = PW_{i,t}$$

$$PP_{r.a,t} = \chi_{r,a,t}^{pp} \sum_i a_{r,a,i,t}^{mk} PW_{i,t}$$

## 2.4 Dynamics

### 2.4.1 Demand shifters

 $\gamma$  $n$ 

$$\lambda_{r,i,t}^c = \lambda_{r,i,t-1}^c (1 + \gamma_{r,i,t}^{c,1} + \gamma_{r,t}^{c,2})^n$$

$$\lambda_{r,i,t}^{bf} = \lambda_{r,i,t-1}^{bf} (1 + \gamma_{r,i,t}^{bf,1} + \gamma_{r,t}^{bf,2})^n$$

$$\lambda_{r,i,t}^{od} = \lambda_{r,i,t-1}^{od} (1 + \gamma_{r,i,t}^{od,1} + \gamma_{r,t}^{od,2})^n$$

$$\lambda_{r,i,t}^{sd} = \lambda_{r,i,t-1}^{sd} (1 + \gamma_{r,i,t}^{sd,1} + \gamma_{r,t}^{sd,2})^n$$

 $\gamma^{xfd}$  $i$ 

---

$$\lambda_{r,al,lvt,t}^{xfd} = \lambda_{r,al,lvt,t-1}^{xfd} (1 + \gamma_{r,al,lvt,t}^{xfd})^n$$

$$\lambda_{r,al,lvt,t}^{fd} = \lambda_{r,al,lvt,t-1}^{fd} (1 + \gamma_{r,i,al,lvt,t}^{fd,1} + \gamma_{r,i,t}^{fd,2})^n$$

## 2.4.2 Production shifters

$$\lambda_{r,ac,fs,t}^{yld} = \lambda_{r,ac,fs,t-1}^{yld} (1 + \gamma_{r,ac,fs,t}^{yld,1} + \gamma_{r,ac,t}^{yld,2})^n$$

$$\lambda_{r,ac,fs,t}^{area} = \lambda_{r,ac,fs,t-1}^{area} (1 + \gamma_{r,ac,fs,t}^{area,1} + \gamma_{r,ac,t}^{area,2})^n$$

$$CI_{r,fs,t} = CI_{r,fs,t-1} (1 + \gamma_{r,fs,t}^{ci})^n$$

$$\lambda_{r,al,lvt,t}^{herd} = \lambda_{r,al,lvt,t-1}^{herd} (1 + \gamma_{r,al,lvt,t}^{herd})^n$$

$$\lambda_{r,al,t}^{yldlv} = \lambda_{r,al,t-1}^{yldlv} (1 + \gamma_{r,al,t}^{yldlv})^n$$

$$\lambda_{r,al,t}^{oftk} = \lambda_{r,al,t-1}^{oftk} (1 + \gamma_{r,al,t}^{oftk})^n$$

$$\lambda_{r,al,alp,t}^{yldlvp} = \lambda_{r,al,alp,t-1}^{yldlvp} (1 + \gamma_{r,al,alp,t}^{yldlvp})^n$$

## 2.5 Undernourishment module

CD

$\chi^w$

$$CPC_{r,i,t} = \chi_{r,fm,i}^w \frac{CD_{i,t}}{Pop_{r,t}}$$

$$\begin{cases} CAL_{r,it,t} = \varphi_{r,it,t} CPC_{r,it,t} & \text{if } it \in i \\ CAL_{r,it,t} = \alpha_{r,it}^c \lambda_{r,it,t}^c YPC_{r,t}^{\eta_{r,it,t}^c} & \text{if } it \notin i \end{cases}$$

$$DES_{r,t} = \sum_{it} CAL_{r,it,t}$$

DES  
MDER

CV

MDER

SNCDF

P

$$\sigma_{r,t}^u = \sqrt{\log(CV_{r,t}^2 + 1)}$$

$$P_{r,t}^0 = SNCDF \left( \frac{\log\left(\frac{MDER_{r,t}}{DES_{r,t}}\right)}{\sigma_{r,t}^u} + 0.5\sigma_{r,t}^u \right)$$

$$Under_{r,t} = P_{r,t}^0 Pop_{r,t}$$


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---

MDER

$p^1$

MDER

$p^2$

$$P_{r,t}^1 = P_{r,t}^0 - \frac{DES_{r,t}}{MDER_{r,t}} SNCDF \left( \frac{\log\left(\frac{MDER_{r,t}}{DES_{r,t}}\right)}{\sigma_{r,t}^u} - 0.5\sigma_{r,t}^u \right)$$

$$P_{r,t}^2 = MDER_{r,t} P_{r,t}^1$$

## 2.6 Data

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$$P_a(z) = \int_0^z \left(\frac{z-x}{x}\right)^\alpha f(x) dx \quad z$$

$f$

*NES*

---

### 3 Illustrative scenario analysis

#### 3.1 Scenario set up

*et al.,*

*et al.,*

*et al.,*

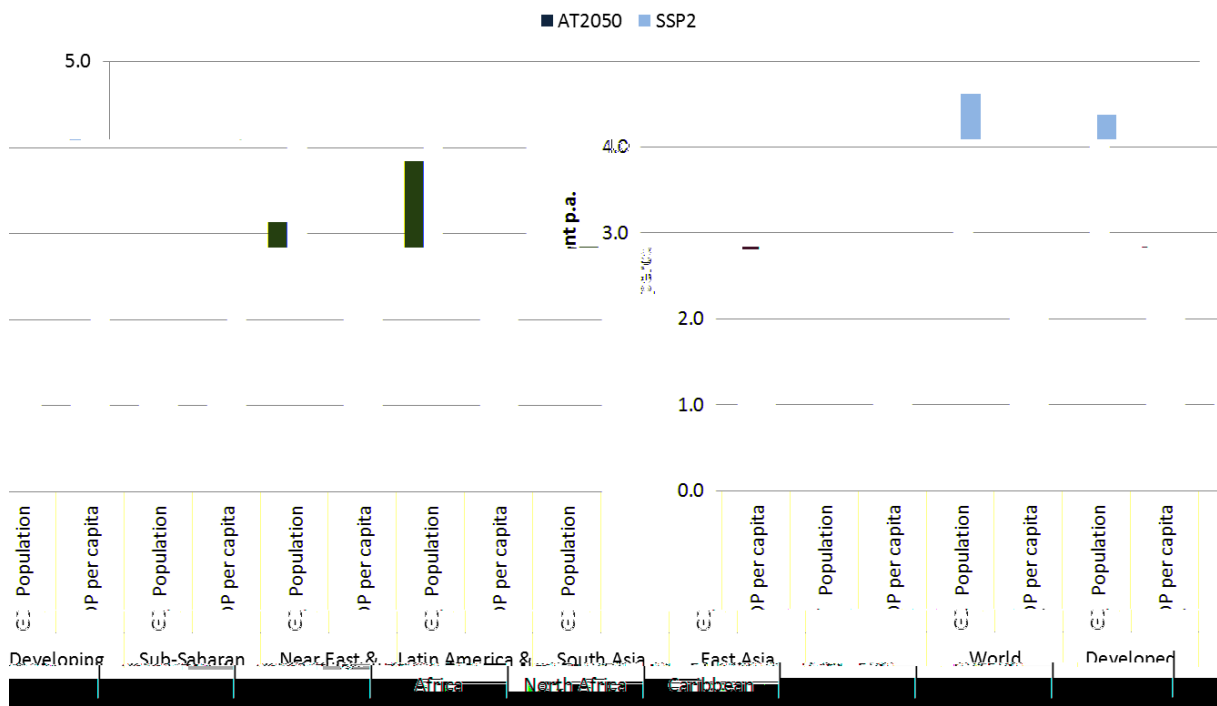
*et al.,*

*et al.,*

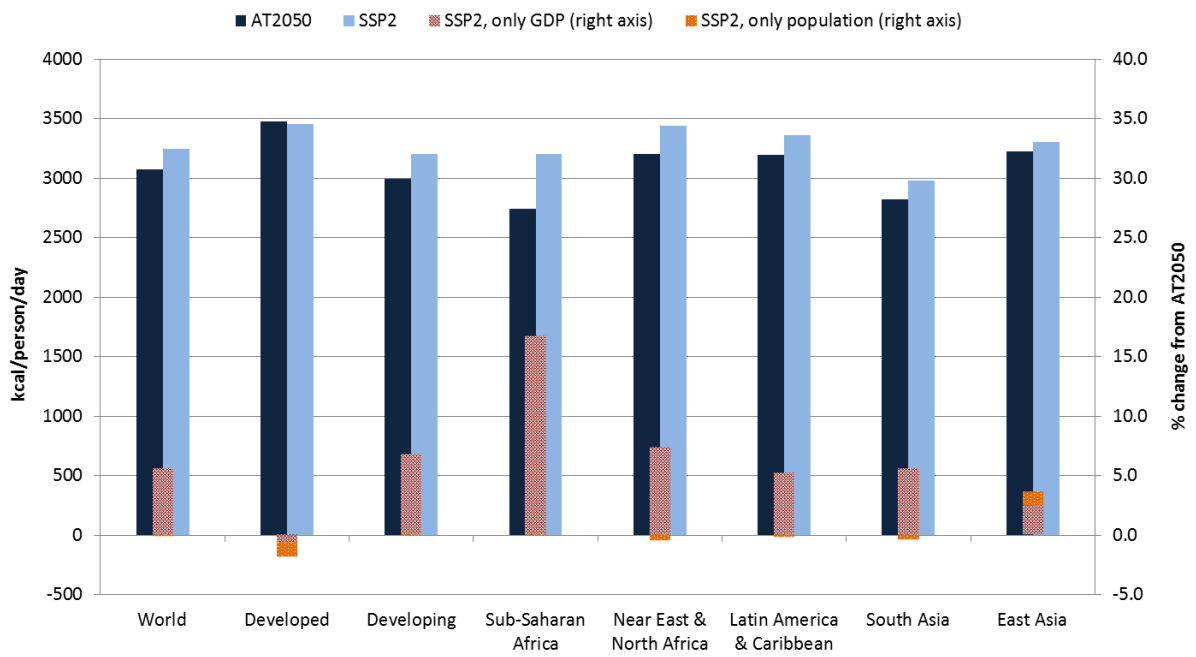
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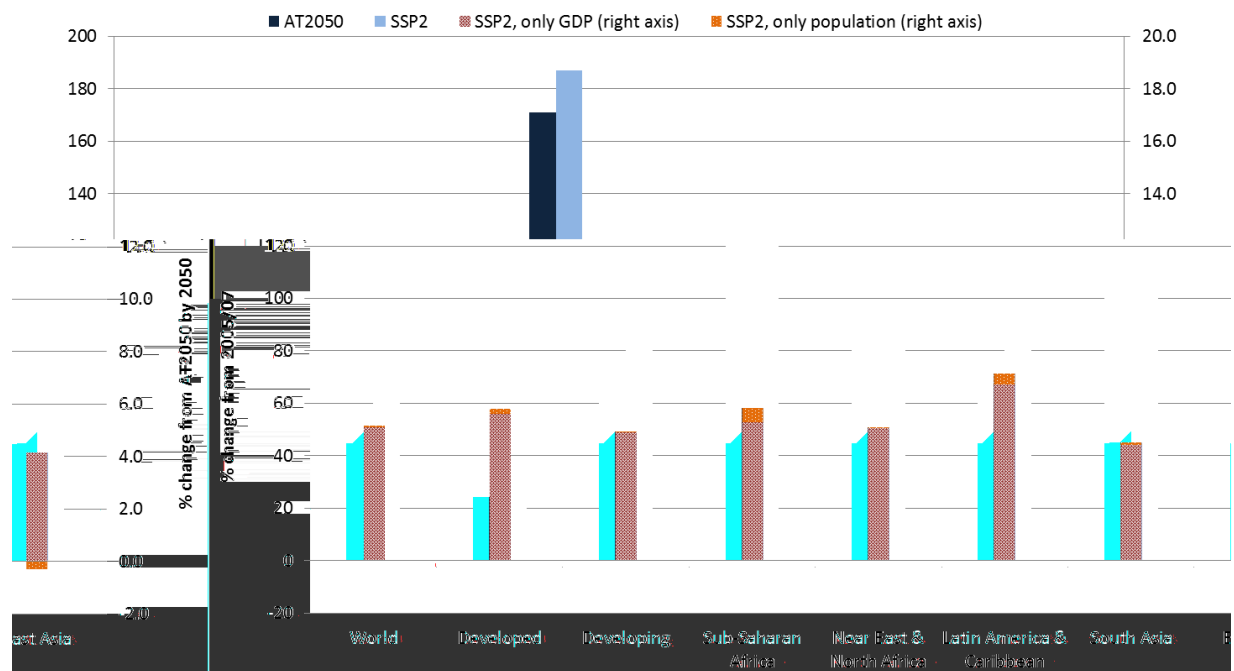
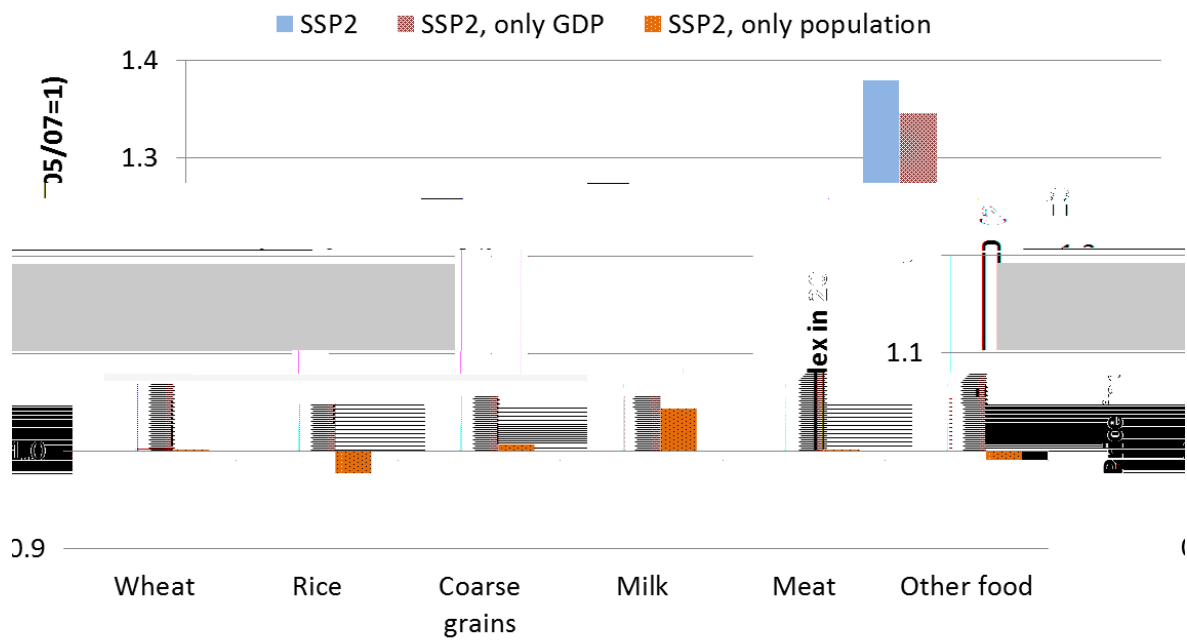
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### 3.2 Illustrative results







## 4 Concluding remarks

## References



**Annex**

Code	Long name	Commodity produced

*αl   αp*

*i*

*α*

*αc*



		<b>Mapping to FAOSTAT commodities in Food Balance Sheets / Supply and Use accounts</b>	
<b>Code</b>	<b>Long name</b>	<b>FAOSTAT code</b>	<b>Long name</b>
<i>Commodities for which supply and demand is projected</i>			

		Mapping to FAOSTAT commodities in Food Balance Sheets / Supply and Use accounts	
Code	Long name	FAOSTAT code	Long name
<i>Commodities for which only calorie demand is projected</i>			

		<b>Mapping to FAOSTAT commodities in Food Balance Sheets / Supply and Use accounts</b>	
<b>Code</b>	<b>Long name</b>	<b>FAOSTAT code</b>	<b>Long name</b>

Region	Mapping with countries in UN 2010 population revision
Code	Long name

Region		Mapping with countries in UN 2010 population revision
Code	Long name	

Region		Mapping with countries in UN 2010 population revision
Code	Long name	

Region		Mapping with countries in UN 2010 population revision
Code	Long name	

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