Working Papers in Applied Economics Economics

Article · January 2013

CITATIONS
0

READS
224

4 authors:

Mariam Camarero
Universitat Jaume I
114 PUBLICATIONS **1,151** CITATIONS
SEE PROFILE

Juana Castillo
University of Valencia
25 PUBLICATIONS **212** CITATIONS
SEE PROFILE

Andrés J. Picazo-Tadeo
University of Valencia
93 PUBLICATIONS **2,208** CITATIONS
SEE PROFILE

Cecilio Tamarit
University of Valencia
112 PUBLICATIONS **1,348** CITATIONS
SEE PROFILE

estructuraeconòmica
ECONOMÍA APLICADA II

Food security in Africans and Arab countries: a review of the topic and some suggestions for building composite indicators with Principal Components Analysis

by

Ernest Reig

July 2012

Working Papers in Applied Economics

WPAE-2012-10

ECONOMÍA APLICADA II

VNIVERSITAT DE VALÈNCIA

Departamento de Estructura Económica (Economía Aplicada II), Facultad de Economía, Universitat de València
Avda dels Tarongers, s/n, 46022 – Valencia, Spain
Phone +34 96 382 83 49 / Fax +34 96 382 83 54
http://www.estructuraeconomica.es
e-mail: investigacion.estructura@uv.es

ISSN 2172-3036

Food security in African and Arab countries: a review of the topic and some suggestions for building composite indicators with Principal Components Analysis

Ernest Reig
Professor of Applied Economics
University of Valencia (Spain)
E-mail: Ernest.Reig@uv.es

Abstract

This paper is concerned with the issue of food security, placing special emphasis on the current situation of Arab and African countries. The main conceptual aspects of food security are briefly reviewed, pointing to the shift from a former focus on food energy availability to a more comprehensive appraisal of this phenomenon in recent times. The most likely causes of recent rises in food prices are also described. Food security issues are analysed in connection with rural poverty issues and with the failure to achieve successful agricultural development in some developing countries, which sometimes have to overcome strong restrictions concerning the availability of land and water resources for food production. The paper points to the convenience of using multivariate statistical tools to summarise a wealth of food security-related indicators, and a practical example of the use of Principal Components Analysis (PCA) for data concerning 52 African and Middle East countries is provided, with a dataset originally comprising 13 variables. The PCA methodology is described in a non-mathematical fashion, also showing the basic steps in its application to this case. Two basic composite indicators, or 'principal components' are selected, one in connection with 'human development' and the other with 'being at risk of hunger', and countries in the sample are ranked according to their situation with regards to these dimensions.

Key words: food security, agricultural development, Arab countries, Principal Components Analysis

Résumé

Ce document de travail s'intéresse à la question de la sécurité alimentaire, en mettant un accent particulier dans la situation actuelle des pays arabes et africains. Les principaux aspects conceptuels de la sécurité alimentaire sont brièvement passés en revue, en montrant le passage d'un premier centre d'attention sur la disponibilité énergétique alimentaire à une évaluation plus complète de ce phénomène dans la période récente. Aussi les causes les plus probables des récentes hausses des prix des denrées alimentaires sont décrits. Les liens sont fournis avec les questions de pauvreté rurale et avec l'échec à obtenir un développement agricole réussi dans certains pays en développement, qui ont parfois à surmonter de fortes restrictions concernant la disponibilité des ressources en terres et en eau pour la production alimentaire. Le document souligne l'intérêt d'utiliser des outils statistiques multivariées, pour résumer une variété d'indicateurs liés à la sécurité alimentaire, et un exemple pratique est fourni de l'utilisation de l'analyse en composantes principales (ACP) pour 52 pays africains et du Moyen-Orient, avec un ensemble de données composé à l'origine d'observations pour 13 variables. La méthode ACP est décrite dans un mode non mathématique, en indiquant également les principales étapes de son application à ce cas. Deux indicateurs composées, ou « composantes principales », sont sélectionnés, l'un en relation avec "développement humain" et l'autre avec "étant à risque de la faim", et les pays sont classés en fonction de leur situation en ce qui concerne ces dimensions.

Mots clés: la sécurité alimentaire, le développement agricole, les pays arabes, analyse en composantes principales

Index

1. Introduction.

This paper is concerned with the problem of food security, which still plagues a large segment of the developing world. For a long time, public attention was focused on mankind's ability to increase the availability of food, in order to cover the needs of an increasing world population, and less emphasis was placed on the social and economic conditions restraining actual access to adequate nutrition for poor people in many countries. Now the phenomenon of food insecurity is better understood, and its linkages to income and gender inequalities have been repeatedly stressed. Also, the dual capacity of agricultural development to simultaneously provide jobs in rural areas and enhance domestic food supplies in poor food-importing countries has been widely recognised. This paper aims to depict the basic features of current food security issues across the world, paying special attention to the challenges faced by Arab and Sub-Saharan countries, and to propose the use of Principal Components Analysis - a multivariate statistical device - as a useful instrument to summarise, in a few dimensions, the multiple faces of a complex topic.

Agricultural production has grown dramatically over the last century. But much of the world's population still does not obtain adequate food to meet their needs. The 1996 World Food Summit held that food security is:

"a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life"

FAO – the United Nations Agency for Food and Agriculture - has coined the term food security to define a situation in which all family households have access, both in the physical and economic sense, to food suitable for all its members, and that there is no risk of losing such access. This definition implies the existence of three characteristic features: availability, stability and access. Availability means that, on average, there are enough food supplies to meet consumption needs. Supplies to ensure availability may derive from subsistence agricultural production - which is still important in many developing countries – and from agricultural products channelled through the market. Within the latter, the source can be domestic production, imports, or the use of previously accumulated stocks. Stability implies a low probability that in difficult years or seasons, food consumption may fall below certain critical levels. Access is the ability

to make effective and widespread use of available food, since the fact of having an adequate national per capita agricultural production is not a sufficient guarantee that all people can get the food they need, since many of them can suffer from hunger due to a lack of financial resources to either acquire the food that they need, or to be able to produce it.

It is difficult to overstate the importance of access as a basic ingredient of food security. Access represents the demand side of the problem of food security, and has to do with the effective endowment of economic rights, or *entitlements*, which people can use to buy food. As was noted by the Nobel Prize-winning economist, Amartya Sen (1981):

"starvation is the characteristic of some people not having enough food to eat. It is not the characteristic of there being not enough food to eat. While the latter can be a cause of the former, it is but one of many possible causes"

Along with these three aspects - availability, stability and access - most recently, a fourth dimension has been added: the dimension of the right utilisation or use of the food. The concept of using food reflects, in this context, the idea that people should make appropriate use of the food to which they have access, in terms of food choices that have an adequate nutritional quality and are safe for consumers, but also in relation to the hygiene conditions of consumption. Also, the health of those eating the food is important to use food correctly, since their ability to absorb and metabolise nutrients will depend on it. Concerns about the use of food have led to attention being paid not only to caloric intake but also to potential micronutrient deficiencies associated with inadequate intake of essential vitamins and minerals.

Achieving food security is not a static phenomenon. There are feedback effects. For example, a healthy state of nutrition can increase the working capacity of families, thus increasing their resources and positively impacting back on food purchases. Similarly, public investment projects aiming to improve agricultural extension services in a developing country will increase the human capital of rural households and their economic returns, which may allow them to acquire capital goods to increase their productive capacities, raising their present and future income; which in turn will translate into improved nutrition.

The risk of incurring a situation of global food insecurity has often been linked to the potential emergence of an imbalance between food production and population. The

modern concern with this topic has an honourable precedent in classical economic thought: Thomas Robert Malthus (1766-1834). According to this great economist, temporary improvements in wellbeing set in motion a natural drive that pushes human populations to expand and overcome their means of subsistence, eventually reaching a new - and lower - equilibrium level of income per capita due to the effect of a set of "natural brakes" (poverty, illness). The core of his argument tends to emphasise that any increase in income per capita will be neutralised, sooner or later, by an increase in the number of inhabitants. Then, a larger number of mouths to feed will force an increase in food prices relative to workers' wages, and the average purchasing power will decline. In modern economic parlance, a rising food demand will meet the law of decreasing returns in farming - within the context of technological stagnation - driving up unit production costs and the real price of food. An expansion of land area for cultivation will not solve the problem. For a time, the standard of living will rise, inducing a rise in fertility and a fall in mortality, and population growth, which would continue to devour the gains in wellbeing until the average wage fell to its original level. Malthusian pessimism underlies the assumption that a permanent change in the standard of living can arise only from restraint in fertility, or a worsening of mortality (more deaths at each wage level).

In modern times, a higher life expectancy, reduced infant mortality, rising income per capita at constant prices, and greater availability of food per person, not only in the developed but also in the developing countries, have witnessed that Malthusian "brakes" have not been able to act globally in the contemporary world, except in exceptional cases. Since the end of World War II, population growth has occurred mainly as a result of falling mortality rates, while fertility rates have tended to decrease in most countries. Contrary to Malthus' expectations, a rising income per capita has not given rise to larger families, but smaller ones.

Despite the current concentration of population growth in the developing economies, it also cannot be said that the world is witnessing a Third World version of Malthus' prophecies. Aided by advances in farming technology and new crop varieties, food production per capita in most regions of the developing world has grown even faster than in highly industrialised countries. Countries like India or China, which used to be put forward as examples of a demographic bomb, have seen agricultural output per capita rise to a level that corresponded in 2007 to respectively 139% and 279% of the 1970 level.

Unfortunately, not all regions of the developing world have shown a progression in the domestic availability of food similar to that recorded in East Asia or even in South Asia. Decreasing per capita food production in sub-Saharan Africa has been a serious concern for many years, given the inadequacy of the average levels of caloric intake in this area, and has reflected the economic stagnation, civil wars and political chaos plaguing the region in the last half century. FAO (2010) has estimated that the total number of undernourished[1] people in the world reached the 1023 million mark in 2009, which in 2010 would fall to 925 million. This means that a still very large number of people face the problem of hunger and that in many countries child mortality rates reflect a poor diet. However, it is now commonly accepted that this situation is more a consequence of the unequal distribution of worldwide purchasing power than of the inadequacy of global food production. It is a manifestation of poverty that prevents people's demand for food to show up as a solvent demand in the market, generating an appropriate supply response, either domestically or through the purchase of imported food.

The vast majority of hungry people currently live in developing countries. Two-thirds live in seven countries: Bangladesh, China, the Democratic Republic of Congo, Ethiopia, India, Indonesia and Pakistan. According to recent estimates of FAO (2010), 578 million of the total numbers of undernourished people live in the Asia-Pacific region, 239 million in sub-Saharan Africa, 53 million in Latin America and the Caribbean, 37 million in North Africa and the Near East, and 19 million in developed countries. Undernourishment is understood as a situation where the energy intake received by a person lies below the minimum food energy which is necessary to perform light activities and maintain a minimum acceptable weight according to height. Sex, age, and geographic location contribute to establishing different minimum requirements. The two basic goals that the international community has set in relation to undernutrition were established by the World Food Summit of 1996 as the first Millennium Development Goals, and consisted in halving the numbers of undernourished between 1990-92 and 2015. At present, the highest proportion of undernourished people on the total population is reached in the African continent, with 30%.

[1] The FAO measurement of undernourishment is based on a comparison of usual food consumption, expressed in terms of dietary energy, with minimum energy requirement norms. The part of the population with food consumption below the minimum energy requirement is considered underfed or 'undernourished'. Basic mean consumption information is obtained from Food Balance Sheets, and the under fed population is estimated assuming a lognormal food consumption distribution, and the use of some estimates concerning the coefficient of variation parameter.

Predictions as to the availability of food per capita over the coming decades revolve around certain assumptions about the trends in population and income per capita, and about the ability of agricultural supply to react positively to a growing demand. It can be said that, in terms of demographics, the main challenges are concentrated in the next half century, during which the world population may increase by 3.000 million people, or almost 50% compared to the present. It is worth noting, however, that the world population, while still recording large global increases, has entered into a clear process of decelerating growth, not only in countries with high income levels but also in developing countries. Predictably, the population of developed countries will decrease by 2050 by 2 per cent, while the population living in developing countries will have increased by 64 per cent, with the fastest increase corresponding to Africa. The total world population could then reach around 9.000 million.

Population growth is the main determinant of rising food needs, and in this sense it makes demand for food fairly predictable. The uncertainty is greater concerning the projections of agricultural production growth, but there are grounds for cautious optimism. In the last fifty years, increases in production per capita have been remarkable, and for example, in the case of cereals, the global per capita availability has increased by an average annual rate of 0.5 per 100. Since this increase in production has taken place in a context of reduction in real prices of cereals and other foods, this represents a considerable achievement, because not only *availability of* but also *access to* food has been increased, reducing the proportion of the undernourished in developing countries.

The expansion of grain production, as well as roots and tubers - which make up the second group of crops in the overall direct contribution to caloric intake - has been produced primarily by increased yields per unit area, while the extension of cultivated areas has not changed as much. Since the trend of yields in metric tons per hectare has a linear character, yields' growth rates are declining. This should not represent, in theory, a global problem as long as the slowdown in population growth continues, and in any case a rise in yields above the recent historical trend would be possible if adequate financial incentives were in place – like sustained price increases. In these circumstances, the increase in average production per unit area would mainly occur through the reduction of the wide gap between the maximum potential yields and those actually obtained in all those lands that meet appropriate growing conditions (Plucknett, 1995).

Currently, some 12 percent of the globe's land surface, around 1.6 billion hectares, is being used as arable land and land under permanent crops. Considering global agro-ecological zones studies, it seems that 4.2 billion hectares of globe's land surface are suitable to some extent for rainfed agriculture, which leaves a balance of 2.6 billion hectares apparently available for further expansion of agriculture, of which 1.8 billion hectares are in developing countries. This is clearly an over-optimistic assessment, because it ignores other land uses for this land surface other than for growing crops: forest cover, protected areas, human settlements, and economic infrastructure. Also, the notion of global land availability is not very useful, taking into account the wide diversity of situations around the world concerning land potentially available for agriculture. Most of the land resources are concentrated in a few countries, mostly in Latin America and in sub-Saharan Africa (Democratic Republic of Congo, Angola, Sudan), while there is virtually no spare land for agricultural expansion in South Asia, North Africa and the Near East. Furthermore, much of the remaining land suffers from ecological fragility and low fertility, or requires expensive inputs and infrastructure packages to be fully exploited.

Some basic conclusions have been reached concerning the potential for growth in agricultural production to 2050 (Bruinsma, 2009):

- Despite the slowdown in population growth, agricultural production would still need to increase by 70 per cent by 2050 to cope with a 40% increase in world population, and to raise the average food consumption to 3130 calories per day/person
- Ninety percent of the growth in crop production, eighty per cent in developing world, would come from higher yields and increased cropping intensity, with the remainder coming from land expansion. Land used for agricultural purposes will decline in the developed economies.
- Crop yields would continue to grow, but at a slower rate than in the past, declining from a yearly historical rate of 1.7%, to 0.8 per cent.

All in all, it seems that the world has enough resources to feed a rising population in the next half-century. Tables 1 and 2 report increases in agricultural production and sources of growth along the last fifty years, and advance projections to 2050. It can be observed that the slowdown in expected production growth mirrors the decelerating growth in population. The strategic role of yield increases in guaranteeing growth in crop production also stands out, even more importantly in the expected future than in the recent past. The scope for yield increases is based more on the ability of

underperforming countries to close the gap with top performers, or at least to reduce distances, than on high-yield countries to shift ceilings obtained on research stations upwards. Currently, the largest producers of wheat, rice and maize only achieve half the yields achieved by top performers. Even if a part of the gap cannot be exploited, because of country-specific agro-environmental conditions, there is still room for bridging the surmountable part of the gap, putting improved technologies and practices to use. Historical experience shows that farmers react quickly by adopting technologies leading to an increase in production if scarcities develop and prices rise. But this general observation must be qualified if the social and institutional environment, as sometimes happens in poorer countries, prevents this response. For these countries, supportive policies must be in place to help farmers overcome difficulties arising from lack of access to credit and markets, deficient educative qualifications, or lack of research and development investment meeting their specific needs.

Table 1: Increases in agricultural production. past and future

	1961/63	2005/07	2050	1961/63 to 2005/07	2005/07 to 2050
	million tonnes / persons			increment in percent	
World (146 countries)					
population#	3133	6372	8796	103	38
total production*				148	70
crop production*				157	66
cereals**	843	2012	3009	139	49
livestock production*				136	76
meat production	94	249	461	165	85
(93) Developing countries					
population#	2139	5037	7433	135	48
total production*				255	97
crop production*				242	87
cereals**	353	1113	1797	215	61
livestock production*				284	117
meat production	42	141	328	236	132
(53) Developed countries					
population#	994	1335	1362	34	2
total production*				63	23
crop production*				64	30
cereals**	490	900	1212	84	35
livestock production*				62	17
meat production	52	108	133	108	23

2005/07 = 2005; 2050 from the UN 2002 Assessment; the 2050 projection from the UN 2008 Assessment amounts to 9056 million for the 146 countries covered.
* in value terms.
** including rice in milled form. The latest data show a world cereal production of 2138 million tons for 2006/08 implying an increment to 2050 of less than 900 million ton if measured from the 2006/08 average.

Source: Bruinsma.J. (2009)

The causes of the food insecurity that still affects an important part of the world's population do not lie, therefore, in a basic failure in the overall food availability per capita. The problem consists of a lack of purchasing power for access to food by a significant proportion of the world's population, which still lives in dire poverty. Most of the rural poor live in regions where agricultural production has failed to develop sufficiently for a variety of reasons having to do with the failure to apply the appropriate techniques, which elsewhere have helped to increase agricultural yields, the prevalence of armed conflicts and political instability, and lack of social institutions, basic transport and agricultural infrastructure.

Table 2: Sources of growth in crop production (percent)

	Arable land expansion		Increases in cropping intensity		Yield increases	
	1961 - 2005	2005/07 -2050	1961 - 2005	2005/07 -2050	1961 - 2005	2005/07 -2050
All developing countries	23	21	8	8	70	71
sub-Saharan Africa	31	25	31	6	38	69
Near East/North Africa	17	-7	22	17	62	90
Latin America and Caribbean	40	30	7	18	53	52
South Asia	6	5	12	8	82	87
East Asia	28	2	-6	12	77	86
World	14	9	9	14	77	77
developing countries with less then 40 percent of their potentially arable land in use in 2005*		30		15		55
developing countries with over 80 percent of their potentially arable land in use in 2005**		2		9		89

* 42 countries accounting for 15 percent of the population in developing countries.
** 19 countries accounting for 35 percent of the population in developing countries.

Source: Bruinsma.J. (2009)

Abandoning the global perspective with regard to potential imbalances between population and food to focus on the countries that suffer the most from food insecurity, it is clear that for many of them there are some persistent difficulties that prevent substantial progress being made to alleviate this situation. Covering the gap between nutritional requirements and local availability of food on the basis of massive imports is not a viable strategy for some poorer countries, scarcely endowed with natural resources available for export, and therefore unable to generate much needed foreign exchange. The fundamental way in which these countries have to deal with this

problem and improve the nutrition of their population is by increasing domestic agricultural production, which simultaneously generates income and jobs for rural people and reduces dependency on food imports. In turn, this requires a major effort to raise agricultural yields, particularly in those countries, such as those in sub-Saharan Africa, where they are currently too low. Also, national averages of food intake in many developing countries can be misleading as to the actual situation faced by large segments of the population. If income distribution is very uneven, social groups with lower levels of income may be suffering from food insecurity that could remain veiled by national averages. The computation of food deficits must accurately reflect the segmentation of the population concerning the satisfaction of food needs and the different severity of nutritional gaps faced by different social groups (Hoddinott, 2002).

2. Global situation.

Wide disparities exist between large areas of the world regarding the prevalence of undernourishment. As previously indicated, the most serious situation, and also where the least progress has been seen in proportion to the total population, corresponds to sub-Saharan Africa. Table 3 provides information regarding the absolute number of people affected by malnutrition, while Table 4 depicts the proportion of the undernourished in relation to the population.

As can be observed, even if most of the undernourished live in Asia and the Pacific, the highest prevalence corresponds to Africa, particularly Central Africa. Asia still hosts millions of people suffering from insecure access to food, but it has registered a substantial amount of progress, when the current situation is compared to the prevailing conditions of two decades ago. Unfortunately, this is not the case for Sub-Saharan Africa, where the number of food-insecure has been on the rise. Nevertheless, there is a wide range of different national conditions. According to FAO (2010a), which uses data for the period 2005-2007, some countries, - Congo, Ghana, Mali and Nigeria – have already reached the first target of the Millennium Development Goal, cutting by half the proportion of people suffering from hunger, and Ethiopia is clearly heading in that direction. On the other hand, the proportion of hungry people in the Democratic Republic of Congo has gone up to 69% of the total population, from 26% in 1990-92. Two demographic giants, China and Brazil, were close to reach the aforementioned target, while India, which had experienced slow progress during the decade following the 1990-92 starting point, has recently seen a deterioration in the percentage of undernourished people over the total population. The figure for 2005-07

in India was 21%, while it was 20% in 1990-92. Bangladesh is seeing progress, from 38% in 1990-92 to 27% in 2005-07, although it is still far away from reaching the Millennium target. The percentage of the population at risk of suffering from lack of adequate access to food has stagnated in Pakistan at around 25%, while in Indonesia it has come down from 16% to 13% along the same period. Both countries still remain a substantial distance away from meeting the conditions of achieving the first Millennium goal.

Table 3. Undernourishment

Number of undernourished persons (millions)				
Country groups	**1990-1992**	**1995-1997**	**2000-2002**	**2005-2007**
WORLD	**843.4**	**787.5**	**833.0**	**847.5**
Developed countries	**16.7**	**19.4**	**17.0**	**12.3**
Developing World	**826.6**	**768.1**	**816.0**	**835.2**
Asia and the Pacific 1/	**587.9**	**498.1**	**531.8**	**554.5**
East Asia	215.6	149.8	142.2	139.5
Southeast Asia	105.4	85.7	88.9	76.1
South Asia	255.4	252.8	287.5	331.1
Central Asia	4.2	4.9	10.1	6.0
Western Asia	6.7	4.3	2.3	1.1
Latin America and the Caribbean	**54.3**	**53.3**	**50.7**	**47.1**
North and Central America	9.4	10.4	9.5	9.7
The Caribbean	7.6	8.8	7.3	8.1
South America	37.3	34.1	33.8	29.2
Near East and North Africa	**19.6**	**29.5**	**31.8**	**32.4**
Near East	14.6	24.1	26.2	26.3
North Africa	5.0	5.4	5.6	6.1
Sub-Saharan Africa	**164.9**	**187.2**	**201.7**	**201.2**
Central Africa	20.4	37.2	47.0	51.8
East Africa	76.2	84.7	85.6	86.9
Southern Africa	30.6	33.3	35.3	33.9
West Africa	37.6	32.0	33.7	28.5

1/ incl. Oceania

Source:FAO

Table 4. Undernourishment

Prevalence of undernourishment in total population (%)				
Country groups	**1990-1992**	**1995-1997**	**2000-2002**	**2005-2007**
WORLD	**16**	**14**	**14**	**13**
Developed countries	**—**	**—**	**—**	**—**
Developing World	**20**	**17**	**17**	**16**
Asia and the Pacific 1/	**20**	**16**	**16**	**16**
East Asia	18	12	10	10
Southeast Asia	24	18	17	14
South Asia	22	20	21	22
Central Asia	8	9	18	10
Western Asia	41	27	15	7
Latin America and the Caribbean	**12**	**11**	**10**	**8**
North and Central America	8	8	7	7
The Caribbean	26	28	22	24
South America	12	10	10	8
Near East and North Africa	**6**	**8**	**8**	**7**
Near East	**7**	**11**	**10**	**9**
North Africa	**—**	**—**	**—**	**—**
Sub-Saharan Africa	**34**	**33**	**31**	**28**
Central Africa	32	49	55	53
East Africa	45	44	39	34
Southern Africa	43	41	38	33
West Africa	20	15	14	10

Source: FAO

The first decade of the 21th Century has not been positive in terms of obtaining substantial improvements in food security for the developing economies of the world. It has been marked by two crises: the food price crisis of 2006-08, and the international financial and economic crisis from 2008 onwards. We must pay some attention to both in order to understand their consequences for food-insecure people.

After a period of low and stable prices, international agricultural prices began to rise in mid-2006 and recorded historically high levels at their peak in mid-2008. In June 2008, the price of corn tripled its average value of 2002, and the price of rice increased by over a factor of five in May 2008 from its low 2002 value. Afterwards, the decrease was also intense, as farmers reacted to high prices with record harvests in the 2008 and 2009 crop years, but food commodity prices have remained volatile, and prices of some commodities that are inputs for agriculture, like energy and fertilisers, have also

displayed a substantial amount of volatility. Now the FAO is reporting new price hikes, with prices for wheat and maize in December 2010 about 50 percent higher than a year ago, and uncertain perspectives for the 2011 global wheat production.

A varied collection of causes have been advanced to provide an explanation for recent episodes of rapidly increasing prices, which have induced great hardship among the poorest people of the world, and which depart from the recorded long price trend of the most important food commodities in the post World War II period. These causes may be classified in two groups, according to their relation with demand and supply factors.

From the demand side:

- Strong population growth in absolute terms in the developing world, even if the rates of growth are decreasing after a transition towards lower fertility rates
- Strong Gross Domestic Product per head growth in some highly populated countries, especially in China, may have helped to fuel food price rises. But this is debatable, as China and also India emerged at the time of the crisis as net exporters, and, while China has been a significant importer of soya beans, its imports have been growing steadily since the nineties and did not surge at the period (Abbot, 2009)
- High income demand elasticity for meat, milk and vegetable fats in developing countries. Rising average income levels in some developing economies have led to dietary changes favouring the consumption of animal products and more costly crop products. An increasing share of animal products in the diet requires the production of more *primary calories* - to feed expanding livestock numbers – in order to obtain the same number of *final calories* for the consumers
- Emergence of new demands on farm output (sugarcane, corn, rapeseed oil), mainly related to an increase in bio-fuel production, as OECD governments have put incentives in place to fight global warming by stimulating the shift to bio-fuels from fossil fuel consumption. According to the OECD (2008), by 2007, the use of ethanol accounted for about 14% of the total world corn demand. Also, an increasing demand for crops that may be used for energy production exerts pressure on prices of other seemingly unrelated crops, as land is taken away from these crops (i.e soya beans).

From the supply side:

- Production shortfalls related to climatic conditions, which affected cereal harvests in 2005 and 2006. As an example, a severe Australian drought had an impact on wheat prices.
- Gradual depletion of food stocks in developed economies, as a consequence of agricultural policy changes, leading to rapid upturns in prices in the face of production shortfalls
- Pass-through of price increases in energy markets
- Lack of enough R&D investment in agriculture, particularly investment concerned with the specific research needs of developing countries
- Slowing down of the trend of increase in agricultural yields

Some of these factors represent long term trends (rising population and income per head, dietary changes), while others reflect short term shocks (escalating price of crude oil, bad harvests as a consequence of adverse weather). Also, some policy responses at the time contributed to deepening the negative impact of price spikes. We must mention the behaviour of some food exporters that restricted exports to prevent or moderate price rises within the domestic economy, destabilising international markets and undermining the confidence of importing countries in the international trade system. Export bans have been an important force in causing high prices in the thin world rice market.

Rising prices in the international markets do not necessarily drive up domestic prices to the same proportion. Border prices are not always transmitted to domestic prices, and the transmission to rural and urban areas may also be different. There are two main reasons to explain imperfect transmission. The first affects countries that are largely self-sufficient and not well integrated into international markets, because of high transaction costs and a deficient network of transport infrastructures. The second has to do with governments pursuing policies adopted with the goal of stabilising domestic markets and effectively severing the links between price developments in domestic and international markets. Importers may cut tariffs and subsidise consumption and exporters may apply new taxes to exports. Both can resort to the management of public stocks for stabilisation purposes, as the release of stocks can limit domestic price increases. Generally speaking, urban areas are more likely to be integrated with

world markets, while rural areas suffer from poorer market information and infrastructures and can remain more isolated.

Global price increases are more likely to be transmitted to domestic markets when some conditions are met: the food commodity of reference is internationally traded, local and international commodities are close substitutes, national trade policy is relatively open, and there are good transportation links with international markets. But even if the composition of domestic diets includes some food items that are not traded in international markets, price pressures may show up in the domestic market when consumers react to high prices in tradable food commodities by shifting demand to domestic staples, thus changing local demand conditions for all farm commodities. Energy prices can also exert a disproportionate amount of influence on food prices, not only because energy enters as an input in the production of fertilisers, or is consumed to fuel agricultural machinery, or that bio-fuels compete with food crops for scarce farmland, but also because a rise in fuel prices sets off a rise in transportation costs. Agricultural commodities tend to display a low value-bulk ratio and are more prone than other economic activities to more acutely reflect rises in fuel costs.

Food inflation is a good instrument to measure the extent to which domestic food items become more expensive as world prices go up. Many factors influence developments along the causal chain linking price rises for food commodities in international markets and increases in the cost of living for domestic households. One is the share of basic staples, like grains and oilseeds, in diets, that is normally higher in developing economies than in developed ones. Another is the extent to which animal product producers, processors and distributors absorb in their margins much of the cost increases or pass them fully to the consumers. Processing and distribution margins are habitually lower in developing economies, implying that there is little room for shrinking in response to rising prices of raw food items. Another element, as stated before, is the willingness and ability of governments to prevent the transmission of price increases by using different trade and fiscal policy instruments. Finally, the share of food in household budgets also influences the final outcome. It is well known that the weight of food expenditure in household budgets diminishes as a country becomes richer, with the implication that poorer people living in developing economies are more severely hit during episodes of food inflation. Table 5 presents food-inflation related data for a group of developed and developing economies

Table 5. Food price contribution to consumer inflation from February 2007 to February 2008.Selected countries

Country	Total CPI % Change [1]	Food Price inflation [1]	Expenditure share of food	Food contribution to change in CPI[3]
Developing				
Guatemala	8.04	11.6	38.9	4.5
Sri Lanka [2]	19.37	25.6	62	15.9
Bostwana	7.7	18.3	21.8	4.0
India[2]	4.6	5.8	33.4	1.9
Indonesia	6.8	11.4	26.7	3.0
Pakistan[2]	10.6	18.2	41.5	7.6
South Africa	8.6	13.6	21	2.9
Jordan	5.4	9.1	39.7	3.6
Peru	4	6.4	29.6	1.9
Senegal	5.8	10.9	40.3	4.4
Egypt	9.5	13.5	41.5	5.6
Haiti	9.9	11.8	50.3	5.9
Kenya	15.4	24.6	50.5	12.4
Bangladesh	10.3	14.2	64.5	9.2
China	8.7	23.3	27.8	6.5
Developed				
USA	4.0	5.1	9.8	0.5
France	2.8	5.0	16.3	0.8
Germany	2.8	7.4	10.4	0.8
UK	2.5	5.6	11.8	0.7
Japan	1.0	1.4	19.0	0.3
Greece	4.4	6.6	17.8	1.2
Spain	4.4	7.1	21.9	1.6
Switzerland	2.4	2.2	11.0	0.2
Poland	4.3	7.1	30.4	2.2
Sweden	3.1	5.9	13.4	0.8

1 Percentage change February 2007 to February 2008.
2 Includes beverages and tobacco.
3 Contribution is column 2*3/100
Souce: OECD Secretariat. For OECD member countries, April 2008. FAO Secretariat for non-OECD countries.

As can be observed, there are wide differences between countries. While the contribution of food to the total change in the Consumer Price Index (CPI) was 15.9% in Sri Lanka from February 2007 to February 2008, it was only 0.2% in the case of Switzerland. Food price inflation ranged from 1.4% in Japan to around 25% in Sri Lanka, Kenya and China, largely different figures from those registered in international prices for grains and oilseeds, which doubled or more than doubled over the same period (Abbot, 2009).

The impact of higher food prices in rural areas has been the subject of some controversy. Some people argue that price increases represent an incentive for farmers to produce more, and consequently allow them to earn more and escape poverty. But not all rural inhabitants are net food sellers, and the consequences of higher food costs are strongly felt by those farmers less endowed with productive assets, particularly landless labourers. Poor people are more constrained in terms of the adoption of

coping strategies in the face of a food crisis, and they are particularly vulnerable if they were already reliant on food assistance, or if they inhabit conflict zones. A consensus has been reached, at least among international institutions, that high food prices in the last few years have contributed to an increase in the number of hungry people, spreading poverty, not curing it. Nevertheless, the assessment of the quantitative effects differs. The World Bank (2008) has estimated that an additional 105 million people have fallen below the threshold of extreme poverty, and the FAO (2008) has estimated that an additional 75 million people are now suffering from hunger. It seems that most of the supply response to the episode of high prices has taken place in exporting countries belonging to the OECD area, and not in developing economies.

The evidence that poor people are most severely affected by food inflation calls for effective policy tools to protect the most vulnerable consumers. These tools must be targeted to these groups, and involve the creation or enhancement of safety net programs based in means-tested cash transfers or in-kind transfers. A number of Asian, African and Latin American countries have, in recent years, introduced these programs to address the risk of starvation of some of their citizens. An example is the case of Ethiopia, where food or money transfers for public works in the Productive Safety Net Programme was increased by 33% in January 2008. Input support programmes were also scaled up in many African countries to counteract the rapid rise in the international price of fertilisers, which overcame the rise in food prices. The main advantage of the adoption of food-for-work or cash-for-work programmes lies in their potential for self-targeting to poor individuals that are able and willing to work, and the direct link with the *access* facet of the food security problem, as these programs contribute to the maintenance of incomes of the most deprived segments of the population in the event of negative shocks (i.e. a fall in labour demand in the private market). These programs also offer a positive by-product in the form of their contribution to the creation of valuable infrastructures if good-quality projects are chosen for their implementation.

On the other hand, resorting to trade policies as a policy response presents important risks. Food importing countries have applied tariff cuts to contain food price increases in the domestic market, but tariff data suggests that most developing economies no longer apply high tariff rates on basic foods, meaning that the scope for substantial cuts offsetting an inflationary trend in food prices is rather limited. For a sample of 60 low-income food importers that were surveyed in 2008, applied tariffs on cereals and vegetable oils fell within the range of 8% and 14% respectively, and tariffs were much

lower than this average for a majority of these countries (FAO, 2010c). Also, cutting tariffs or taxes on food reduces government revenue and does not allow for the targeting of disadvantaged people, as benefits accrue to both wealthier and poorer net food consumers. Other developing economies have implemented export restrictions to protect domestic food security, even completely banning food exports. The problem is that such a move, when undertaken by big exporters, can exert a significant influence on the destabilisation of world markets. An example is that the 2008 decision of India and Vietnam to ban rice exports resulted in a 43% increase in the price of rice between October and February of the same year. Wild fluctuations in price levels in international markets can diminish the willingness of importers to accept international food supplies as a reliable source to complement domestic production and boost food security. And in the long term, export restrictions may discourage investment in the modernisation of agriculture and damage food security.

When the appropriate response on the part of domestic authorities and international agencies is lacking, rural households in developing economies resort to more painful ways of adjustment, which impoverish themselves and damage the prospects for agricultural development. They disinvest in human capital, taking their children out of school, decrease their purchasing of agricultural inputs, which are essential to increase farm productivity, sell capital assets, mainly livestock, and consume part of the seed that was stored for the next planting season.

Food price developments and food security impacts do not only depend on changes or special events directly originating in the farming sector and the rural economy. After the food crisis of 2006-08, an international financial crisis has hit the world economy since 2008, and developing economies have been severely affected. Even if there are some common elements with other crises in the past, the current crisis presents some peculiar aspects that make it different. In the first place, the troubles caused by the current economic and financial crisis have been more widespread, having hurt all large industrial economies and most of the developing world. Secondly, the crisis has arrived in the aftermath of a period of exceptionally high food prices, while the poorest segment of the population of developing countries has not yet recovered from the hardship involved in the transmission of high world prices to domestic markets in 2006-2008. Finally, a third specific aspect is that developing economies are nowadays more heavily integrated into the world economy, both financially and commercially, and have become more exposed to macroeconomic impacts arising in international markets.

The consequences of these special traits of the current crisis are important. While in the past developing countries could expect to reap some benefits from depreciations of the exchange rate, to ease their economic adjustment to macroeconomic shocks, this is no longer the case. When domestic markets in both developed and developing economies suffer from demand slump, it is much more difficult to boost exports by resorting to a sharp depreciation of the domestic currency. Also, when mass unemployment plagues the destination countries of third world migrants, remittances slow down, hurting consumption by poor households in the countries of origin. It should be noted that income from migrant remittances has achieved a strategic relevance in some developing economies, helping to fund consumption and investment, and amounting to a relatively high share of GDP. According to World Bank figures, recorded workers' remittances amount to 2% of GDP in the developing world as a whole, and reach 6% levels for low-income countries. In some countries, like Lebanon, remittances represent 24% of GDP, and account for between 5 and 10% of GDP in several African countries, including Egypt and Morocco.

The recession in the developed economies has also had a severe impact on trade, credit and aid flows to developing economies. The International Monetary Fund has estimated that global trade fell by 11% in 2009, damaging the prospects for an export-led recovery in some developing economies, and that foreign direct investment has fallen by 40% in developing economies as a group, while in sub-Saharan Africa there has been a 30% fall. Also, budgetary constraints in 2009 in donor countries have led to projections of a drop in financial assistance to poor countries, where it often makes up a large proportion of GDP (FAO, 2010b).

Table 6—Potential policy responses to food crises

TYPE OF INTERVENTION	TIME FRAME		
	SHORT TERM (< 1 YEAR)	MEDIUM TERM (1–3 YEARS)	LONG TERM (> 3 YEARS)
Reduce food prices for consumers (price-oriented policies)	• Reduce tariffs/taxes on food • Adopt food price controls/take action against profiteers • Adopt consumer subsidies • Adopt food export bans or taxes • Pursue government food imports • Release food reserve stocks	*Same options as short term plus:* • Establish food reserves and release policy • Establish variable tariffs or variable export subsidies/taxes • Pursue options to increase domestic food production (see below)	*Same options as medium term plus:* • Invest in marketing infrastructure, institutions, and information • Invest in increased food production capacity (see below)
Increase food production (supply-oriented policies)	*Limited short-term options*	• Adopt input subsidies • Adopt producer price supports and subsidies • Expand agricultural credit • Strengthen agricultural extension	*Same options as medium term plus:* • Pursue agricultural R&D • Invest in productive infrastructure and assets (e.g., irrigation, mechanization) • Improve natural resource management • Improve property rights and resource tenure systems
Increase food availability for or income of target groups (income-oriented policies)	• Increase support through existing social protection programs • Increase public sector wages • Increase food aid programs	*Same options as short term plus* • Establish new social protection programs or expand/improve existing ones	*Same options as medium term and those for increasing food production plus* • Invest in other development and antipoverty programs (e.g., education, promote rural nonfarm enterprises)

Source: (Benson et al. 2008)

Table 6 summarizes potential policy responses to food crises. Each type of intervention offers different options according to the timeframe of reference. It can be observed that in the short term policy interventions focus, for the most part, on reducing the impact of food price rises in household budgets, through a variety of policy tools-trade interventions, subsidies, stock management etc. - or on providing support to disadvantaged people by using existing social protection programs. More prolonged time frames allow policy-makers to take on board some policy measures intended to create incentives for an increase in agricultural supply, foster productivity and improve institutions and infrastructures.

3. Rural poverty and food insecurity.

There is a wide consensus that poverty is probably the main determinant of people being food insecure. Thus, the focus on poverty and its determinants is important to gain insight into the factors leading to food insecurity at the household level. Developing economies are home to the overwhelming majority of poor people in the world and three out of four people in those countries live in rural areas. Most of the

rural dwellers in developing countries depend on agriculture for their livelihoods, and that is why a dynamic agricultural sector can be a key element in any scheme to escape poverty and improve living conditions on a mass scale. The large share of agriculture in the labour force and in GDP of poor countries suggests that strong growth in the farming sector is of critical importance to foster global economic growth in the first stages of the development process. Later on, economic history shows that, as income per capita rises, the share of agriculture declines and other economic sectors take over. But, during a crucial take-off stage, there is a persistent gap between the share of agriculture in employment and the share of agriculture in GDP, the first being higher, which explains why poverty is concentrated in rural areas even when non-agricultural output follows an accelerated path of expansion.

There are sharp contrasts worldwide in the ability of agriculture to act as an engine of growth. China and South Asia have experienced a very satisfactory performance concerning agricultural change, in the aftermath of the green revolution, while Sub-Saharan African remains anchored in a still-unsatisfactory performance of this sector.

The World Bank' World Development Report (2007) has expounded the existence of 'the three worlds of agriculture for development' in recent years, by classifying countries in three main categories according to the share of aggregate growth originating in agriculture and the share of aggregate poverty in rural areas. The $2.15 a day threshold has been adopted in this case for the definition of the poverty line. It is worth paying close attention to this classification as it sheds light into alternative strategies of agricultural development that fit the specific needs of countries belonging to different categories. Basic social, demographic and economic data of the three country types are displayed in Table 7 and Table 8.

Table 7: Demographic and economic characteristics of three country types. 2005

	Agriculture-based countries	Transforming countries	Urbanized countries
Population			
Total (millions)	615	3.510	965
Rural(millions)	417	2.220	255
Share of rural population (%)	68	63	26
Annual population growth. 1993–2005(%)	2.5	1.4	1.0
Geographical distribution of rural population (%)			
Sub-Saharan Africa	82.2	13.6	4.2
South Asia	2.2	97.8	0
East Asia and Pacific Islands	0.9	96.1	2.9
Middle East and North Africa	8	92	0
Europe and Central Asia	0	12	88
Latin America and Caribbean	2.2	9.7	88.1
Labor force(in2004)			
Total (millions)	266	1.780	447
Agricultural (millions)	172	1.020	82
Share of agriculture (%)	65	57	18
Economy			
GDP per capita(2000 US$)	379	1.068	3.489
Annual GDP growth. 1993–2005(%)	3.7	6.3	2.6
Agriculture			
Agriculture value added per capita(2000 US$)	111	142	215
Share of agriculture in GDP(%)	29	13	6
Agriculture's contribution to growth. 1993–2005(%)	32	7	5
Annual agricultural GDP growth. 1993–2005(%)	4	2.9	2.2
Annual nonagricultural GDP growth. 1993–2005(%)	3.5	7	2.7

Sources: World Bank (2007).
Note: Averages are weighted and based on 74 countries with at least 5 million people, except for agriculture value added, which is based on 71 countries because of missing information. Data are for 2005 unless otherwise noted.

Table 8: Poverty in three country types. 2002 countries

	Agriculture-based countries	Transforming countries	Urbanized countries
Population (millions)			
Total	494	3.250	888
Rural	335	2.100	251
Poverty ($2.15 a day)			
Total poverty rate (%)	80	60	26
Number of rural poor (millions)	278	1.530	91
Share of rural poor in total poor	70	79	39
Rural poverty rate (%)	83	73	36
Urban poverty rate (%)	73	35	22
Poverty ($1.08 a day)			
Total poverty rate (%)	49	22	8
Number of rural poor (millions)	170	583	32
Share of rural poor in total poor (%)	70	82	45
Rural poverty rate (%)	51	28	13
Urban poverty rate (%)	45	11	6

Source: World Bank (2007).
Note: Averages are weighted and based on 60 countries. Poverty lines are defined in 1993 purchasing power parity dollars.

The first group is made up of *agriculture-based countries*, most of them in Sub-Saharan Africa, where the share of agriculture in GDP is 29% and agriculture accounted for about a third of overall growth over 1993-2005. They face rapid population growth and rural areas host 68% of the total population, which amounts to 494 million people. The share of agriculture in the labour force is very high, around 65%. The rural poverty rate is higher than the urban poverty rate in these countries, but the difference is not as important as in later stages of economic development. The rural poverty rate is 83%, the urban poverty rate is 73%, and 70% of the total of poor people inhabit rural areas.

The second group comprises *transforming countries*, which with 3.510 million inhabitants host the largest population of the developing world. This group encompasses most of South and East Asia, North Africa and the Middle East, and some countries from Europe and Central Asia. Agriculture contributed only 7% to growth during the period 1993-2005, and makes up 13% of GDP, but still represents 57% of the labour force. In these countries there is a striking difference between rural poverty rate, at 73%, and urban poverty rate, which is much lower, at 35% ($2.15 a day benchmark). The share of the rural poor in the total poor is therefore very high, around 82%. These countries also face strong competition for the use of natural resources, for

example land and water, from a rapidly growing urban population and the expansion of non-agricultural economic sectors.

The third category contains a group of *urbanised countries*, where agriculture makes up only 6% of GDP and 18% of the labour force, with a contribution to growth of about 5% during 1993-2005. The total population of this group of countries is 965 million, and the poverty rates are substantially lower than in the other categories, but 36% of the rural population and 22% of the urban population still live below the poverty line. The share of the rural poor in the total poor is 45%.

There are substantial differences in the role that agriculture can play in the process of economic development and in poverty-reducing strategies in these three, broadly defined, categories of countries. The agricultural sector is critical for development in *agriculture-based countries*, and typically comprises two different subsectors: a staple crop sector, which is the largest and produces mostly for the domestic market, and a non-staple export sector that exports traditional commodities, but also some more high value products, such as vegetable, flowers and fish. Gains in staple crop productivity are important because they increase domestic food supply and reduce food prices, keeping labour costs low in the non-farm labour-intensive sectors. The poverty reduction effects of increasing farm output depend on a variety of factors, including the net marketing position - food buyers or sellers – of poor households and the price elasticity of food demand. Rising productivity in the staple crop sector helps to reduce urban poverty, because basic food items become more affordable, and also helps to improve the living conditions of a substantial share of the rural population, because it has been estimated that at least half of poor rural households are net food buyers. On the other hand, the food-exporting subsector has recently benefited from the opening of new foreign markets- for fish, flowers, vegetables, and premium coffees - and contributes to aggregate growth by supplying a steady flow of foreign currency, which allows imports of capital goods necessary for economic development.

A sustained increase of domestic food production in *agriculture-based countries* is a must, and faces some favourable conditions to be accomplished. In fact, prospects for strong growth in food demand in these countries are good, as they face rapid population growth and their own low levels of living standards ensure high food demand elasticity. A frequent shortage of foreign currency also advises in favour of enhancing domestic capabilities for agricultural growth. And in some African countries belonging to this category, there is a comparative advantage of the export of

unprocessed primary products, which can provide a further stimulus for agricultural growth.

For *transforming countries* the problems are different. A specific issue is the great divide between the rural and urban conditions concerning incomes and poverty, as non-agricultural sectors now account for most of the economic growth. Sometimes rural people face difficulties, based on a lack of education, in taking jobs in the urban services sector. In other cases rural outmigration in excess of the absorbing capacity of the urban economy produces congestion in urban centres, and increases in the number of urban unemployed, which only contributes to the urbanisation of poverty. This means that agricultural growth can do much to foster rural income and reduce poverty. But, even if it is still necessary to focus on increasing the production of basic staple foods to improve food security, new drivers of agricultural growth tend to emerge in this type of countries. As economic growth proceeds and average income levels rise, the composition of the diet of the population changes and the demand for livestock products and high value crops rapidly expands. Therefore, the challenge for these economies, in order to alleviate poverty, is to connect poor people with these new growth processes, either as smallholders or as labourers. The ability to pull people out of poverty also depends on the potential of the agricultural sector to spread the positive effects of growth across rural dwellers, which in turn depends on institutional factors like enjoying a relatively equitable distribution of land ownership. In China, where such equity conditions are met, the reduction in poverty was almost four times higher from agricultural GDP growth than from growth originating in industry or services, while in India and Indonesia growth in rural services contributed as much as growth in agriculture toward reducing poverty (World Bank, 2007). Also, as these countries achieve higher levels of economic development, growth in non-farm employment puts upward pressure on agricultural wages, benefitting the landless poor.

Urbanised economies agriculture is mostly tradable and the challenge concerning the role of agriculture in the pursuing of economic development is the creation of enough opportunities for small farmers in supplying the modern food markets and occupying the new jobs in the modern rural and urban sectors of the economy. Agribusiness and food retailing are increasingly concentrated, which makes it more difficult for people poorly endowed with physical or financial assets to rise to this challenge. The tradability of agricultural production means that prices do not necessarily fall as a consequence of productivity increases, and that large landowners are now able to capture most of the economic surplus arising from farm output. The poverty-alleviating effects of output

expansion are not automatic. There are a variety of experiences. While in some countries, like Chile, the rural poor have benefitted from a labour-intensive export boom, in others, like Brazil, the main contribution to the reduction in rural poverty rate has been the creation of jobs in the rural non-farm economy and income transfers (World Bank, 2007).

The World Bank Report (2008), repeatedly mentioned in the previous paragraphs, has stressed the importance of agriculture in achieving a sound rate of growth in developing economies. To realise the full potential of the agricultural sector, some policy reforms must be adopted. In some cases, as in eliminating the bias towards agriculture in macroeconomic and trade policies, the main responsibility lies in the hands of national governments, and some important positive steps have been taken since it was asserted, a long time ago, that many developing economies were taxing agriculture relative to other sectors (Krueger et al., 1991). In other cases, as in reforming international trade policies to improve access to domestic markets in developed countries to Third World's producers, and eliminating the depressing effect on world prices of farm income support policies of developed countries, the path has been initiated - mostly in the aftermath of the conclusion of the Uruguay Round of the World Trade Organisation - but not concluded. On the other hand, there has been the temptation in developing economies to privilege the extraction of surplus from the farming sector, to fund growth projects in other sectors, before agriculture development has taken off. Now, both academics and politicians are more sensitive than in the past to the risks involved in this approach, and are ready to recognise that public investment in agriculture must not be neglected in the early phases of agricultural development. The core of public investment must be centred on the supply of public goods, such as agricultural research, rural infrastructure, education and health. Also, donor support to the agriculture of developing economies has to be reactivated by the international community, as it has fallen behind other development initiatives in the last two decades.

A recent effort has been undertaken to summarise the main traits concerning poverty and the characteristics of the rural poor (Valdés et al., 2010). After pointing to the existence of approximately 3.000 million people living in the rural areas of the developing world, with about 30 percent of them living on less than $1 a day, it has been stressed that the decline in the global number of poor owes most to economic growth in East Asia and, particularly, in China. During the mid-1980s, China accounted for nearly a third of the number of the world's poor, while in 2004, after a period of

sustained high rates of GDP increase, it accounted for only 13%. Unfortunately this success story has not characterised the experience of some other areas in the world, particularly that of Sub-Saharan countries, where the numbers of poor increased along the same period of time.

Across all regions of the developing world, the incidence of poverty is greater in rural areas than in urban areas, particularly in East Asia, the Middle East and North Africa. The greatest share of the poor in all developing countries is concentrated in rural areas, with the exception of Latin America and the Caribbean. Rural populations have higher rates of fertility than urban populations. Rural populations also have higher dependency ratios of the non-working-age population to the working-age population, and the ratio of females to males – the feminity ratio – in rural areas is higher in rural than in urban areas in South Asia, the Middle East and North-Africa, and Sub-Saharan Africa. Both aspects are important, because it has been shown that, all things being equal, female-headed households are more likely to be poor, and that high dependency ratios are correlated with poverty.

Concerning poverty dynamics, recent research in developing countries has reached some basic empirical findings, which have been summarised in Valdés (2010):

- Gradual trends in poverty result from a lot of movement in and out of poverty, which correspond to the existence of a variety of types of poverty. A basic distinction has been drawn between *transient* poverty, which is occasional and may be tackled by safety nets, insurance or income-smoothing programs, and *chronic* poverty. Chronic poverty instead demands structural growth-promoting interventions, and is linked to persistent deficiencies in terms of human and physical capital or infrastructures.
- Escaping and entering poverty may have different determinants. Some natural (weather), social (employment) and health shocks exert a large influence as determinants of falling into poverty. Rural non-farm activities are a key route out of poverty, but many of the rural poor that are successful in getting out of poverty remain active in agriculture.
- Chronic poverty is connected to a low endowment of assets and/or a low return to these assets: low levels of education and lack of access

to land and other productive assets. An unfavourable location and large household size are also influential factors.

Finally, a general assessment of the patterns observed in rural households in 15 developing countries – using FAO's RIGA database - has shown that poor rural households have more members, a greater share of dependents, less education, less land and less access to running water and electricity than non-poor households. Frequently, but not always, they also own less livestock. Income sources in rural areas may broadly correspond to on-farm activities (self-employed farming), agricultural wage activities and non-farm activities (the sum of non-agricultural wage employment and non-farm enterprises). According to the information provided by RIGA countries, off-farm sources of income account for at least 50 percent of total income in those countries belonging to Eastern Europe, Latin America and Asia (with the exception of Vietnam), while on-farm sources of income are more important for the African countries included in the dataset. Not all countries share the same pattern in terms of the main source of income for rural households. Non-farm income has a higher share among poorer rural households in Pakistan and Kenya, but a higher share among richer households in Niger, Rwanda, Mozambique and Vietnam. Poor people in Jordan and Honduras have a lower share of income from non-farm activities than the non-poor, while in Egypt and China the opposite happens. Land ownership is negatively correlated with non-farm work and income, which explains that the access to land determines whether households may remain in agriculture or decide to move to other activities. Land is of paramount importance for the decision to undertake farming activities, but also has an indirect value for many households even if they are not fully dedicated to farming, because land frequently provides useful collateral for credit in undertaking other economic activities.

For both farming and non-farming activities, there are important differences with regards to the income that can be obtained. There is a high productivity segment, which generates high income, which is confined to the better-endowed social groups, while a low-productivity segment serves as a refuge for the rural poor. Typical low productivity activities are subsistence farming, seasonal agricultural wage labour and some forms of off-farm self employment. Households with a very low endowment of assets, or a dependency on seasonal subsistence farm production, may find the only viable mechanism to cope with situations of food insecurity is poorly remunerated off-farm activities.

Generally, human capital, measured by the number of years of schooling, is linked to a shift to non-farm activities, because it is in these types of activities where the returns to this asset are more likely to be the highest. Also, if people have access to infrastructure and population centres, they are more likely to enjoy better opportunities of developing non-farm activities. Winters at al. (2007) have examined the relationships between rural household assets and activities, with data belonging to the 15 RIGA countries. They have found that households participating in on-farm activities own land, possess lower levels of education, are headed by an older male and tend to live further from infrastructure. On the other hand, households engaged in non-farm wage labour have higher levels of education, live closer to infrastructure and have a younger head. Households that depend on wage labour within the farming sector own little or no land, are poorly educated, live further from infrastructure and tend to have a younger male as the head of the household.

Some basic messages emerge from the research undertaken by Valdés et al. (2010). The first is that diversification of income sources is important in fighting poverty, as more and more rural workers incorporate to non-farm activities. But in the poorest countries of the sample, agriculture remains a key source of income, even for relatively wealthy households. The second lesson is that the relative importance of the three basic assets - land, education and infrastructures - considered in the study varies according to the country and context, but in most cases poor people are endowed with low amounts of all three assets. Higher levels of education are almost universally associated with higher household incomes, especially when access to education is combined with access to the other assets, infrastructure in particular. Acquiring education also helps to increase mobility within and between rural and urban areas. The third lesson is that the possibilities of increasing land holdings to such a degree that substantially higher farm income levels could be achieved are limited, even if it might increase agricultural production: surplus land may not be available, given population density, or the costs of land transfers may be too large and ineffective without further support in terms of working capital and longer-term investments. Instead it is suggested that the encouragement of rental markets could be a convenient and practical option.

Recommended policy actions include improving access to infrastructures, which improves farmers' access to markets and expands the number of employment opportunities in the non-farming activities. But specific policy measures might also be adopted, because agriculture will remain the main gainful activity of the bulk of rural

families for a long time. Besides infrastructure investments, other programs oriented to reduce transaction costs and improve productivity in on-farm activities should be adopted: improvements to the security of property rights, promotion of cooperatives or other farmers' organisations to overcome the problem of lack of economies of scale, technology transfers, and others.

4. The background: agricultural growth in Africa

The final section of this paper will be devoted to the construction of a composite indicator of agricultural development and food security for the Mediterranean Partner Countries, using as a reference the situation in this respect across the African continent. This section aims to assess the situation and main trends and challenges concerning agricultural growth in African countries. Most of the comments and insights will refer to sub-Saharan Africa, the classical counter-example for the improvements in agricultural modernisation and food nutrition that have taken place all around the world.

Sub-Saharan Africa now accounts for only 10 per cent of the world population, but 30 per cent of the world's poor. One in two Africans are poor, spending less than $1 a day to cover basic needs, a proportion that is twice as high as the world average. The lagging position of Africa with regard to the eradication of poverty and malnutrition responds to its slow and erratic growth performance. Since 1960, and for a period of 45 years, African income per head grew at about one-fifth of the average rate for other developing countries - that is to say 0.5 percent versus 2.5 percent. As a consequence, although in 1960 per capita incomes for Africa and East Asia were very similar, by 2003 the GDP per capita in East Asia was five times higher than that in Africa. Measured in purchasing power parity (PPP) adjusted terms, African incomes pr capita were more than two-thirds of those of the East Asia and Pacific region, while by the end of the 20th century they had dropped to less than a quarter (Ndulu et al. 2007). There is a wide amount of variation in growth experience within sub-Saharan countries, as there is also a variety of national conditions within the region, from middle-income and relatively sophisticated countries as South Africa to failed states as Somalia, and also from large oil-rich countries such as Nigeria to small and resource-poor countries as Niger, and from land-locked to coastal economies better connected with external markets.

Six lessons have been drawn from the analysis of Africa's growth experience along nearly half a century (Ndulu et al., 2007):

- African countries' growth experiences have been extremely varied and episodic, with large countries showing slow growth and a marked instability characterising the performance of a large number of countries.
- Disentangling the factors explaining the slow rates of growth, it is the slower productivity growth that more sharply distinguishes African performance from the experience of the rest of the world. This means that, even if attracting foreign investment and improving business climate remains very important for raising the too-low levels of domestic investment, process and product innovation is also relevant to raise productivity and competitiveness.
- Policy and governance matter a great deal for growth. While shop-floor level unit costs in Africa are comparable to those prevailing in other regions of the developing world, this is not the case with other 'indirect costs'. These include the cost of transportation and energy infrastructure services, the cost of contractual enforcement and protection of property rights, and the costly consequences of corruption and inefficient public regulations.
- Tropical location affects the prevalence of disease and pests, and, for some countries, being landlocked impacts negatively on the costs of production and trade. Geographic isolation and fragmentation and lack of regional coordination in the provision of vital infrastructures also hamper growth capacities in the region.
- Results from empirical analysis suggest a very powerful influence from the growth of trading partners' economies, pointing to the relevance of reducing barriers to trade in order to profit from the opportunities offered by global markets.
- The delayed demographic transition has also played a large role in explaining the relatively slower growth performance in Africa. Only from the mid-1980s did a slow demographic transition start in many African countries, while total fertility rates had already fallen sharply in other developing countries. Accordingly, population growth rates remained at a high level in Africa for the rest of the 20th century and age dependency increased. In turn, higher levels of age dependency ratios explain the lower savings rates in the region and have left governments facing strong fiscal pressures to deal with a larger dependent-age population.

The failure to experience economic growth has left a legacy of poverty, and, combined with a high rate of population increase, has also led to decades of stagnation or decline

in food production per capita, making Africa more dependent on food imports. This dismal growth performance has disproportionately exposed many African countries to the hardship involved in recent food price shocks.

The farming sector has also suffered from poor macroeconomic management, overvalued exchange rates and high protection rates, which have imparted an anti-export bias to the development model followed by most of these countries. More specifically, the agricultural sector has been penalised by ill-conceived agricultural policies, and from declining international terms-of-trade for agricultural products from the early 1970s to the late 1980s. Overvalued exchange rates, industrial protection and direct agricultural taxation resulted in a *negative rate of protection* for African agriculture. Since the nineties, economic policies were reformed and net protection rates have improved from about -20% in 1975-79 to less than -10% in the first half of the present decade. But even now Africa lags far behind other developing regions concerning the design of efficient incentives to foster agricultural growth. Asia has changed from a negative net protection rate for agriculture in around 1960 to high levels of positive net protection of about 20-25% since the second half of the 1980s, and Latin America is protecting its agriculture at a rate of about 5%, while the average level for the developed economies of the world remains at close to 40%. The antitrade bias is concentrated in exportable commodities. All in all, and despite recent improvements in incentives, African farmers still face the world's worst agricultural incentives (Binswanger-Mkhize, 2009). Agricultural incentives also suffer from barriers to regional integration across sub-Saharan Africa and from poor phytosanitary capacities.

Some of the circumstances that had created a negative environment for agricultural development have begun to disappear since the nineties. Macroeconomic stability has improved, a more open trade regime has been established and more flexible conditions for the operation of private operators in the farming sector have been created. Other problems, including insufficient financial support and inefficient structures for agricultural R&D focused on the specific needs of African farming, remained in place. Also, the decreasing trend in real food prices in the international markets first stopped and then started to be reversed.

The increases in prices in world food markets that have taken place in the first decade of the 20th century entail both problems and opportunities for farmers. In the short run, the ability of food importing countries to prevent the translation of international price

rises to their domestic markets has been limited. They reduced import taxes on food, and tried to expand domestic supply, but they could not effectively isolate a large number of people, that were already poor before the food crisis, from the impoverishment caused by price rises. Poor people are particularly vulnerable to food price increases because they expend an important percentage of their household budget on food, and, contrary to some intuitions, many rural households are net buyers of food. On the other hand, and taking a long-term view, gradually rising food prices may be a good thing for the rural populations of Africa, because farming may then become more profitable, leading to higher investment and output and allowing for a rise in rural wages.

While export markets now offer better opportunities to develop export flows from developing economies, some experts still see domestic markets as the key driver to increase food supply in African countries. According to them, the greatest market potential for African farmers lies in domestic and regional markets for food staples like cereals, roots and tubers, oil crops and livestock products (Diao et al., 2006). Using market figures for 2000, and trade figures for 1995-2000, it has been estimated that domestic markets for food staples, including own consumption, represent a market value of around US$50 billion, while exports to non-African countries represent around 16.5 billion and intra-Africa trade 1.9 billion. Thus, even if non-traditional exports to other continents in horticultural products, or in the products of organic agriculture, are growing rapidly, albeit from a small base, traditional food staples provide the best opportunities for small farmers in Africa. For Africa as a whole, the domestic consumption of these commodities accounts for more than 70% of agricultural output.

Rapid population growth has been a drag on African economic growth for a long time. The AIDS epidemic has further complicated the situation by increasing mortality rates in prime age, productive, adults. The demographic transition has been delayed, because it depends on raising standards of living, obtaining advances in female education and on the reduction of infant mortality rates, both causing a fall in fertility, and all these variables are somehow linked to economic growth. Now the situation is changing, and it is expected that demographic transition will take a significant leap forwards in the coming decades. Even in this case, it will take a long time before the number of young people looking for a job in the labour market starts to decline in absolute terms.

Rapid increases in the huge numbers of young people in need of a job imply that development policies must emphasise the creation of productive employment. Since agriculture is an economic sector characterised, at least in developing world environments, by its labour intensity, it must receive a priority consideration on the part of development authorities. Besides population, land is the other African resource that is in large supply. There is no scarcity of productive land per capita in Africa, in comparison with other regions of the developing world, with the possible exception of Latin America. But for a long time it has been argued that this basic resource was severely degraded, and that further population growth will only add to this degradation, that manifests itself in the form of nutrient depletion, soil erosion, and overgrazing.

Now, the view that saw in land degradation a formidable obstacle for increasing food production per capita in many African countries has been challenged. Here is not the place to reach a conclusion on this contentious issue, but, as the conventional view has been widely publicised, it is fair to pay some attention to the arguments of experts defending a different point of view.

Opponents to the pessimistic view of rapid and severe land degradation start from the historical evidence that higher population densities lead the evolution of farming systems toward technological improvements that permit higher land use intensity. The introduction of new techniques reverses the trend of decreasing soil fertility that happens to occur when permanent agriculture substitutes long fallow systems in a traditional agricultural context (Boserup, 1965). Population growth, better access to markets and a higher income per capita allow for a more sustainable use of agricultural land, promoting higher applications of organic matter and fertilisers, which stem nutrient mining, a better crop livestock integration and higher investments in land (Binswanger-Mkhize, 2009). The problems of land degradation and desertification, according to this view, do not arise from population growth, but are usually associated with open access regimes, insecurity of tenure and a long-time failure of agriculture to provide returns that justify investment in land improvements. Correction of these institutional and market failures will help to avoid land degradation.

5. The food security situation in the Arab countries.

Even if the Sustainmed Project refers specifically to a small subset of what international institutions designate sometimes as ‘Arab countries’, and others as ‘Middle East and North Africa countries’ (MENA), most of the documents issued by those institutions

concerned with the food security issue refer to the whole region. In the following I will also adopt this large region as the reference.

The MENA Region has as one of its most important characteristics that of being the most food import-dependent region in the world, with net food imports accounting for 25-50 percent of national consumption. Different factors have contributed to this result. From the demand side, the population has grown very rapidly in the last few decades, and consumption patterns have changed, because of a higher average income. It must be taken into account that the MENA population has tripled from 100 million in 1960 to more than 300 million in 2006. From the supply side, the natural endowment of the region presents limited resources of cultivable land and water.

A direct consequence of the failure to meet growing food demands with domestic supply has been rising external food trade deficits. However, it is well known that food security should not be confused with self-sufficiency. Food trade deficits may be an acceptable way of guaranteeing the availability of food supplies, but only under the condition that deficit-prone countries are able to generate enough foreign currency to pay for their imports. In practice it means being able to keep a relatively low ratio of food imports over total exports. But MENA countries are currently using 11.5% of their total exports to pay for their food imports, a percentage higher than the world average, and only three out of the sixteen countries of the region outperform the world average with regard to this food security indicator: Kuwait, United Arab Emirates and Iran (Breisinger et al., 2010). Also, the high dependence of export earnings from oil exposes the region to food security risks related to oil price fluctuations. This is particularly the case for Algeria, Iraq, Libya, Sudan, Syria and Yemen.

The MENA region compares favourably with other regions of the developing world with regard to the share of its population that suffers from hunger, a conclusion that can easily be reached by using the three basic indicators that have been employed to build the Global Hunger Index (GHI) designed by the International Food Policy Research Institute (IFPRI): proportion of undernourished in the population, prevalence of underweight in children and under-five years old mortality rate. For 2009 the GHI, computed as a simple average of the three sub-indices, took a value of 5.2, roughly similar to the value for Latin America and the Caribbean, lower than in Southeast Asia, and much lower than in Sub-Saharan Africa and South Asia (see Table 9). Nevertheless, and going beyond the region average, the global food security situation is very bad in some countries, like Yemen, Djibouti and Sudan. Another worrying fact is

that the proportion of the undernourished in the whole region has risen since the nineties, and the Table does not fully account for the effects of the current international financial and economic crisis or the recent food price hikes.

Table 9: Data underlying the calculation of the 1990 and 2009 Global Hunger

Indexes Region	Proportion of undernourished		Prevalence of underweight in children		Under-five mortality rate			GHI
	1990–1992	2003–2005	1988–1992	2002–2007	1990	2007	1990	2009
Sub-Saharan Africa	31	28.5	27.4	23.4	17.7	14.3	25.4	22.1
South Asia	25	21.7	55.2	40.4	12	7	30.7	23.0
Southeast Asia	17.5	11.4	20.5	12	5.5	2.7	14.5	8.7
Near East and North Africa	**3.8**	**4.6**	**12.2**	**7.9**	**7**	**3**	**7.7**	**5.2**
Latin America and Caribbean	11.8	8.3	9	4.3	5.4	2.6	8.7	5.1
World	**19.7**	**16.1**	**30.4**	**22.7**	**9.8**	**6.8**	**20.0**	**15.2**

Source: Breisinger et al. 2010.

Despite their similarities, there is a wide range of specific situations and problems, concerning food security, across the MENA region. Domestic situations can be assessed according to national scores in four basic indicators: the number of times that total exports cover food imports, food production per capita, the Global Hunger Index, and Gross National Income per capita. Table 10 establishes a typology of MENA countries by combining these four indicators with a basic distinction grounded on the mineral resources endowment of each country. All four Mediterranean Partners of the Sustainmed Project belong to the category of countries facing a food security challenge (FSC). On the other hand, countries are defined as 'food secure' (or non-facing a food security challenge), when the value of the corresponding food security indicator is above the respective international average for this indicator.

Table 10: Classification of MENA countries according to food security levels and mineral wealth

	Total exports/ food imports	Food production per capita	Global Hunger Index	GNI per capita
Food security challenge countries				
Mineral resource rich				
Algeria	8.7	111	<5	2,720
Iraq	n/a	n/a	n/a	*800
Libya	11.1	133	<5	5,860
Sudan	5.5	148	19.6	640
Syria	8.9	237	5.2	1,430
Yemen	4.9	44	27	650
Mineral resource poor				
Djibouti	2.1	54	22.9	1,000
Egypt	6.9	199	<5	1,270
Jordan	4.7	120	<5	2,490
Lebanon	2.4	258	<5	5,520
Morocco	8.1	163	5.8	1,990
Tunisia	11.2	220	<5	2,880
West Bank and Gaza	1.1	135	n/a	1,230
Food secure countries				
Mineral resource rich				
Iran	15.9	246	<5	2,580
Bahrain	n/a	n/a	n/a	*24,733
Kuwait	25.4	55	<5	30,630
Saudi Arabia	19.2	104	<5	12,540
United Arab Emirates	17.2	114	n/a	22,583
Qatar	n/a	n/a	n/a	*76,000
Oman	n/a	n/a	n/a	*24,674
MENA average	**9.6**	**146**	**5.2**	**6,001**
MENA - Food security challenge	**6.3**	**152**	n/a	**2,307**
MENA - Food secure	**19.4**	**130**	n/a	**17,083**
World average	**11.3**	**233**	**15.2**	

Source: Breisinger et al. (2010)
Note: Countries are defined as food secure (green) if the value of the food security indicator is above the respective international average of this indicator. Gross national income (GNI) is for 2005 based on World Development Indicators 2008. MENA = Middle East and North Africa.
*International Monetary Fund Gross Domestic Product estimate for 2007.

About half of the populations of the FSC countries live in rural areas, and within this category agriculture plays the most important role in Sudan, Syria, Egypt, Tunisia, Morocco and Jordan. One of the main problems in the region is that economic diversification has been slow and a significant export-led manufacturing sector has not emerged, as has been the case for some successful East Asian economies.

Therefore, rural poverty is at the core of food security problems in the region, and recent rises in food prices have contributed to an increase in the incidence, depth and

severity of poverty. Some rough calculations have suggested that, barring economic growth, a 30 percent increase in food prices in Egypt would result in a 12 percentage point increase in poverty, and in Morocco a 14 percent increase in food prices would result in a 4 percentage point increase in poverty (World Bank, 2009). Nevertheless these calculations are made under rather stringent assumptions, as they do not take possible positive effects of higher food prices on farmers' income into account.

An additional characteristic feature of poverty in this part of the world is a relatively high concentration of the population near the poverty line. This fact makes the number of people facing poverty risk very sensitive to even small increases in the cost of living (World Bank, 2006).

Arab countries, on average, import at least 50% of the calories they consume, what means that they are more exposed than other countries in the developing world to the volatility of agricultural commodity prices. Three basic pillars can be adopted to improve their food security: strengthening safety nets, enhancing domestic food supply and improving rural livelihoods by addressing lagging productivity growth, and reducing exposure to market volatility by improving supply chain efficiency and using financial instruments to hedge risk (World Bank, 2009). Here attention will be focused on increasing agricultural productivity, as it provides a natural link with agricultural development and raising the level of wellbeing in rural areas.

The main advantages of pursuing a strategy leading to an increase in agricultural productivity lies in the possibility of simultaneously attaining three main goals: increasing the purchasing power of the rural poor, increasing foreign-exchange earnings and reducing excessive food import dependence. The importance of rising levels of agricultural productivity to increase food production responds to the limited possibilities of basing agricultural development on an expansion of land brought under cultivation, particularly in Arab countries, where land is scarce and population is rapidly growing.

Land productivity in the Arab countries lags behind other food-importing developing regions, and cereal yields are currently at half the world average. During the eighties some catching-up took place, probably due to the widespread adoption of improved wheat and rice varieties in Syria and Egypt, but, more recently, productivity growth has begun to fall again. But it must be recognised that even if raising productivity levels remains a big challenge for these countries, by no means does their primary sector

show symptoms of stagnation. The rapid diffusion experienced by new crop varieties shows the remarkable change and modernisation of a large segment of the agriculture of the MENA countries, especially in the irrigation subsector, which has benefited from a variety of advances in water management, crop improvement, and marketing and processing. Private sector companies have introduced modern production technology, such as plastic houses, tunnels and mulches, improved hybrid varieties, drip irrigation systems, soluble fertilisers and herbicides, modern market information systems, and refrigerated transport equipment for long hauls (Baum, 2004).

The fruit and vegetables sector does not present abnormal productivity levels. The problem lies in low cereal productivity growth, combined with land and water constraints and a lack of investment in research and in farmers. We now summarise the main findings of a World Bank-FAO-IFAD paper (World Bank, 2009) that deals specifically with this topic.

Scarcity of water is a big problem, given the dependence on irrigation in the area, as shown in Table 11. Egypt is nearly one hundred per cent dependent on irrigation, and in Syria nearly a third of total agricultural land is irrigated, while the Maghreb countries are much less dependent on irrigation. For the region as a whole, per capita renewable water resources have fallen by approximately 75% since 1950, and are expected to decrease by an additional 40% from present levels by 2050. Non-agricultural water demand is now growing rapidly, with the implication that 85% of all abstracted water that is currently used by agriculture will have to decrease in the future. All in all, this implies that new water resources for an increase in agricultural production must come from water saving and from a combination of wastewater recycling, desalination and water harvesting (i.e. capturing storm water using small dams).

Table 11. Irrigation Use (2007)

Country	Percent total land irrigated	Percent annual land irrigated	Percent perennial cropland irrigated
GCC	100	100	100
Yemen	47	42	65
Djibouti	100	100	100
Egypt	95	97	87
Somalia	—	14	—
Sudan	9	8	99
Iraq	32	27	91
Jordan	31	32	31
Lebanon	41	43	39
Syria	30	32	19
Algeria	17	10	90
Libya	14	11	17
Mauritania	7	6	9
Morocco	18	10	75
Tunisia	8	9	8

Source:, World Bank (2009)
— = Not available.

Current policies which keep the cost of water artificially low have traditionally encouraged non-efficient uses of water by farmers, and kept low value crops in production. The World Bank's World Development Report (2007) has argued that Arab countries should diversify production out of staples and into high-value crops, like fruits and vegetables, for export markets. This would increase dependence on imported cereals, but crop exports would simultaneously generate enough foreign currency to pay for additional cereal imports. It has been estimated that vegetable production yields six times more value added per unit of water than wheat production and ten times more than beef production, but at present 40% of irrigated land in the Maghreb is dedicated to growing cereal, and in North-East Africa this figure rises to 64%.

In many Arab countries, including Morocco, Tunisia and Syria, rain-fed agriculture still represents more than half of all arable land. Climate change is increasing the volatility of yields in this farming sub-sector and it is expected that the average yearly rainfall could decrease by 10% in the next 50 years, pulling yields in a downward trend. Farmers must be helped to adapt to climate change, which demands a serious effort from research into genetically modified drought-resistant crops, and in the spread of technologies such as conservation tillage, which allow for better soil-moisture retention.

Research and development yields high returns, including broad social advantages related to enhanced food security and rural livelihoods, which are a reason for governments' playing a big role in the promotion of this type of investment. Yet funding

for agricultural research remains comparatively low in Arab countries, not only in comparison with developed countries, but also in relation to some emerging economies, like Brazil, Argentina or Mexico, as can be observed in Table 12. The average funding as a percentage of agricultural GDP is only 0.5% on average in the Arab countries. Some countries like Libya, Morocco and Bahrain – an exceptional case of high R&D investment - perform better. A new policy oriented towards an increase in agricultural R&D must enhance incentives for agricultural researchers, increasing their number, paying them better, and improving their technical equipment, which requires better funding. Private investment in R&D must be also increased, which requires the use of policy tools already implemented in other developing economies (stronger intellectual property rights, competitive funding etc.). Another positive move would be to increase the number of beneficiaries from the adoption of a common research agenda. Because many Arab countries share the same agricultural goals and challenges, and have to overcome similar obstacles to agricultural development, a multi-nation research agenda would be convenient, and could lead to the creation of a regional R&D fund with a committed long-term budget. Moreover, investments in R&D must be coupled with improvements in agricultural extension, which is underperforming in most countries. Efforts in this direction should be addressed for both large and small farmers. Large farmers must be an objective because they have the greatest productive potential and can afford innovative technologies. Small farmers also, because they make up a large proportion of the rural population and must be helped in the transition towards more value added market crops.

Table 12: National Agricultural Research and Funding

	Potential researcher years (PRYs)[1]	Funding (millions of 2000 US$)	PRYs/100,000 rural residents	Funding as percent AgGDP
Algeria	575	14	8	0.4
Bahrain	32	3	457	17.9
Egypt	6,710	68	27	0.5
Iraq	770	—	30	—
Jordan	198	6	35	1.2
Lebanon	83	4	66	0.4
Libya	261	13	83	1.6
Morocco	606	40	6	0.9
Sudan	595	3	3	0.1
Syria	1,058	15	22	0.4
Tunisia	368	15	16	0.6
UAE	73	—	46	—
Yemen	245	6	3	0.8
Arab world	11,574	187	14	0.5
Brazil	3,943	924	11	1.4
Argentina	1,858	270	45	1.0
Mexico	3,097	357	12	1.6

Sources: World Bank (2009).
1 A potential researcher year is the equivalent of one year's worth of research. This unit is used since many researchers have a position that also consists of teaching, extension, and consulting, making them only part-time researchers.
— = Not available..

Furthermore, another important step in the direction of enhancing food security must be enhancing the access of the rural population to assets such as land, physical capital, education and health. These assets are critical to improving purchasing power and require significant amounts of public investment (i.e. rural infrastructure, payments for environmental services), and taking measures to improve access to financial services and improve the performance of product markets and the organisation of producers.

6. Exploring the possibilities of building up a composite indicator of food security for African and Middle East countries.

6.1. Introduction: the Global Hunger Index.

There are many factors influencing the food security situation of a country, and international institutions, donors and academic researchers frequently need to establish priorities and draw global comparisons among countries. It explains that, to meet these demands, some efforts have been directed towards the creation of composite indicators, able to summarise a whole array of partial food security-related indicators.

The Global Hunger Index (GHI) is one of those composite indicators, currently being produced by the International Food Policy Research Institute to measure and track global hunger. The GHI is based on a combination of three equally weighted indicators:

(i) The proportion of undernourished as a percentage of the population, which reflects the share of the population with insufficient dietary energy intake. Undernutrition is not only the result of an inadequate intake of food, both in quantitative or qualitative terms, but also of poor utilisation of nutrients as a consequence of bad health.

(ii) The prevalence of underweight children under the age of five, which indicates the proportion of children suffering from low weight with regards to the adequate weight for their age

(iii) The mortality rate of children under the age of five, reflecting the interaction between an inadequate energy intake and an unhealthy environment. Children are highly vulnerable to a lack of nutrients, causing illness, poor physical and cognitive growth and, in some cases, death.

The GHI ranks countries on a 100-point scale. Values less than 5.0 reflect low levels of hunger, values between 5.0 and 9.9 reflect moderate hunger, values between 10.0 and 19,9 indicates the presence of a serious problem of hunger, values between 20.0 and 29.9 are alarming, and values of 30.0 or higher are considered as extremely alarming.

Table 13: Global Hunger Index Scores by country, 1990 GHI and 2010 GHI

Country	1990	2010
Algeria	6.1	<5
Egypt	7.0	<5
Jordan	<5	<5
Lebanon	<5	<5
Lybia	<5	<5
Mauritania	22.0	13.1
Morocco		
Syrian Arab. Republic	7.3	5.2
Tunisia	5.0	<5
Turkey	6.0	<5
Sierra Leone	32.7	28.9
Ethiopia	43.7	29.8
Chad	37.6	30.9
Eritrea	-	35.7
Burundi	31.8	38.3
Rep. Dem. Of Congo	24.7	41.0

Source:IFPRI (2010)

Table 13 shows the GHI scores for some North Africa and Middle East countries, in comparison with the six countries that appeared at the bottom of the world list in 2010. It can be seen that the situation of North Africa and Middle Eastern countries is relatively good with regards to this index and widely differs from the situation of those African countries that suffer the most from food insecurity. Concerning the Mediterranean Partner Countries, progress has been general between 1990 and 2010. All of them are classed, in 2010, in the category of countries with low hunger levels, with the exception of Morocco and Syria, which appear with moderate hunger levels. Table 14 shows the disaggregated data that have been used in the construction of GHI scores for the years 1990 and 2010. The best scores among the MPC correspond to Tunisia, and the worst to Morocco, where the prevalence of underweight children under five years of age has increased between the average of 1988-92 and the average of 2003-08, to 9,9%.

Table 14: Data underlying the calculation of the 1990 and 2010 Global Hunger Indexes

Country	Proportion of undernourished in the population (%)		Prevalence of underweight in children under five years (%)		Under-five mortality rate (%)		GHI	
	1990–92	2004–06	1988–92	2003–08	1990	2008	1990 (with data from1988–92)	2010 (with data from: 2003–08)
Algeria	4.0 *	3.0 *	8.0	3.0	6.4	4.1	6.1	<5
Egypt	3.0 *	3.0 *	9.1	6.8	9.0	2.3	7.0	<5
Jordan	3.0 *	3.0 *	4.8 *	3.5 *	3.8	2.0	<5	<5
Lebanon	3.0 *	2.0 *	4.6 *	4.2	4.0	1.3	<5	<5
Lybia	1.0	2.0 *	4.1 *	5.6	3.8	1.7	<5	<5
Mauritania	10.0	8.0	43.2	19.4 *	12.9	11.8	22.0	13.1
Morocco	5.0	4.0 *	8.1	9.9	8.8	3.6	7.3	5.8
Syrian Arab. Republic	4.0 *	4.0 *	14.2 *	10.0	3.7	1.6	7.3	5.2
Tunisia	1.0 *	1.0 *	9.1	3.3	5.0	2.1	5.0	<5
Turkey	1.0 *	2.0 *	8.6 *	2.6	8.4	2.2	6.0	<5
Sierra Leone	45.0	46.0	25.4	21.3	27.8	19.4	32.7	28.9
Ethiopia	71.0	44.0	39.2	34.6	21.0	10.9	43.7	29.8
Chad	59.0	38.0	33.8 *	33.9	20.1	20.9	37.6	30.9
Eritrea	-	66.0	- *	35.3 *	15.0	5.8	-	35.7
Burundi	44.0	63.0	32.4 *	35.0	18.9	16.8	31.8	38.3
Rep. Dem. Of Congo	29.0	75.0	25.2 *	28.2	19.9	19.9	24.7	41.0

Note: * indicates authors' estimates.
Sourde: IFPRI 2010.

The GHI allows for a richer understanding of the multifaceted food security issue than a mere headcount of people suffering from hunger, or recording the proportion of the undernourished in the total population, but it still leaves out many explanatory factors. Food insecurity is a complex phenomenon, encompassing elements related to standards of living, health, income distribution, and other aspects, and analysts must commonly deal with a vast mass of information. In this last section of the paper a multivariate analysis is proposed in order to summarise in a small number of composite indicators an array of data concerned with specific social and economic aspects related to food insecurity. Applying this methodology, it is possible to obtain scores that permit ranking individual countries according to the seriousness of the risk of suffering from hunger that their populations have to face.

6.2. Discovering aggregate dimensions of the food security problem by using Principal Components Analysis.

Principal Components Analysis (PCA) is a statistical technique, belonging to the field of multivariate analysis, which is particularly suitable in summarising the impact of a set of interconnected variables, as occur in the problem at hand. The main task of PCA in our case is to achieve data reduction, creating a small set of variables that can replace the larger original set of variables, while preserving the core of the relevant information contained in them. PCA identifies new variables, called 'components' or 'factors'[2], which are linear combinations of the original variables. The objective of the analysis is to select the minimum number of factors needed to account for the maximum portion of the total variance[3] represented in the original set of variables, and then being able to assign a reasonable practical meaning to each factor. After doing that, and taking into account the specific influence of each original variable on each factor ('factor loadings') it is possible to ascertain the 'factor scores' corresponding to each observation. Observations are countries in our case, and we are constrained to take into account

[2] The terminology concerning Principal Component Analysis and a very close multivariate method called Factor Analysis is sometimes confusing. Here we use 'components' as synonymous to 'factors', but other people reserve 'factors' for Factor Analysis (FA) and 'components' for PCA.

[3] To understand the meaning of "total variance" as it is used in a principal component analysis, it must be taken into account that the observed variables are standardized in the course of the analysis. This means that each variable is transformed so that it has a mean of zero and a variance of one. The "total variance" in the data set is simply the sum of the variances of these observed variables, but, because of standardisation, each observed variable contributes one unit of variance to the "total variance" in the data set. Because of this, the total variance equals the number of observed variables.

that their number must be kept in proportion with the number of the original variables included in the analysis.

According to PCA, the first factor extracted may be viewed as the particular linear combination of the original variables that accounts for most of the variance in the data as a whole, than any other of all possible combinations. The second factor represents the second best linear combination of the variables, in the sense that it accounts for most of the variance that is left unexplained after the effect of the first factor has been removed from the data. A basic restriction for the extraction of this second factor is that it must be orthogonal to the first factor, meaning that the two should not 'share' any amount of the variance of the original set of variables. A mathematical interpretation of being orthogonal is that if factors are represented by geometrical axes, each axis is at a right angle to the others. After the extraction of the first and second factors, the extraction process proceeds and new factors are extracted until all of the variance is extracted. A number of *n* factors can be extracted if the original set of variables contains *n* variables. But, of course, it makes no sense to replace old *n* variables for new *n* variables if we are aiming for data reduction, and therefore different criteria are available for the selection of a sub-set of factors.

The interest of using PCA is double. First, we gain insight into the structure of the food security problem, by discovering a reduced set of underlying factors strongly connected to a collection of partial indicators or variables that we are able to observe. Second, we are able to substitute these factors for a larger number of variables and summarise the performance of each country according to each factor. Doing this, it is possible to simplify the analysis of the information at hand, allowing for a ranking reflecting the relative position of each country in a scale that depicts the seriousness of the problem. As an example, we may start with a set of 10 partial indicators, and after applying PCA we may decide to keep only two factors. Then it is possible to rank countries in the sample according to their performance ('factor scoring'), with regards to the dimensions accounted for factors 1 and 2.

Principal Components Analysis has been recognised as one of the main methods currently available for analysts concerned with the construction of composite indicators (Nardo et al. 2008). Some steps must be followed in a correct application of this methodology (see Hair et al., 2006, and Sharma, 1996 for a detailed presentation of this and other multivariate techniques):

(i) Checking the correlation structure of the data. If the correlation among the original variables is low then it is unlikely that they share common factors.

(ii) Identification of a small number of factors, smaller than the number of partial indicators also called ‘original variables’. Different approaches can be employed to decide the number of factors to retain. Leaving aside the possibility of having a priori criteria for the determination of the number of factors, the most common approach is to retain only those factors that have an associated eigenvalue greater than one. The eigenvalue (or ‘latent root’) represents the amount of total variance of the original variables accounted for by a factor, and it is easy to see that we expect this first factor to have an eigenvalue at least as high as the variance of each standardised original variable.

(iii) Analysis of the factor loadings of the variables. Factor loadings show the correlation between the original variables and the factors, and squared factor loadings are equal to the percentage of the variance in the corresponding original variable that is explained by a factor. The best situation from the viewpoint of the analyst is when a variable has a high loading on only a factor and small loadings, which can be disregarded, on all the other factors. If this situation happens for all the variables, then it is easy to assign sub-sets of variables to specific factors, easing the interpretation of the dimensions accounting for specific factors. Variables with higher loadings on a single factor are deemed more important and have more relevance in order to establish the meaning of that factor or, say, in ‘labelling’ the factor.

(iv) Applying factor rotation. When no clear pattern emerges in step (iii), concerning the relationship between variables and factors, or even if the pattern exists but we require the establishment of stronger connections between variables and factors, it is possible to resort to ‘factor rotation’. Factor rotation is the name for a process of adjustment of factor axes to achieve a more meaningful factor solution, by maximising the association of each variable with a single factor. The simplest case of rotation is adopting orthogonal factor rotation, in which the newly positioned axes are kept at right angles (90 degrees), but other non-orthogonal procedures can sometimes be applied.

(v) Considering the convenience of deleting variables. Sometimes a variable has no significant loadings, is too low, or it may be that a variable has more than one significant loading (‘cross-loading’). If the problem persists after

rotation the variable can be considered for deletion, depending on its relevance for the research. Before taking that decision, an increase in the number of factors retained may also be considered, to see whether adding a new factor may allow for an adequate representation of this variable.

(vi) Labelling the factors. Once a well-defined structure of the remaining variables emerges, with a clear sub-set of variables assigned to each retained factor, it is time to proceed to factor interpretation, using a priori knowledge concerning the problem being analysed.

(vii) Computing factor scores. Factor scores are measures of each factor computed for each observation in the sample. In the present case this corresponds to an assessment of each country's performance with regard to the newly defined variables (factors) related to food security. There is a variety of specific methods for computing factor scores, but they are basically based on the factor loadings of all variables on the factor. After factor scoring it is possible to determine the rank of food security performance, or risk of incurring food insecurity, for each country in the sample. To compute the factor score for a given country and a given factor, the country's standardised score on each variable must be taken and multiplied by the corresponding factor scoring coefficient of that variable for the given factor, and afterwards the analyst must proceed to the summation of these products across variables loading on the specified factor.

Before proceeding with the application of this methodology we have chosen to use a set of variables, which are publicly available, for a set of observations corresponding to the vast majority of African and Middle East countries. We have been forced to leave aside some countries, which lacked sufficient data. The criteria for the selection of the original variables have been inspired by the most usual assumptions concerning the basic determinants of food security. Food security is commonly conceptualised as a desirable outcome of social and economic policy resting on three broad pillars: availability, access and utilisation. These pillars are inherently hierarchical (Barrett, 2010), in the sense that food availability, obtained through imports or domestic production, is a necessary precondition for food security, but is not sufficient, because access must be guaranteed to the whole of the population. Access reflects the demand side of food security, and has to do with the range of food options open to the people, given their income, prevailing prices and formal or informal safety net arrangements. Finally, utilisation is concerned with the capacity of people to make good use of the

food to which they have access, because bad health may prevent the absorption and metabolism of essential nutrients.

Opting for a specific measure necessarily involves focusing on some dimensions and disregarding others. Here, the selection of variables has been inspired by the idea of obtaining equilibrium among the three basic pillars aforementioned, but difficulties arising from missing data for some countries have also conditioned the choice. Caloric intake is a variable representing the supply side (availability) of the food security problem, while Gross National Income per capita is a basic determinant of access. Access is also conditioned by the degree of inequality in the distribution of income, which can be measured by the Income Gini Coefficient. Gender inequality also worsens food access at the household level, but finding a measure that properly reflects the empowerment of women - a positive element with regards to food security – is not easy. The Human Development Report of 2010 has advanced in the measurement of the gender dimension, but its Gender Inequality Index currently presents too many gaps in its coverage. Instead, two partial indicators of the empowerment of women have been selected: female participation rate in the labour force and adolescent fertility rate. Both belong to the set of basic or partial indicators used in the construction of the Gender Inequality Index, but have a wider coverage than the composite indicator. More specifically, the inclusion of adolescent fertility rate implies taking on board a concern for reproductive health. Quoting the Human Development Report (2010):

"Reproduction is not only risky – it often begins too early, compromising health and limiting future opportunities. Early childbearing, as measured by the adolescent fertility rate, is associated with greater health risks for mother and baby and tends to prevent young women from going to school, often destining them to low-skilled jobs at best" (p.91)

Finally, a concern for utilisation has led to the inclusion of several variables related to human health, like life expectancy at birth, and with the health conditions of children, a particularly vulnerable group, using underweight and early mortality as indicators. The influence of a healthy/unhealthy environment is reflected in the inclusion of two variables that measure the access to fresh water and basic sanitation facilities. Also, the intake of basic nutrients has been represented by the daily intake of iron in the diet. Finally a group of three variables are intended to measure net food security outcomes:

the proportion of the undernourished in the total population and the intensity of food deprivation (food deficit of the undernourished population).

Therefore, the following variables were initially included in the analysis:

1) Gross National Income per capita (PPP $2008). Source: Human Development Report 2010 (2010). Acronym: GNI.
2) Dietary Energy Consumption (calories/person/day), 2003-2005. Source: FAOSTAT Yearbook 2009. Acronym: CAL.
3) Proportion of undernourished in total population, 2006-2006 (%). Source IFPRI (2010). Acronym : UNDERNOURISHED
4) Food deficit of the undernourished population (calories/person/day). Source: Food Security Statistics (FAO). Acronym: FDEFICIT
5) Dietary Iron for human consumption, 2005-2007 (mg/person/day). Source: Food Security Statistics (FAO). Acronym: IRON
6) Life expectancy at birth, 2007 (years). Source: FAOSTAT Yearbook 2009.Acronym: LIFE
7) Under-five children mortality rate (% of live births), 2003-2008. Source: IFPRI (2010). Acronym: CHILDMORT.
8) Prevalence of underweight in children under five years (%), 2003-2008. Source: IFPRI (2010). Acronym: UNDERWEIGHT.
9) Improved sanitation facilities (% of population with access), 2008. Source: World Development Indicators (World Bank). Acronym: SANITATION.
10) Improved water source (% of population with access), 2008. Source: World Development Indicators (World Bank). Acronym: WATER
11) Adolescent fertility rate (number of births per 1.000 women aged 15-19), 1990-2008 (most recent year within this period). Source: Human Development Report 2010 (2010). Acronym: ADFERTILITY
12) Female participation rate in the labour force, 2008 (%). Source: Human Development Report 2010 (2010). Acronym: FPARTICIPATION
13) Income Gini Coefficient, 2000-2010 (most recent year within this period). Source: Human Development Report 2010 (2010). Acronym: GINI

As the number of countries included in the data base was 52, the number of variables (13) is a little excessive for performing a PCA, because the maximum recommended observations/variables ratio is five. The quality of the information contained in some variables is also disputable (i.e. the Income Gini Coefficient), as the data come from

different years for different countries, and not always from official sources (some countries lacked an official estimate). Nevertheless, the main aim of this section of the paper is to show how a PCA methodology, - see Annex 1 for a brief mathematical description - can be put to good use in order to condense and summarise information concerned with complex social and economic problems, like food security. An improvement and refinement of the data base - see Annex 2-, and multi-disciplinary work oriented to discuss which food security-related variables are actually more relevant for the analysis, would permit a substantial upgrading of the findings of this preliminary exercise.

The first step in the application of the aforementioned methodology involves the calculation of the correlation coefficients among the original variables. We see in Table 15 the correlation matrix and the corresponding significance levels. Variables are supposed to be highly correlated if we aim for a reduction in their number and the creation of new composite variables (principal components) representing different dimensions within the data.

Table 15: Correlation Matrix

		GNI	CAL	UNDERNOURISHED	FDEFICIT	IRON	LIFE	UNDERWEIGHT	CHILDMORT	SANITATION	WATER	ADFERTILITY	FPARTICIPATION	GINI
Correlation	GNI	1.00	0.66	-0.54	-0.47	0.10	0.59	-0.65	-0.63	0.71	0.57	-0.58	-0.51	0.21
	CAL	0.66	1.00	-0.83	-0.74	0.32	0.64	-0.64	-0.62	0.66	0.60	-0.51	-0.70	-0.13
	UNDERNOU	-0.54	-0.83	1.00	0.73	-0.32	-0.50	0.49	0.56	-0.50	-0.45	0.27	0.59	0.09
	FDEFICIT	-0.47	-0.74	0.73	1.00	-0.24	-0.42	0.46	0.43	-0.36	-0.44	0.29	0.41	-0.03
	IRON	0.10	0.32	-0.32	-0.24	1.00	0.00	0.14	-0.01	-0.01	0.05	-0.03	-0.24	-0.19
	LIFE	0.59	0.64	-0.50	-0.42	0.00	1.00	-0.52	-0.77	0.61	0.52	-0.64	-0.58	-0.08
	UNDERWEI	-0.65	-0.64	0.49	0.46	0.14	-0.52	1.00	0.59	-0.72	-0.63	0.48	0.44	-0.16
	CHILDMORT	-0.63	-0.62	0.56	0.43	-0.01	-0.77	0.59	1.00	-0.67	-0.66	0.73	0.52	-0.05
	SANITATION	0.71	0.66	-0.50	-0.36	-0.01	0.61	-0.72	-0.67	1.00	0.67	-0.68	-0.63	0.02
	WATER	0.57	0.60	-0.45	-0.44	0.05	0.52	-0.63	-0.66	0.67	1.00	-0.66	-0.39	0.21
	ADFERTILIT	-0.58	-0.51	0.27	0.29	-0.03	-0.64	0.48	0.73	-0.68	-0.66	1.00	0.41	-0.03
	FPARTICIPA	-0.51	-0.70	0.59	0.41	-0.24	-0.58	0.44	0.52	-0.63	-0.39	0.41	1.00	0.05
	GINI	0.21	-0.13	0.09	-0.03	-0.19	-0.08	-0.16	-0.05	0.02	0.21	-0.03	0.05	1.00
Sig. (1-tailed)	GNI		0.00	0.00	0.00	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07
	CAL	0.00		0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18
	UNDERNOU	0.00	0.00		0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.25
	FDEFICIT	0.00	0.00	0.00		0.04	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.42
	IRON	0.24	0.01	0.01	0.04		0.50	0.16	0.47	0.48	0.38	0.42	0.04	0.09
	LIFE	0.00	0.00	0.00	0.00	0.50		0.00	0.00	0.00	0.00	0.00	0.00	0.28
	UNDERWEI	0.00	0.00	0.00	0.00	0.16	0.00		0.00	0.00	0.00	0.00	0.00	0.13
	CHILDMORT	0.00	0.00	0.00	0.00	0.47	0.00	0.00		0.00	0.00	0.00	0.00	0.37
	SANITATION	0.00	0.00	0.00	0.00	0.48	0.00	0.00	0.00		0.00	0.00	0.00	0.43
	WATER	0.00	0.00	0.00	0.00	0.38	0.00	0.00	0.00	0.00		0.00	0.00	0.07
	ADFERTILIT	0.00	0.00	0.03	0.02	0.42	0.00	0.00	0.00	0.00	0.00		0.00	0.41
	FPARTICIPA	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00		0.35
	GINI	0.07	0.18	0.25	0.42	0.09	0.28	0.13	0.37	0.43	0.07	0.41	0.35	

TABLE 1 (cont.) KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of		0.85
Bartlett's Test of Sphericity	Approx. Chi-	472.12
	df	78.00
	Sig.	0.00

Source: Author's calculations

The correlation matrix shows a substantial number of high correlation coefficients among the variables that are statistically significant, with the exception of bilateral relationships involving GINI and IRON. Some interesting correlations are discovered. GNI presents high correlations (>0, 6) with caloric consumption and access to

sanitation facilities, and negative correlations with children's underweight and under-five child mortality rate, which point to the importance of *access*, measured through income per head, in conditions leading to food security. A high positive and significant correlation also exists between adolescent fertility rate and child mortality (>0, 7). Contrary to what was expected, female participation rate is positively correlated with undernourishment, and negatively correlated with dietary energy intake, - variable CAL -. The key for understanding this last result is the high negative correlation between GNI and FPARTICIPATION, which point to a characteristically low rate of female participation in the labour market in the Arab countries, in sharp contrast with high participation levels in much poorer Sub-Saharan countries. In fact, Arab countries display some of the lowest activity rates in the world for women. It means that testing the relationship between female participation rates, women's empowerment, and a healthy nutritional status of the households should be made within more homogenous cultural environments, as different and heavily-rooted socio-cultural traditions may exert a large influence and distort the analysis.

Two tests appear at the bottom of the correlation matrix. Bartlett's sphericity test examines the entire correlation matrix, checking whether the correlation matrix is actually different from the identity matrix. Acceptance of the null hypothesis - correlation matrix being equal to identity matrix - would imply the absence of correlation among the variables. A statistically significant Bartlett's test (sig. < 0,05) indicates, as in this case, that sufficient correlations exist among the variables to proceed further with the analysis.

Nevertheless, visual inspection of the correlation matrix is not enough, because the correlations among the variables can also be analyzed by calculating the coefficients of partial correlation among the variables. Partial correlation is the bilateral correlation among variables that subsist when the influence of other variables is taken apart. If some clear underlying dimensions exist in the data, partial correlation should be low. The anti-image correlation matrix, see Table 16, conveys the relevant information. The Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO MSA) gives a global measure of the adequacy of the sample, based on the partial correlations among the variables. Only values over 0.50 can be deemed acceptable, while values over 0.80 are considered very meritorious. In this case a coefficient of 0.845 is fully in accordance with these guidelines. The main diagonal of the anti-image correlation matrix gives individual MSA values. Again, it is critical to have a coefficient higher than 0.5. In this case all the variables satisfy this requirement, taking values higher than 0.8

with the exception of GINI (MSA=0.263). The recommended action in this case is to delete this variable from the analysis.

Table 16: Anti-image Matrices

		GNI	CAL	ED	FDEFICIT	IRON	LIFE	UNDERWEIGHT	CHILDMORT	SANITATION	WATER
Anti-image Covariance	GNI	0,33	-0,03	0,01	0,00	-0,06	-0,04	0,04	0,02	-0,08	0,06
	CAL	-0,03	0,11	0,07	0,07	-0,07	-0,04	0,06	-0,03	0,01	-0,04
	UNDERNOU	0,01	0,07	0,19	-0,09	0,03	-0,04	0,03	-0,09	0,02	-0,01
	FDEFICIT	0,00	0,07	-0,09	0,35	-0,01	0,02	-0,02	0,03	-0,05	0,02
	IRON	-0,06	-0,07	0,03	-0,01	0,62	0,10	-0,15	-0,02	0,05	-0,03
	LIFE	-0,04	-0,04	-0,04	0,02	0,10	0,30	-0,02	0,12	0,01	0,02
	UNDERWEIG	0,04	0,06	0,03	-0,02	-0,15	-0,02	0,30	-0,03	0,09	0,04
	CHILDMORT	0,02	-0,03	-0,09	0,03	-0,02	0,12	-0,03	0,22	-0,01	0,05
	SANITATION	-0,08	0,01	0,02	-0,05	0,05	0,01	0,09	-0,01	0,22	-0,07
	WATER	0,06	-0,04	-0,01	0,02	-0,03	0,02	0,04	0,05	-0,07	0,34
	ADFERTILITY	0,03	0,03	0,10	-0,03	0,03	0,02	0,06	-0,11	0,07	0,07
	FPARTICIPAT	-0,05	0,07	-0,01	0,06	0,06	0,07	0,05	-0,01	0,11	-0,08
	GINI	-0,18	0,09	-0,01	0,08	0,06	0,07	0,06	0,01	0,08	-0,15
Anti-image Correlation	GNI	0,91	-0,18	0,04	-0,01	-0,13	-0,13	0,14	0,06	-0,29	0,17
	CAL	-0,18	0,83	0,47	0,33	-0,25	-0,19	0,33	-0,23	0,05	-0,21
	UNDERNOU	0,04	0,47	0,81	-0,33	0,07	-0,15	0,13	-0,43	0,12	-0,04
	FDEFICIT	-0,01	0,33	-0,33	0,88	-0,03	0,06	-0,06	0,10	-0,19	0,04
	IRON	-0,13	-0,25	0,07	-0,03	0,56	0,22	-0,35	-0,04	0,12	-0,07
	LIFE	-0,13	-0,19	-0,15	0,06	0,22	0,89	-0,08	0,46	0,05	0,05
	UNDERWEIG	0,14	0,33	0,13	-0,06	-0,35	-0,08	0,87	-0,14	0,36	0,11
	CHILDMORT	0,06	-0,23	-0,43	0,10	-0,04	0,46	-0,14	0,85	-0,06	0,19
	SANITATION	-0,29	0,05	0,12	-0,19	0,12	0,05	0,36	-0,06	0,87	-0,25
	WATER	0,17	-0,21	-0,04	0,04	-0,07	0,05	0,11	0,19	-0,25	0,89
	ADFERTILITY	0,10	0,19	0,45	-0,08	0,07	0,07	0,20	-0,44	0,30	0,22
	FPARTICIPAT	-0,13	0,34	-0,05	0,16	0,12	0,21	0,13	-0,03	0,37	-0,22
	GINI	-0,38	0,32	-0,02	0,18	0,09	0,16	0,13	0,02	0,20	-0,32

a. Measures of Sampling Adequacy(MSA)

Source: Author's calculations

The process is initiated again without the GINI variable and new correlation and anti-image matrices are computed. Now, both Bartlett's test and KMO Measure of Sampling Adequacy are satisfactory, and all the individual variables also show MSA > 0.5 in the diagonal of the anti-image matrix. Nevertheless, IRON is close to the critical value (0,533) and, as was already the case with the original set of variables, its correlation with the other variables is not statistically significant. We retain this fact to be taken into account later.

The next step is to proceed to the extraction of the principal components. Table 17 displays the 12 factors or components extracted with their correspondent eigenvalues (the amount of variance accounted for by a factor). Only some of them must be retained if the analysis is to be meaningful. The most common criterion consists in considering only those components with an eigenvalue >1 and is called the *latent root criterion*. The rationale for this criterion, as explained before, is that any individual factor should account for an amount of variance at least equivalent to the variance of one of the original variables. As these variables have been standardised in the process, each of their variances is equal to the unity. Two components are selected, with an accumulated variance explained of 69%, which can be considered reasonable according to the literature.

Table 17: Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1.00	6.75	56.21	56.21	6.75	56.21	56.21
2.00	1.56	13.02	69.23	1.56	13.02	69.23
3.00	0.84	7.03	76.26			
4.00	0.66	5.50	81.75			
5.00	0.59	4.89	86.65			
6.00	0.40	3.35	90.00			
7.00	0.30	2.53	92.53			
8.00	0.26	2.13	94.66			
9.00	0.23	1.93	96.59			
10.00	0.18	1.52	98.11			
11.00	0.15	1.24	99.36			
12.00	0.08	0.64	100.00			

Source: Author's calculations

Table 18 shows the loadings of each variable on each component. Each loading represents the correlation coefficient for a variable/component pair. Loadings provide a hint of the degree of correspondence between a variable and a component. Thus, the variables with the highest loadings on a component become representative of that factor and can help the researcher to 'label' the component. Squared factor loadings indicate what percentage of the variance in a variable can be explained by the corresponding component. Only factor loadings higher than 0.5 are normally considered to be of practical relevance and this value must be increased when the analyst uses small samples, as in this case. We can see in the Table that all variables load significantly on the first component, particularly two of them, CAL and GNI, while only IRON loads significantly on the second component. Variable FDEFICIT presents a more mixed pattern, with a higher loading on the first component, but not so concentrated as in the case of the other variables. A rotated solution may contribute to clarify the pattern of correspondences between variables and components.

Table: 18 Component Matrix

	Component	
	1.00	2.00
CAL	-0.89	0.33
SANITATION	-0.84	-0.25
CHILDMORT	0.84	0.23
GNI	-0.81	-0.08
LIFE	-0.79	-0.17
UNDERWEIGHT	0.77	0.23
WATER	-0.77	-0.22
UNDERNOURIS	0.76	-0.49
ADFERTILITY	0.73	0.38
FPARTICIPATION	0.72	-0.21
FDEFICIT	0.67	-0.45
IRON	-0.16	0.76
Extraction Method: Principal Component		
a. 2 components extracted.		

Source: Author's calculations

Factor, or component, rotation means that the reference axes of the factors are turned about the origin to more clearly link sub-sets of variables to components and obtain a more meaningful structure. Among different rotation methods we have opted for VARIMAX, an orthogonal method. With this rotation, procedure axes are maintained at 90 degrees and the orthogonal character of the components is preserved. The total amount of variance explained by the two principal components extracted in the first place is also kept. As can be seen in Table 19, the system of correspondences has changed. Now the set of variables can be split among those loading heavily in component 1, which are SANITATION, CHILDMORT, ADFERTLITY, UNDERWEIGHT,WATER, LIFE and GNI, and those loading in component 2, represented by UNDERNOURISHMENT, IRON, CAL and FDEFICIT. A clearer pattern has now begun to emerge, with variables connected with standards of living on one side and variables linked to caloric and nutrient intake on the other. But a problem remains: FPARTICIPATION is out of this basic scheme, being a case of so-called *cross-loading*. Now we have a reason to filter our original set of variables again and delete FPARTICIPATION.

Table 19: Rotated Component Matrix(a)

	Component	
	1.00	2.00
SANITATION	-0.86	-0.20
CHILDMORT	0.84	0.22
ADFERTILITY	0.82	0.03
UNDERWEIGHT	0.78	0.18
WATER	-0.77	-0.19
LIFE	-0.77	-0.25
GNI	-0.74	-0.33
UNDERNOURIS	0.41	0.80
IRON	0.24	-0.73
CAL	-0.61	-0.73
FDEFICIT	0.35	0.72
FPARTICIPATION	0.52	0.54

Source: Author's calculations

We restart one more time the whole process, without GINI and FPARTICIPATION, and observe that now in the new anti-image matrix, IRON falls below the critical level of sampling adequacy of 0,5, with a value of 0,475, the only variable in this situation, as all the others remain above, and nearly all of them exceed the 0,8 mark. Perhaps if a more complete analysis of nutrient intake had been considered, with the addition of variables representing other nutrients, IRON would have contributed to the definition of

a composite measure of critical nutrient intake, through the extraction of a third principal component. In that case, the original sample of countries should also have been modified, to allow for a higher observations/variables ratio. According to the present circumstances, it is advisable to do without this variable and we delete IRON from the original set of variables. Now, the ratio among observations (52) and variables (10) is just over five, the minimum that is commonly considered acceptable.

Following this iterative process of computation, we start again, after the deletion of IRON. The Bartlett's test again rejects the null hypothesis of absence of correlation, the KMO MSA is 0.863, which is also satisfactory, and all the cells in the diagonal of the anti-image matrix exhibit values over 0.8, with the only exception of UNDERNOURISHMENT (0.749), which is not far below. Two components are extracted, accounting now for nearly three quarters of the variance in the data (0, 7481). The first component has an eigenvalue of 6.249 (explaining 62.489% of the variance) and the second has an eigenvalue of 1.233 (explaining an additional 12.325%). The third component is not selected, as it falls far behind, with an eigenvalue of only 0.633. Now we obtain the new rotated solution, which is displayed in Table 20.

Table 20: Rotated Component Matrix(b)

	Component	
	1.00	2.00
ADFERTILITY	-0.89	0.04
SANITATION	0.82	-0.30
CHILDMORT	-0.82	0.32
WATER	0.76	-0.30
LIFE	0.73	-0.34
GNI	0.69	-0.44
UNDERWEIGHT	-0.66	0.43
UNDERNOURIS	-0.26	0.89
FDEFICIT	-0.18	0.88
CAL	0.50	-0.80
Extraction Method: Principal Component		
Rotation Method: Varimax with Kaiser		
a. Rotation converged in 3 iterations.		

Source: Author's calculations

Variables in Table 20 can be grouped according to their loadings on specific components. The following variables load mostly on the first component: GNI, LIFE,

UNDERWEIGHT, CHILDMORT, SANITATION, WATER and ADFERTILITY. The relationship is positive with those variables for which an increase implies a rise in wellbeing, and negative with those – UNDERWEIGHT, CHILDMORT and ADFERTILITY- for which higher levels of the variable are associated with a situation of low social and economic development and deprivation. As we are considering economic and social aspects of wellbeing, including expectations of longevity and health risks, we may label this first component 'human development'. Another group of variables mainly exert their influence on shaping the second component: CAL, UNDERNOURISHMENT, and FDEFICIT. All of them are clearly linked to the intake of energy contained in food. The association is positive with UNDERNOURISHMENT and FDEFICIT, and negative with CAL. Accordingly, we may label this second component 'risk of suffering from hunger'. It means that we have extracted two basic dimensions out of a mass of information concerning food security-related indicators, one linked to the level of human development and the other to the risk of insufficient basic caloric intake. It is interesting to observe that some variables conditioning an adequate utilisation of food, like the access to sanitation and drinking water, appear well connected with other variables that represent income per head and the health situation of groups at risk, like children, while the three variables representative of food energy intake, - CAL, UNDERNOURISHMENT and FDEFICIT - are grouped together to form a single composite indicator.

The final step in the analysis is to calculate the scoring of each country in any of the two dimensions that we have been able to discover. We use Table 21, that informs us of the scoring coefficients which will act as weights for the original (standardised) variables in order to obtain the scores for components 1 and 2. Table 22 reports the ranking of countries according to each component. Lebanon tops the list for the first component, and Tunisia is the first MPC to appear, in the third position, followed by Egypt (7), Morocco (9) and Syria (12). Niger, Chad and Mali occupy positions at the bottom of the list. As was expected, the Arab countries and Turkey are clearly better positioned than Sub-Saharan countries in terms of human development. Concerning the second indicator the situation is more mixed. Some poor countries, like Burkina Faso, appear in a better shape than expected, concerning the risk of food deprivation in terms of caloric intake, even if they present a dismal performance concerning sanitary risks and the health situation of children. On the other hand, wealthier

countries as Morocco, Egypt, Algeria or South-Africa do not appear as well positioned concerning the satisfaction of the food needs of their populations as could be thought in accordance with their income per head. If the scale is constructed from lower to higher risk of food insecurity Turkey occupies the 8th position, followed by Syria (9), Tunisia (16), Egypt (19) and Morocco (21). Sierra Leone, Rwanda, Comoros, Eritrea and Burundi fill the bottom positions in this list.

Table 21 Component Score Coefficient Matrix

	Component	
	1.00	2.00
GNI	0.13	-0.04
CAL	-0.05	-0.31
UNDERNOURIS	0.18	0.44
FDEFICIT	0.20	0.46
LIFE	0.18	0.03
UNDERWEIGHT	-0.12	0.05
CHILDMORT	-0.22	-0.07
SANITATION	0.23	0.08
WATER	0.20	0.06
ADFERTILITY	-0.33	-0.25
Extraction Method: Principal Component		
Rotation Method: Varimax with Kaiser		
Component Scores.		

Source: Author's calculations

Table 22: Scores according to components 1 and 2

SCORES	COMPONENT 1	SCORES	COMPONENT 2
Lebanon	1.84	Burundi	2.55
Mauritius	1.74	Eritrea	2.41
Tunisia	1.62	Comoros	1.99
Turkey	1.59	Rwanda	1.50
Algeria	1.50	Sierra Leone	1.31
Libyan Arab Jamahiriya	1.49	Zimbabwe	1.17
Egypt	1.47	Ethiopia	1.11
Jordan	1.40	Congo	1.04
Morocco	1.12	Zambia	1.02
Comoros	1.11	Democratic Rep.Congo	0.97
Botswana	1.11	Togo	0.87
Syrian Arab Republic	1.04	Central African Republic	0.80
Swaziland	0.73	Angola	0.73
Djibouti	0.73	Djibouti	0.69
South Africa	0.70	Liberia	0.67
Burundi	0.61	United Republic of Tanzania	0.46
Rwanda	0.57	Gambia	0.45
Eritrea	0.51	Malawi	0.44
Gambia	0.44	Botswana	0.38
Zimbabwe	0.39	Madagascar	0.36
Namibia	0.34	Chad	0.33
Gabon	0.14	Mozambique	0.30
Togo	0.07	Sudan	0.16
Malawi	-0.04	Kenya	0.10
Congo	-0.09	Guinea-Bissau	0.00
Sudan	-0.26	Swaziland	-0.12
Senegal	-0.27	Niger	-0.17
Ghana	-0.27	Mauritius	-0.28
Zambia	-0.36	Senegal	-0.29
Lesotho	-0.40	Benin	-0.44
United Republic of Tanzania	-0.46	Namibia	-0.46
Kenya	-0.48	Morocco	-0.51
Liberia	-0.50	Cameroon	-0.59
Central African Republic	-0.52	Egypt	-0.59
Angola	-0.54	Algeria	-0.69
Benin	-0.58	South Africa	-0.70
Ethiopia	-0.63	Tunisia	-0.76
Cameroon	-0.63	Côte d'Ivoire	-0.83
Côte d'Ivoire	-0.66	Uganda	-0.83
Sierra Leone	-0.72	Lebanon	-0.86
Uganda	-0.89	Lesotho	-0.91
Madagascar	-0.95	Ghana	-0.92
Mozambique	-1.00	Jordan	-0.92
Mauritania	-1.00	Syrian Arab Republic	-1.06
Guinea-Bissau	-1.05	Turkey	-1.08
Democratic Rep.Congo	-1.11	Mali	-1.11
Guinea	-1.26	Nigeria	-1.13
Nigeria	-1.43	Burkina Faso	-1.15
Burkina Faso	-1.47	Libyan Arab Jamahiriya	-1.31
Niger	-1.52	Guinea	-1.31
Chad	-1.52	Gabon	-1.39
Mali	-1.65	Mauritania	-1.39

Source: Author's calculations

7. Conclusions

Food security is still an issue of paramount importance for many developing countries. While, in the past, this topic was predominantly analysed under the perspective of there being an adequate availability of food to cover the average needs of caloric intake, a more multifaceted approach is now commonly adopted. Not only availability, or other supply indicators, is taken under consideration, but access to food, and also stability in preserving this access, have entered the current definition of food security. Access represents the demand side of the problem of food security, and has to do with the effective endowment of economic rights which people can use to buy food. Plenty of supplies are not enough to warrant food security if people at risk lack the purchasing power to buy the food they need. A wide variety of factors may influence access, including income distribution and gender issues. Attention has also been paid to the ability of people to put their available food to good use, an important matter which is strongly linked to the quality of the social and institutional environment and personal and public health issues.

Food production per capita has increased enormously over the last fifty years, driven mainly by farming intensification and the use of new, more productive, crop varieties. These developments have recurrently disproved old Malthusian-style prophecies concerning mounting risks of global disequilibrium between food resources and population. Projections for the future are moderately optimistic concerning the likelihood of obtaining further increases in agricultural production, which will rest more on rising yields, and conversion of rain fed lands to irrigation, than on the net expansion of crop lands. Nevertheless, some areas of the globe have failed to perform as required to solve the food security problem, with Sub-Saharan Africa being the most prominent case. Political instability, rapid demographic growth, and macroeconomic mismanagement have combined to prevent agricultural development from fulfilling its double role of facilitating the creation of jobs in rural areas, and the corresponding purchasing power, and increasing domestic food supply. Recent food price rises have exposed the vulnerability of these economies to sudden increases in their food import bills.

The situation of the Arab countries in terms of food security is not particularly bad when compared with other regions of the developing world, but they still face a host of problems: scarce endowments of agricultural land and water, excessive food-import dependence, and the presence of some poverty-stricken rural zones. A World Bank

typology, which classifies developing economies according to their stage of agricultural development, has placed most Arab countries in the middle-of-the-way category of *transforming countries*. A specific issue for this type of countries is the great divide between the rural and urban conditions concerning incomes and poverty, as non-agricultural sectors now account for most of their economic growth.

Arab countries, as an average, import at least 50% of the calories they consume, which means that they are more exposed than other countries in the developing world to the volatility of agricultural commodity prices. To improve their food security they need to strengthen safety nets, enhance domestic food supply and improve rural livelihoods. Achieving these goals means that they would have to resort to higher farm productivity growth, as they face severe restrictions concerning the availability of natural resources – land suitable for farm production, water - which prevent the adoption of more extensive forms of agricultural development. The implementation of a regional agenda for R&D, specifically addressing the common needs of their agricultural sector, has also been highly recommended.

The need to establish priorities and draw global comparisons among countries has, in recent times, promoted the creation of composite indicators of food security, able to summarise a whole array of partial indicators. The Global Hunger Index (GHI) is one of the best known attempts to build up such indicators, and is currently being produced by the International Food Policy Research Institute to measure and track global hunger. The GHI is based on a combination of three equally weighted indicators: the proportion of the undernourished as a percentage of the population, the prevalence of underweight in children under the age of five, and the mortality rate of children under the age of five. Special attention is given to the situation of children, as they are highly vulnerable to a lack of nutrients, causing illness, poor physical and cognitive growth and, in some cases, death.

The Mediterranean Partner Countries (MPC) have experienced substantial progress, with regards to GHI, between 1990 and 2010. All of them are classed in 2010 in the category of countries with low hunger levels, with the exception of Morocco and Syria which appear with moderate hunger levels. Among them, Tunisia registers the best scores, and Morocco the worst. In this last country, the prevalence of underweight in children under five years has in fact increased between the average of 1988-92 and the average of 2003-08, to 9.9%.

Even if the GHI allows for a better representation of the multifaceted food security issue than a mere headcount of people suffering from hunger, it still leaves out many explanatory factors. A full appraisal of the topic requires the management of a huge amount of information concerning multiple economic, demographic, social and health indicators. To make sense of such a vast volume of data some statistical tools can be of help. In this paper, the usefulness of a multivariate technique, Principal Components Analysis, is expounded and illustrated with an exercise comprising 52 countries and a set of 13 variables, addressing different facets of food security. The main aim of adopting this methodology in this case is to summarise the information contained in the data in a small number of dimensions, or 'principal components'. The computation process has been described step by step, and has involved the deletion of some food security-related variables from the original set.

Two components have been finally retained and given an interpretation. It has been found that the following variables have strong links ('loads') with the first component: Gross National Income per head, life expectancy at birth, children's underweight, under five years child mortality rate, access to adequate sanitation facilities, access to drinkable and safe water supplies, and adolescent women's fertility rate. The relationship is positive with those variables for which an increase implies a rise in wellbeing, and negative with those for which higher levels of the variable are associated with a situation of low social and economic development and the presence of deprivation. Accordingly, we label this first component 'human development'. Another group of variables mainly exert their influence on shaping the second component: caloric intake, percentage of undernourished people, and food deficit. All of them are clearly linked to the intake of energy contained in food. The association is positive with variables measuring undernourishment and food deficit, and negative with caloric intake. Therefore, we label this second component 'risk of suffering from hunger'.

Countries in the sample have been ranked according to the aforementioned two components. The Arab countries and Turkey top the list concerning the 'human development' indicator – a sub-indicator of food security - with Tunisia, which occupies the third position, as the best positioned country among the MPC. Sub-Saharan countries are clearly more disadvantaged. The second sub-indicator, which measures the 'risk of hunger', gives rise to a more blurred ranking. Now some countries with a relatively high standard of living – within the African context – appear not as well-off as

expected. This is, for example, the case of South-Africa, which occupies the 17th position – in a scale from lower to higher risk - and also the case of some of the MPC.

Annex 1
Principal Components Analysis

Principal Components Analysis (PCA) aims to explain the total variability of a set of *p* correlated variables through the use of *p* orthogonal principal components. The components are weighted linear combinations of the original variables (i.e. the *x*). The first principal component can be expressed as follows:

$$C_1 = w_{11}x_1 + w_{12}x_2 + ... + w_{1p}x_p$$

Or, in matrix form, $C_1 = w_1'x$, where w_1 is the weight vector corresponding to component C_1. The variance of C_1 is λ_1.

The weights *w* are estimated such that two conditions are met:

1. The first principal component accounts for the maximum variance in the data
2. The square of the weights sum to one, in order to fix the scale of the new variable (component). Accordingly, and in matrix form: $w_1'w_1 = 1$

Next, the second principal component C_2 is computed, such that its variance, λ_2, accounts for the maximum variance that has not been accounted for by the first principal component. It must also fulfil the condition of being orthogonal to the first component, or $w_1'w_2 = 0$. The process of extracting components goes on until some stopping criteria, as accounting for a minimum amount of variance, is encountered, or until a total of *p* components are formed.

Computation of principal components may start from either the covariance matrix or correlation matrix of the *p* original variables. When the original variables adopt different scales the correlation matrix, *R*, is preferred. The problem consists now in finding the weight vector such that the variance $w_1'Rw_1$ of the new variable C_1 is maximum over the class of linear combinations of the original variables that can be formed subject to the constraint $w_1'w_1 = 1$. The final solution of the maximisation process is:

$$(R - \lambda I)w = 0$$

For the above system to have a nontrivial solution the determinant of $(R - \lambda I)$ should be zero:

$$\left|R - \lambda I\right| = 0$$

This equation has *p* roots (*p* values for λ). Each value of λ results in a *p*-component vector of weights by solving the following equations:

$$(R - \lambda_i I) w_i = 0$$

$w'_i w_i = 1$

The first component is given by the eigenvector w_1 corresponding to the largest eigenvalue λ_1. Afterwards the second *p*-component of weights, w_2, is obtained such that the variance of $C_2 = w'_2 x$ is maximum subject to the constraints $w'_1 w_2 = 0$, and $w'_2 w_2 = 1$. See Sharma (1996) for a more detailed explanation.

Annex 2

Database

	GNI	CAL	NDERNOURISHE	FDEFICIT	IRON	LIFE	NDERWEIGH	CHILDMORTS	ANITATION	WATER	ADFERTILITY	PARTICIPATION	GINI
Algeria	8.320,16	3.095,19	3,00	180,00	13,60	72,20	3,00	4,10	95,00	83,00	7,34	38,20	35,30
Angola	4.941,20	1.879,95	44,00	290,00	9,80	46,50	15,50	22,00	57,00	50,00	123,68	76,30	58,60
Benin	1.499,11	2.293,09	19,00	200,00	15,40	61,00	20,20	12,10	12,00	75,00	111,79	68,10	38,60
Botswana	13.204,19	2.203,27	26,00	240,00	14,70	53,40	8,40	8,40	60,00	95,00	52,13	75,10	61,00
Burkina Faso	1.214,83	2.619,83	9,00	170,00	24,20	52,70	37,40	16,90	11,00	76,00	130,90	79,70	39,60
Burundi	401,57	1.629,11	63,00	360,00	13,50	50,10	35,00	16,80	46,00	72,00	18,62	91,50	33,30
Cameroon	2.196,89	2.233,19	23,00	160,00	15,80	50,90	16,60	13,10	47,00	74,00	127,50	54,00	44,60
Central African Republic	757,85	1.896,84	41,00	280,00	12,30	46,70	24,00	17,30	34,00	67,00	106,62	71,60	43,60
Chad	1.066,75	1.980,30	38,00	290,00	18,00	48,60	33,90	20,90	9,00	50,00	164,42	64,00	39,80
Comoros	1.176,07	1.800,32	51,00	340,00	9,20	64,90	22,10	10,50	36,00	95,00	45,66	74,60	64,30
Congo	3.257,64	2.327,25	75,00	250,00	12,00	53,50	11,80	19,90	30,00	71,00	112,81	62,40	47,30
Côte d'Ivoire	1.624,86	2.515,69	14,00	190,00	11,10	56,80	16,70	11,40	23,00	80,00	129,93	51,30	48,40
Djibouti	2.471,38	2.260,00	31,00	220,00	10,20	60,73	30,10	9,50	56,00	92,00	22,98	63,20	39,90
Democratic Republic of the Congo	291,23	1.500,04	21,00	430,00	8,40	47,60	28,20	12,70	23,00	46,00	201,41	57,40	44,40
Egypt	5.889,20	3.316,77	3,00	230,00	17,70	69,90	6,80	2,30	94,00	99,00	39,02	24,40	32,10
Eritrea	643,41	1.532,68	66,00	350,00	13,20	59,20	35,30	5,80	14,00	61,00	66,87	61,60	43,80
Ethiopia	992,03	1.807,73	44,00	310,00	15,40	54,70	34,60	10,90	12,00	38,00	104,40	80,80	29,80
Gabon	12.746,55	2.761,39	3,00	140,00	15,50	60,10	8,40	7,70	33,00	87,00	89,91	71,70	41,50
Gambia	1.357,68	2.135,29	29,00	240,00	11,30	55,70	15,80	10,60	67,00	92,00	88,13	71,20	47,30
Ghana	1.385,47	2.687,00	8,00	160,00	14,00	56,50	14,30	7,60	13,00	82,00	64,04	75,20	42,80
Guinea	953,46	2.537,88	16,00	130,00	10,70	57,30	20,80	14,60	19,00	71,00	152,31	82,30	43,30
Guinea-Bissau	538,09	2.053,60	31,00	240,00	9,10	47,50	17,20	19,50	21,00	61,00	129,17	61,20	35,50
Jordan	5.955,98	2.822,27	3,00	110,00	11,20	72,40	3,50	2,00	98,00	96,00	24,54	24,70	37,70
Kenya	1.627,74	2.038,52	30,00	220,00	13,40	53,60	16,50	12,80	31,00	59,00	103,54	77,60	47,70
Lebanon	13.474,63	3.160,08	2,00	160,00	16,10	71,90	4,20	1,30	99,00	100,00	16,20	24,10	53,00
Lesotho	2.021,15	2.424,83	15,00	110,00	16,40	44,90	13,60	7,90	29,00	85,00	73,46	71,90	52,50
Liberia	319,81	2.008,29	38,00	310,00	11,70	57,90	20,40	14,50	17,00	68,00	141,57	69,10	52,60
Libyan Arab Jamahiriya	17.067,63	3.018,44	2,00	80,00	14,00	73,80	5,60	1,70	97,00	71,00	3,16	25,10	50,90
Madagascar	953,06	2.004,79	35,00	260,00	11,30	59,90	36,80	10,60	11,00	41,00	132,77	86,00	47,20
Malawi	910,97	2.132,29	29,00	290,00	16,20	52,40	15,50	10,60	56,00	80,00	135,24	74,60	39,00
Mali	1.171,31	2.566,36	10,00	210,00	18,70	48,10	27,90	19,40	36,00	56,00	162,90	38,10	39,00
Mauritania	2.118,32	2.784,83	8,00	130,00	13,30	56,60	19,40	11,80	26,00	49,00	90,00	60,40	39,00
Mauritius	13.343,58	2.884,90	6,00	230,00	13,20	72,10	12,40	1,70	91,00	99,00	39,30	46,30	38,50
Morocco	4.627,57	3.194,47	4,00	230,00	16,30	71,00	9,90	3,60	69,00	81,00	18,87	28,70	40,90
Mozambique	854,09	2.069,81	37,00	280,00	8,80	47,80	21,20	13,00	17,00	47,00	149,20	85,70	47,10
Namibia	6.323,11	2.294,16	19,00	140,00	14,00	60,40	17,50	4,20	33,00	92,00	74,41	53,50	74,30
Niger	675,38	2.136,99	28,00	250,00	23,50	50,80	32,90	16,70	9,00	48,00	157,37	37,90	43,90
Nigeria	2.156,50	2.602,75	8,00	190,00	19,60	47,70	26,70	18,60	32,00	58,00	126,58	39,50	42,90
Rwanda	1.190,34	1.941,48	40,00	330,00	17,40	49,70	18,00	11,20	54,00	65,00	36,71	87,90	46,70
Senegal	1.815,78	2.154,34	25,00	170,00	11,30	55,40	14,50	10,80	51,00	69,00	104,37	65,30	39,20
Sierra Leone	808,72	1.912,10	46,00	390,00	11,40	47,30	21,30	19,40	13,00	49,00	126,02	67,10	42,50
South Africa	9.812,13	2.900,18	5,00	210,00	14,30	51,50	10,10	6,70	77,00	91,00	59,16	51,00	57,80
Sudan	2.051,14	2.292,28	20,00	240,00	15,70	57,90	31,70	10,90	34,00	57,00	56,82	32,30	46,60
Swaziland	5.132,03	2.323,08	18,00	220,00	13,80	81,70	6,10	8,30	55,00	69,00	83,85	55,20	50,70
Syrian Arab Republic	4.759,93	3.009,70	4,00	130,00	13,30	74,10	10,00	1,60	96,00	89,00	61,10	22,00	40,50
Togo	843,78	2.018,39	37,00	280,00	13,10	62,20	20,50	9,80	12,00	60,00	64,78	64,60	34,40
Tunisia	7.979,31	3.275,03	1,00	190,00	15,70	73,80	3,30	2,10	85,00	94,00	6,88	27,70	40,80
Turkey	13.359,24	3.339,32	2,00	170,00	15,80	71,70	2,60	2,20	90,00	99,00	38,78	26,90	41,20
Uganda	1.224,06	2.385,17	15,00	190,00	14,50	51,90	16,40	13,50	48,00	67,00	149,95	80,50	42,60
United Republic of Tanzania	1.344,29	2.010,00	35,00	280,00	14,70	55,00	16,70	10,40	24,00	54,00	130,44	88,80	34,60
Zambia	1.358,52	1.886,52	45,00	330,00	11,30	44,50	14,90	14,80	49,00	60,00	141,80	60,40	50,70
Zimbabwe	176,17	2.036,72	39,00	310,00	14,30	43,40	14,00	9,60	44,00	82,00	64,63	60,80	50,10

Acknowledgments

Financial support from Sustainmed Program (FP 7- KBBE, European Commission) is gratefully acknowledged.

8. References

Abbot,P. (2009) “Development Dimensions of High Food Prices” *OECD Food, Agriculture and Fisheries Working Papers*, No.18, OECD Publishing, doi: 10.1787/222521043712.

Baum,M. (2004) “Agriculture and biotechnology in MENA” *Paper presented at the Regional Workshop on Biotechnology in the Middle East and North Africa*. September 29-30 Cairo (Egypt).

Barrett, Ch.B. (2010) “Measuring Food Insecurity” *Science* 327, pp.825-828.

Benson, T., Minot,N., Pender,J., Robles,M., von Braun,J. (2008) ”Global Food Crises. Monitoring and assessing Impact to Inform Policy Responses” *Food Policy Report*, International Food Policy Research Institute (Washington, D.C.).

Binswanger-Mkhize,H.P. (2009) “Challenges and opportunities for African agriculture and food security: high food prices, climate change, population growth, and HIV and AIDS” *Expert Meeting on How to feed the World in 2050*. Food and Agriculture Organization of the United Nations. Economic and Social Development Department.24-26 June 2009.

Boserup,E. (1965) *Conditions of agricultural growth: The economics of agrarian change under population pressure.* Aldine Publishing (New York).

Breisinger,C., van Rheenen,T., Ringler,C., Nin,A., Minot,N., Aragon,C., Bingxin,Y., Ecker,O., Tingju,Z. (2010). “Food Security and Economic Development in the Middle East and North Africa. Current State and Future Perspectives” *IFPRI Discussion Paper 00985. May 2010.* International Food Policy Research Institute.

Bruinsma,J. (2009) “The resource outlook to 2050. By how much do land, water and crop yields need to increase by 2050?” *Paper presented at the FAO Expert Meeting , 24-26 June 2009, Rome, on “How to Feed the World in 2050”.*

Diao,X., Hazell,P., Resnick D., Thurlow,J. (2006) “The role of agriculture in development: Implications for Sub-Saharan Africa” *DSG Discussion Paper 29*. International Food Policy Research Institute (Washington D.C.).

FAO (2008) *The State of Food Insecurity in the World*, FAO, Rome (Italy).

FAO (2010a) *The State of Food Insecurity in the World*, FAO (Rome, Italy).

FAO (2010b) “Impacts of the financial crisis on agricultural commodity markets” *Committee on Commodity Problems, Sixty-eight Session*, Rome 14-16 June 2010.

FAO (2010c) “Management of wide international commodity price movements. National and international experiences and policy responses” *Committee on Commodity Problems, Sixty-eight Session*, Rome 14-16 June 2010.

Hair,J.F., Black,W.C., Babin,B.J., Anderson,R.E., Tatham,R.L. (2006) *Multivariate Data Analysis (6th Edition).* Prentice Hall (Upper Saddle River, New Jersey, USA).

Hoddinott,J. (2002) “Targeting : Principles and policy” en J.Hoddinott (Editor) *Food Security in Practice.* International Food Policy Research Institute.

International Food Policy Research Institute (2010) *2010 Global Hunger Index. The Challenge of Hunger: Focus on the Crisis of Child Undernutrition.* IFPRI (Washington DC, USA).

Krueger, Anne O., Maurice Schiff and Alberto Valdés (1991*), The Political Economy of Agricultural Pricing Policy, Volume 1: Latin America, Volume 2: Asia, and Volume 3: Africa and the Mediterranean*, Baltimore: Johns Hopkins University Press for the World Bank.

Nardo,M., Saisana,M., Saltelli,A., Tarantola,S., Hoffman,A., Giovannini,E.(2008). *Handbook on Constructing Composite Indicators: Methodology and User Guide*. Joint Research Center, OECD, Paris.

Ndulu, B., Chakraborti, L., Lijane, L., Ramachandran,V., Wolgin,J. (2007) *Challenges of African Growth. Opportunities, Constraints and Strategic Directions.* The World Bank. Washington D.C. (USA).

OECD (2008b) *Biofuel Support Policies: An Economic assessment*. Organisation for Economic Cooperation and Development.

Plucknett,D.L. (1995) "Prospects of meeting future needs through new technology" en N.Islam (Editor) *Population and Food in the Early Twenty-First Century : Meeting Future Food Demand of an Increasing Population.* International Food Policy Research Institute.

Sen, A. (1981) *Poverty and Famines*. Clarendon (Oxford, UK).

Sharma, S. (1996). *Applied Multivariate Techniques*. John Wiley and Sons (New York, USA).

Valdés,A., Foster,W., Anríquez,G., Azzarri,C., Covarrubias,K., Davis,B., DiGiuseppe,S., Essam,T., Hertz,T., Paula de la O,A., Quiñones,E., Stamoulis,K., Winters,P., Zezza,A. (2010) "A Profile of the Rural Poor" *Background Paper for IFAD Rural Poverty Report 2010.*

Winters,P., Davis,B., Carletto,G., Covarrubias, K., Quiñones,E.J., Zezza, A., Azzarri,C., Stamoulis,K. (2009) "Assets, Activities and Rural Income Generation: Evidence from a Multicountry Analysis" *World Development* 37,9, pp.1435-1452.

World Bank (2006) "Sustaining Gains in Poverty Reduction and Human Development in the Middle East and North Africa" Social and Economic Development Group, Middle East and North Africa. The World Bank (Washington DC).

World Bank (2007) *World Development Report 2008.Agriculture for Development.* The World Bank (Washington D.C.).

World Bank (2008) Double Jeopardy: Responding to High Food and Fuel Prices *G8 Hokkaido-Tokayo Summit* (Japan). The World Bank (Washington D.C.).

World Bank (2009) *Improving Food Security in Arab Countries.* The World Bank (Washington DC.)